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Pannon University of Agriculture, Faculty of Animal Science, Kaposvár



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**PROCEEDINGS
OF THE
7TH INTERNATIONAL SYMPOSIUM**

'ANIMAL SCIENCE DAYS'

**THE PRESENT SITUATION, AND TASKS TO BE
ACCOMPLISHED IN ANIMAL PRODUCTION PRIOR TO
ENTRY INTO THE EUROPEAN UNION**

Edited by J. Csapó & Á. Kovách

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PRELIMINARY REPORTS



Strategie zur Entwicklung der Tierproduktion in Ungarn

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ZUSAMMENFASSUNG

Die Autoren fassen die in den vergangenen Jahrzehnten eingetretenen Veränderungen in der ungarischen Tierproduktion zusammen. Sie stellen fest, dass die Tierbestände bedeutend zurückgegangen sind. Die vorhandene Kapazität der ungarischen Tierhaltung wird gegenwärtig von den Wiederkäuern zu 35% ausgenutzt, von den mit Kraftfutter versorgten Tierarten zu 50%. Als wichtigste Schwerpunkte für eine Entwicklung werden genannt: Die Erzeugung von tierischen Produkten soll hauptsächlich auf inländischer Futterbasis beruhen und die gezüchteten Bestände sollen auch Sonderansprüche der Verbraucher befriedigen können. In diesem Interesse müssen züchterisch die Genotypen, die Geschlechter, die Aufzucht- und Mastdauer sowie die zahlreichen Elemente der Haltung und Fütterung optimiert werden. Bei der technologischen Entwicklung ist unbedingt auf die Einhaltung der Tierschutzbestimmungen und die Reduzierung des Wasserverbrauches zu achten. Es ist zweckmäßig, zwei verschiedene Entwicklungsstrategien zu verfolgen, eine für jene tierischen Produkte, die zur Konkurrenzsphäre gehören (Milchproduktion, Schweine- und Geflügelsektor) und eine andere für jene Bereiche, die auch Zielen in der Umwelt- und Sozialpolitik dienen (Rinder, Pferde usw.). Die Konzeption wird einmal am Beispiel der Schweinefleischproduktion, zum anderen am Beispiel der weidenden Tierarten dargestellt.

(Schlüsselwörter: Entwicklungsstrategie, Tierzucht, Schweinefleischproduktion, Weidenutzung)

ABSTRACT

Developing strategy in Hungarian animal production

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The main changes in the field of Hungarian animal husbandry during the past decades are summarised by the authors. It was established that the number of livestock decreased strongly, the level of ruminants being 35 per cent lower and that of non-ruminants 50 per cent lower than would be desirable. In the area of developing concepts the main aspects are: yield production must be based on an inland forage base; the breeding livestock should also be capable of satisfying the particular demands of the consumer. Therefore it is essential that genotype, sex and length of the growing and fattening period, together with a number of elements of the keeping system and feeding

regime used, be optimised. During technological development the aspects of animal protection and lower water consumption must also be borne in mind. Different recommendations should be made for strategies with respect to livestock belonging to the market sphere (milk production, pig and poultry sectors, etc.) and for livestock serving purposes not only in animal production but also with respect to environmental and social policy (cattle, horses, etc.). The concept is presented in detail: on the one hand, for the depiction of the market sphere, by the example of the strategy for pig production, and on the other hand, to illustrate the sphere which is not absolutely market-oriented, by the example of the strategy for grazing animals.

(Keywords: animal production, developing strategy, pig production, grazing animals)

EINFÜHRUNG

Die Wirtschaftsgeschichte der Länder mit entwickelter Agrarwirtschaft bestätigt, dass ohne eine auf hohem Niveau stehende Tierproduktion weder eine sich erhaltende Agrarwirtschaft denkbar ist noch eine gepflegte Umwelt bewahrt werden kann; auch die Probleme der Beschäftigungspolitik könnten nicht gelöst werden, und es würde auch zu keiner Erhöhung der produzierten Werte kommen.

Aus ökologischer Sicht dargestellt: Ohne eine entwickelte Tierproduktion wäre es nicht möglich, die durch die Sonnenenergie jährlich immer wieder neu entstehenden Vorräte an Biomasse zu einem Teil in wertvolle Produkte umzuwandeln bzw. die produzierten Getreideüberschüsse flexibler und wirksamer als heute zu nutzen.

Diese grob umrissene Darstellung bestätigt, dass die globale Situation der Tierzucht nicht nur fachliche Interessen berührt, sondern durch Tausende von Fäden mit der gesamten nationalen Wirtschaft verbunden ist.

Aus dieser Sicht ist es also eine schwere Belastung, dass die ungarische Tierzucht - die im Laufe unserer Geschichte über Jahrhunderte hinweg erfolgreich die Lebensmittelversorgung der Bevölkerung sicherte und eine unentbehrliche Rolle bei der Verbesserung des Außenhandelsgleichgewichts spielte - diese Aufgabe in der Gegenwart nicht mehr restlos erfüllen kann.

Die gegenwärtige Lage unserer Tierzucht ist in der Geschichte des XX. Jahrhunderts ohne jedes Beispiel. Der heute registrierte Tierbestand beträgt lediglich 50% des für unser Land charakteristischen Bestandes, ausgenommen. So lag z. B. in den Jahren 1911, 1938 und 1985 der registrierte Tierbestand immer über der 3-Millionengrenze (heute lediglich 1,6 Millionen).

Die Bestandsabnahme ist besonders bei den Tierarten auffallend, die mit Massenfutter versorgt werden und deren Bestand kaum 35% der Bestandszahl von 1938 beträgt. Die gegenwärtig niedrige Tierdichte kann langfristig zu einem schweren Hindernis bei der Erhaltung der ungarischen Agrarwirtschaft werden.

Neben dem Absinken des Bestandes erschweren noch zahlreiche andere, gesellschaftlich-wirtschaftliche Spannungen die Lage dieses Wirtschaftszweiges. Die nach der politischen Umgestaltung zustande gekommene zersplitterte Eigentumsstruktur, der hohe Anteil der nicht integrierten Kleinproduzenten sowie die Tatsache, dass zahlreiche Tieranlagen nicht über dazugehörige entsprechende Futteranbauflächen verfügen, sind objektive Nachteile gegenüber vielen EU-Mitgliedsländern. Darüber hinaus werden zu viele tierische Produkten für einen bereits gesättigten Markt erzeugt (EU, Schweiz). Jene Regionen in der Nachbarschaft dagegen, in denen eine ständige Nachfrage an tierischen Produkten vorhanden ist, sind von ihrer Zahlungsfähigkeit her gesehen unberechenbar.

STRATEGISCHE GRUNDPRINZIPIEN

In der Strategie zur Entwicklung der ungarischen Agrarwirtschaft ist eine überdurchschnittliche Entwicklung in Qualität und Quantität der Tierproduktion ein wichtiges Element, kombiniert mit dem Bestreben nach Vielseitigkeit und Flexibilität bei Veränderungen. Dieses Ziel ist ein nationales Interesse und damit unabhängig von einem Anschluss an die EU.

Bei der Entwicklung der Tierproduktion müssen unbedingt einige allgemeine Grundprinzipien berücksichtigt werden, was sich auf die Aufrechterhaltung bezieht, die Umweltbelastung auf ein Minimum beschränkt und eine gute Konkurrenzfähigkeit sichert.

- In Ungarn ist es zweckmäßig, tierische Produkte auf der *einheimischen Futterbasis* zu erzeugen und sich nur in geringem Maße auf den Import von Futterkomponenten zu stützen (einige hochwertige biologische Proteine, Aminosäuren, Enzyme, Futterergänzungstoffe oder -komponenten usw.).
- Mit einer *Erhöhung der Futterkosten* muss gerechnet werden (die jedoch im Preiswettbewerb bestimmend sind). Deshalb können in den marktorientierten Sektoren, die zur qualitätsgerechten Massenproduktion gehören und in denen die Konkurrenz sehr groß ist (Milchprodukte, Schweine- und Geflügelproduktion), nur solche Rassen, Genotypen und Technologien angewendet werden, die von der Futterverwertung und der Wirtschaftlichkeit her gesehen am günstigsten sind.
- Diese Strategie - übertragen auf eine Produkteinheit - sichert auch ein Minimum an durch Düngung verursachter Umweltbelastung und verringert weiterhin die Emission schädlicher Gase in die Atmosphäre.
- Der *Wasserverbrauch* ist bei der Herstellung tierischer Erzeugnisse in allen Bereichen rationell zu *verringern*, einerseits wegen der zu erwartenden Erhöhung der Wasserkosten und andererseits wegen der Erschöpfung der Wasservorräte. Auch ein verminderter Wasserverbrauch bedeutet eine geringere Umweltbelastung (Statt Gülle Tiefstreu).
- Bei der technischen Entwicklung der Tierhaltungsanlagen erhalten in Zukunft die *Gesichtspunkte des Tierschutzes* ein größeres Gewicht. Es muss allerdings darauf geachtet werden, dass einige - sogenannte tierfreundliche - Technologien keine erhöhten gesundheitliche Gefahren für die tierbetreuenden Menschen bedeuten.
- In allen Tierproduktionsbereichen ist es notwendig, sich mehr auf die Herstellung von Produkten für *besonderen Verbraucheransprüche* zu konzentrieren, und zwar durch Optimierung des Genotyps, des Geschlechts, der Mast, der Aufzuchtzeit und der Fütterung sowie durch die vielen Elemente der Haltungstechnologie.

Die hier aufgezählten Punkte treffen nicht auf solche Bereiche der Tierproduktion zu, die sich den ökologischen Bedingungen anpassen oder zur Befriedigung spezieller, aber auch zahlungsfähiger Verbraucheransprüche dienen, d.h. die nicht zur Massenproduktion für die breite Verbraucherschicht bestimmt sind.

Aus all diesem ist klar zu ersehen, dass zur Entwicklungsstrategie und zur Schaffung von Regelungen in der Tierproduktion die Trennung in zwei große Gruppen notwendig ist.

Zur *ersten Gruppe* gehören jene Bereiche, deren Hauptziel eine qualitätsgerechte Massenproduktion ist - die auch schon heute existiert - und bei der sich in absehbarer Zeit globalisierende Tendenzen zeigen. Diese Bereiche gehören ausgesprochen zur

Konkurrenzsphäre, und bei ihrer Entwicklung ist die einzig in Frage kommende Strategie die internationale Konkurrenzfähigkeit und Wirksamkeit, wobei grundlegend alle übrigen Gesichtspunkte außer Acht gelassen werden. Halten wir uns nicht an diesen Grundsatz, werden uns mit Sicherheit die Konkurrenten auch noch vom Inlandsmarkt verdrängen.

In dieser Gruppe sind aufzuführen die Milchproduktion, die Schweinefleischproduktion und die Geflügelfleischproduktion mit ihren verschiedenen Bereichen (Broiler, Puten, Enten, Eierproduktion).

Zur zweiten Gruppe gehören die *nicht unmittelbar zur Konkurrenzsphäre* zählenden Bereiche. Ausschlaggebend dafür sind z.B. das charakteristisch Ungarische, oder eine besonders *umweltfreundliche Bewirtschaftung* während ihrer Entwicklung. Hierzu gehören alle weidenden Tierarten, um die reichlich vorhandenen Weideflächen in Ungarn besser zu nutzen. Auch Landschaftsgestaltung, Touristik, Beschäftigungspolitik und regionale Entwicklung spielen eine wichtige Rolle, was nicht unmittelbar eine direkte Konkurrenzfähigkeit für ein gegebenes Produkt bedeutet (z.B. höherer Ertrag bei Obst durch die Bestäubung der Bienen gegenüber dem Handelsprodukt Honig). In die zweite Gruppe gehören somit Schafe, Fleischerinder, Pferde, Gänse, Fische, Kaninchen, Bienen und gezüchtete Wildtierarten.

Überschneidungen zwischen den beiden Gruppen sind vorhanden und wird es auch weiterhin geben, teilweise auch abhängig vom Volumen der einzelnen Bereiche.

Das Realisieren der Grundprinzipien für die vorgestellten Strategien in den einzelnen tierzüchterischen Bereichen macht natürlich das Abwägen und Überdenken zahlreicher anderer Umstände notwendig. Dadurch wird das Erarbeiten von Konzeptionen zur Bereichsentwicklung ziemlich kompliziert. Wegen der zeitlichen Begrenzung werden jetzt für jede Gruppe die Entwicklungsvorstellungen eines Bereiches vorgestellt:

- die zur ersten Gruppe und damit zur Konkurrenzsphäre gehörende Schweinefleischproduktion,
- die zur zweiten Gruppe gehörende und damit nicht direkt der Konkurrenz unterliegende Tierproduktion mit Weidenutzung, die die Spezialität dieser Bereiche gut illustriert.

SCHWEINEFLEISCHPRODUKTION

Die bis zur Mitte der 80-er Jahre anhaltende dynamische Entwicklung in diesem Bereich bestätigte, dass unser Land fähig ist, auf seiner Getreideproduktion und einer zahlungsfähigen Nachfrage basierend, einen Inlandsbedarf von 40-45 kg pro Kopf plus 30% Exportbedarf zu befriedigen, was mit einer Haltung von 10 Mill. Schweinen zu erreichen ist.

Aufgrund der schlechteren Wirtschaftsbedingungen begann im zweiten Halbjahr 1987 ein ständiges Absinken des Tierbestandes. Der große Absturz in der Bestandszahl begann in den ersten 90-er Jahren. Mit der politischen Wende und der damit verbundenen Umwandlung der Eigentumsstruktur wurde gleichzeitig das Integrationssystem zerstört. Das Einführen der freien Preise, mangelnde Informationen und der Verlust an inländischen und ausländischen Märkten hatten die völlige Aufhebung der Stabilität und der Vorausplanung zur Folge.

Durch die entstandenen Absatzprobleme und die Zwangsmaßnahmen in der Tierhygiene sank der Tierbestand zwischen 1991 und 1995 sehr stark ab - auf das

Niveau des Jahres 1960. Damit ergab sich die Situation, dass in der EU zwischen 1987 und 1995 eine Bestandserhöhung von 3,8% zu beobachten war, aber in Ungarn eine Bestandsverringerung um 38,6% eintrat.

Dieser außerordentliche Rückgang des Schweinebestandes in den letzten Jahren ging leider nicht mit einer Bestandskonzentration einher und auch nicht mit einer Verbesserung der Qualitätsparameter. Gründe dafür sind die Eigentumsveränderungen, die häufige Unwissenheit der neuen Eigentümer, Mangel an gezüchtetem Nachwuchs, Verzicht auf wertvolle Futtermittel aus Sparsamkeit sowie eine außerordentlich veraltete Haltungstechnologie und -ausrüstung.

Aus den aufgeführten Gründen und auch wegen der mehr auf Quantität gerichteten Produktionsziele sind die heutigen Produktionsparameter bedeutend schwächer als der europäische Durchschnitt. Die zurückgebliebenen Leistungen in der ungarischen Schweineproduktion, die gleichzeitig die Produktionskosten bestimmen, gehen aus *Tabelle 1* hervor.

1. Tabelle

Leistungsvergleich in der Schweineproduktion (Wittmann, 1997)

	(1) Entwöhnte Ferkel/Sau pro Jahr	(2) Tägliche Zunahme während der Mast g/Tag	(3) Futtermittelverbrauch kg/kg	(4) Fleischanteil %
Dänemark (5)	22,00	730	2,90	59,90
Deutschland (6)	18,60	641	3,01	56,00
Ungarn, Groß-betriebe (7)	15,75	520	3,60	50,07

Table 1.: Comparison of pig production in different countries

Weaning piglet/sow/year(1), Daily gain during the fattening (g/day)(2), Feed conversion(3), Meat (%) (4), Denmark(5), Germany(6), Hungary(big farms)(7)

Schwerpunkte zur Entwicklung der Schweineproduktion

- In der Schweineproduktion liegt der Hauptschwerpunkt sowohl kurz- als auch langfristig in erster Linie auf den Leistungen, der Wirksamkeit und Verbesserung der Qualität, was zu einer besseren Konkurrenzfähigkeit im In- und Ausland führt. Mit verbesserten Produktionskennziffern kann neben einer unveränderten Anzahl von Sauen ein Produktionswachstum um 15-20% sowie ein entsprechendes Niveau bei Vermehrung, Gewichtszunahme und Fleischanteilen erreicht werden. Es ist zu überlegen, ob eventuell eine Mast mit höherem Endgewicht als gegenwärtig anzustreben wäre (aus vielen, hier nicht detailliert aufzuführenden Gründen). Auf jeden Fall deckt das erwähnte Wachstum den übrigens zu erwartenden langsamen Anstieg des Inlandsverbrauches, hat aber auch gleichzeitig - durch die Verbesserung der Parameter - eine billigere Produktion und eine Verbesserung der Qualität zur Folge, was mit einer Erweiterung der Exportmärkte einhergehen kann.

- Zur Entwicklung und Organisation des Schweine-sektors sind unbedingt strukturelle Veränderungen erforderlich, die sich gleichzeitig eng an die technische Entwicklung sowie an das Investitions- und Rekonstruktionsprogramm anpassen.

Die Entwicklung der landwirtschaftlichen Betriebe, die gegenwärtig im Voll- oder Nebenerwerb Schlachtwaren erzeugen sowie die Kleinwirtschaften, die zur Selbstversorgung produzieren, muss unter Berücksichtigung des zur Verfügung stehenden finanziellen Rahmens so gesteuert werden, dass eine Konzentration und eine integrierbare qualitätsgerechte Schlachtwarenproduktion in zufriedenstellendem Volumen erreicht wird.

Die Unterstützung der Entwicklung kann - abhängig von den zur Verfügung stehenden Quellen - einmalig oder stufenweise je nach Vorrang erfolgen. Wird die Entwicklung stufenweise durchgeführt, sind folgende Schritte zu empfehlen:

Als erster Schritt ist eine Rekonstruktion der vorhandenen Produktionsanlagen zweckmäßig, so dass eine Mindestkapazität von 200-300 Sauen bzw. 4.000-5.000 Mastschweinen möglich ist. Vorteil der Rekonstruktion:

- Konzentration
- Integrierbarkeit
- Ausnutzung der vorhandene Infrastruktur und
- der zur Verfügung stehenden Fachkenntnisse

Als zweiter Schritt wird empfohlen, jene Betriebe zu entwickeln, die gegenwärtig kleinere Bestände als Nebenerwerb halten. Ergebnis ihrer Entwicklung:

- Schaffung der Voraussetzungen zum Integrieren in Produktionsketten
- Konzentration der Kleinproduktion

Für die Entwicklung ist es zweckmäßig, ein ungarisches „Segregated Early Weaning“-Programm zu erarbeiten, wo neben einer früheren Entwöhnung - die aber den Tierschutzvorschriften der EU entspricht - die Ferkelerzeugung, die Läuferaufzucht und die Mast in spezialisierten Betrieben stattfindet.

- Unter Beachtung der biologischen Basis ist die Entwicklung sowohl in den Zuchtbeständen unter Herdbuchführung als auch in den Produktionsbeständen so zu steuern, dass mit den potentiell zur Verfügung stehenden Rassen und Kreuzungskonstruktionen unter entsprechenden Bedingungen
- ein Fleischanteil von 56-58% mit guter Qualität garantiert ist,
- die Zunahme pro Masttag 800-900 g/Tag beträgt,
- der Futterverbrauch nicht höher ist als 2,6-2,9 kg pro kg Körpergewicht und dass
- jährlich 20-22 entwöhnte Ferkel pro Sau aufgezogen werden.

PLAN ZUR ENTWICKLUNG VON TIERARTEN AUF DER BASIS VON WEIDENUTZUNG

Ein besonderer Schwerpunkt unter den zahlreichen wichtigen Elementen unserer Agrarstrategie ist die Bestandserhöhung der Wiederkäuer bzw. Tierarten mit Weidenutzung. Hintergrund dieser Bemühungen sind gleichzeitig wirtschaftlicher als auch gesellschaftlicher Natur. Ohne Anspruch auf Vollständigkeit sind hier aufzuführen:

- eine bessere Ausnutzung der ökologischen Gegebenheiten (Biomasse)
- Verwirklichen von Konzeptionen für Landschaftsgestaltung und Umweltschutz
- Erweiterung der exportfähigen Warenpalette (Schlachtlämmer und -rinder)

- Erzeugung von Produkten mit besserer Qualität (Fleischfohlen, Farmhirsch usw.)
- Förderung der regionaler Entwicklung und der Beschäftigungspolitik

Die aufgeführten Ziele können allein durch marktgerechte Mittel nicht realisiert werden, denn hier handelt es sich um gesamt gesellschaftliche Ansprüchen, die einer Unterstützung durch den Staatshaushalt bedürfen.

Zur Realisierung der Ziele ist ein Überblick notwendig, um die unterschiedlichen Alternativen der Weidehaltung dahingehend beurteilen zu können, welche Entwicklung in welchen Gebieten und in welchen Schritten sinnvoll ist. Die Möglichkeiten dazu zeigt *Tabelle 2.*

2. Tabelle

Entwicklungsmöglichkeiten für die Tierhaltung mit Weidenutzung

(1) Bezeichnung	1998	(2) 2005 voraus- sichtlich	(2) 2010 voraus- sichtlich	(3) Veränderung
<u>Mutterschafe</u> (4)				
Bestand tausend Stück (5)	630	1.500	2.000	+1.400
Bedarf an Weidefläche tausend ha (6)	250	600	800	+500
<u>Fleischrinder</u> (7)				
Bestand tausend Stück (5)	25	100	150	+125
Bedarf an Weidefläche tausend ha (6)	30	120	180	+150
<u>Jungrinder</u> (8)				
Bestand tausend Stück (5)	180	200	230	
Bedarf an Weidefläche tausend ha (6)	110	120	140	+30
<u>Zweinutzungsrinder (Fleckvieh)</u> (9)				
Bestand tausend Stück (5)	70*	50	50	-20
Bedarf an Weidefläche tausend ha (6)	50	50	50	±0
<u>Alternative Tierarten mit Weidenutzung</u> (10) (Fleischpferde, Hirsche, Ziegen usw.)				
Bestand tausend Stück (5)	10	20	30	+20
Bedarf an Weidefläche tausend ha (6)	8	16	24	+16
Gesamtbedarf an Weidefläche tausend ha (11)	450	900	1.150	+ 750
Heubedarf für nicht weidende Tiere (Milchrinder, Sportpferde) tausend ha (12)	200	200	200	±0
Weideflächenbedarf insgesamt, tausend ha (13)	1.200	1.500	1.700	+500
Ausnutzung der Weideflächen % (14)	55	70	80	+30

* Wahrscheinlich gibt ein Teil der Tierhalter das Melken auf und stellt auf Fleischrinderhaltung um

Table 2.: Alternatives in developing grazing animals

Denomination(1), Expected(2), Changes(3), Ewe(4), 1000 number(5), 1000 ha(6), Beef cattle(7), Yearling heifers(8), Dairy cows (dual purpose)(9), Non traditional animals(10), Total grasland of grazing animals (1000 ha)(11), Hay consumption of non grazing animals(12), Total grasland (1000 ha)(13), Utilization of graslands %(14)

Schafzucht

Unter den Weidetieren haben unbestreitbar die Schafe den Vorrang, so dass die Entwicklung dieses Bereichs Priorität hat. Aufgrund der Spezialität der Schafe können sie auch meist auf den ungarische Weideflächen existieren, und das auch noch in dem Falle, wenn es im Niveau der Weidewirtschaft keine großen Fortschritte geben sollte. Sie passen sich gut jeder Eigentumsstruktur an, besonders dort, wo der Anteil der individuellen und Familienfarmen im Anstieg begriffen ist. Sie haben innerhalb der Tierzucht einen relativ kleinen Investitionsaufwand und sichern ein annehmbares Einkommen. Von der Marktsituation her betrachtet sind Schafprodukte als günstig einzustufen, da sie fast ausschließlich exportiert werden.

Ungarn kann schon seit Jahren die Lämmerquote im Export in die EU-Mitgliedsländer mit ermäßigtem Zoll nicht befriedigen. Dazu müsste der gegenwärtige Schafbestand um mehr als das Doppelte höher liegen. Der Export von Schafmilch bzw. Milchprodukten ist praktisch nicht begrenzt.

Es ist somit klar, dass die Entwicklung eines höheren Bestandes an Mutterschafen eine dringende und unaufschiebbare Aufgabe ist. Die ökologischen Voraussetzungen dafür sind vorhanden, lediglich die biologischen Faktoren und das Maß der Kapitalversorgung bedeuten Grenzen. Im Interesse einer schnelleren Entwicklung halten die meisten analytischen Studien zu diesem Thema einen bedeutenden Zuchttierimport (mehrere hunderttausend) für notwendig. Damit könnte der Mutterschafbestand bis zum Jahre 2005 auf 1,5 Millionen, bis 2010 auf 2 Millionen erhöht werden. Diese dynamische Bestandsentwicklung hätte eine sehenswerte Verbesserung in der Nutzung der Weideflächen zur Folge, d.h. es könnte fast eine halbe Million ha Weidegebiet, das gegenwärtig nicht genutzt wird, in die Erzeugung von tierischen Produkten einbezogen werden. Es stehen bereits heute nicht nur die genannten Weideflächen zur Verfügung, sondern es kommen noch jene Flächen für dieses Programm dazu, die nicht mehr kultiviert werden.

Fleischrinder

Die Fleischrinder sind für die extensive Weidenutzung eine gute Alternative und sind damit ein entwicklungsstrategisch wichtiges Element. Als Grund für die Entwicklung sind gleichermaßen sowohl markttechnische als auch global-ökologische Gesichtspunkte ausschlaggebend.

Schlachtrinder sind für Ungarn ein traditioneller Exportartikel, obwohl das Exportvolumen in den letzten Jahrzehnten außerordentlich zurückgefallen ist. Im Vergleich zum Durchschnitt der Jahre 1986-1990 ist eine Bestandsverminderung 59% festzustellen, und infolge der Verbreitung der Milchrasen sank der Exportwert unter jährlich 100 Mill. USD ab. Die gesamte Schlachtrindererzeugung ging auf den übrigens sehr bescheidenen Pro-Kopf-Verbrauch im Inland von 6-7 kg zurück.

Es muss auch zur Kenntnis genommen werden, dass die BSE-Seuche auf dem Exportmärkten einen Rückgang der Nachfrage verursachte und sich außerdem noch ungünstig auf die Preise auswirkte. Trotzdem ist ein Schlachtrind von guter Qualität unter hygienisch einwandfreier, kontrollierten Haltung, vielleicht als Ergebnis einer ökologischen Bewirtschaftung mit Sicherheit zu vermarkten und bietet eine gute Grundlage zur Entwicklung eines Fleischrinderbestandes, das solche Produkte garantiert.

Zur Nutzung der verstreut liegenden Weideflächen ist das Fleischrind gut für Familienbetriebe geeignet, obwohl es wegen seiner bescheidenen Einkommensbildung hauptsächlich zur Ergänzung des Einkommens dient. Trotzdem kann die

Fleischrinderhaltung in benachteiligt liegenden Regionen für die Beschäftigungs- und Sozialpolitik ein wichtiges Element sein.

Auch vom global-ökologischen Gesichtspunkt aus ist die Entwicklung der Fleischrinderhaltung vorteilhaft, da von ca. 1 Mill. ha Maisanbaufläche die Pflanzenreste nach der Ernte zu einem Teil von den Fleischrindern gut genutzt werden (Stoppelackerweide).

Zusammengefasst sind also die Bemühungen der Regierung zur Entwicklung der Fleischrinderhaltung begründet, und es werden zu diesem Zweck auch Subventionen zur Verfügung gestellt.

Das Entwicklungstempo wird jedoch durch die spezifischen Eigenschaften der Tierart stark eingeschränkt. Mit einem höheren Import von Zuchttieren kann wegen fehlender Mittel nicht gerechnet werden. Beschleunigt werden könnte die Bestandserhöhung der Fleischrinder durch die teilweise Nutzung des Ungarischen Fleckviehbestandes als Fleischrind. Die in großer Anzahl vorhandenen individuellen Kuhhalter (ca. 50.000), die 1-3 Kühe halten, stehen vor einer Entscheidung. Ein kleinerer Teil - neben entsprechender Kapitalversorgung und günstigen ökologischen Bedingungen - wird sich zur Entwicklung einer Milchfarm mit 20-50 Kühen entschließen, die Mehrheit jedoch ist gezwungen, mit dem Melken aufzuhören.

Der sich in ihrem Eigentum befindliche - meistens aus Fleckvieh bestehende - Bestand ist bei Anwendung eines entsprechenden Zuchtprogrammes für eine wirtschaftliche Fleischrinderhaltung geeignet. Voraussetzung für eine erfolgreiche Bewirtschaftung ist aber auch in diesem Falle eine gewisse Bestandskonzentration (mindestens 20-30 Mutterkühe) und eine entsprechende Weidefläche.

Zur Entwicklung einer weibliche Population für die Fleischrinderhaltung kann man auch außer den bereits erwähnten Möglichkeiten die modernen zuchttechnischen Methoden anwenden (Vornutzung von Schlachtfärsen, Baby-Kuh-Verfahren).

Zusammengefasst kann also die Entwicklung der Fleischrinderhaltung sowohl kurz- als auch mittelfristig innerhalb der biologischen Grenzen nur mäßig schnell entwickelt werden kann, und dazu ist noch eine abgestimmte Zusammenarbeit zur Sicherung der langfristigen Interessen mit bedeutenden Subventionen notwendig.

Wir halten eine Bestandszahl von 100.000 Fleischrindern bis zum Jahre 2005 für möglich, die bis zum Jahre 2010 auf 150.000 Tiere gesteigert werden könnte. Die dazu erforderliche Weidefläche von fast 150.000 ha steht zur Verfügung und es besteht nicht die Gefahr, dass die durch Fleischrinder genutzten Weiden die Entwicklung von anderen Weidetieren (z.B. Schafe) beeinträchtigen könnte.

Jungrinder

In der Jungrinderaufzucht ist das Weiden der Tiere im Sommer eine fachliche Erfordernis. Davon ausgehend ist also der Jungrinderbestand in der Weidenutzung ein ziemlich stabiles und gut zu planendes Element. Zur Remontierung des gegenwärtigen Milchkuhbestandes von 400.000 Tieren werden ca. 120.000 Jungrinder benötigt, bei deren Aufzucht eine Weidefläche von 100-110 tausend ha genutzt wird. Veränderungen sind hauptsächlich von der Kuhzahl abhängig. Falls sich die geplante Entwicklung des Fleischrinderbestandes realisiert, hat das Einfluss auf den Nachwuchs an Zuchtfärsen und weiterhin auf die vom Jungrinderbestand gebundene Weidefläche. In diesem Zusammenhang darf jedoch nicht übersehen werden, dass gleichzeitig mit der Entwicklung der Fleischrinderzahl ein Rückgang an Milchkühen prognostiziert werden kann. Werden diese beide Einflüsse zusammen beachtet, muss 2005 mit ca. 20.000, im

Jahre 2010 mit ca. 50.000 mehr weidenden Jungrindern gerechnet werden, was aber die notwendige Weidefläche nur in geringem Maße, um ca. 30.000 ha erhöht.

Verändern kann sich die Größe der genutzten Weidefläche durch den Jungrinderbestand auch dann, wenn über den Nachwuchsbestand an Zuchttieren hinaus noch eventuell die gegenwärtigen Mastfärsen vorgenutzt werden (Schlachtfärsenvornutzung). Die diesbezüglichen Forschungen und Erfahrungen in der Praxis bestätigten, dass bei spezieller Aufzucht und Abkalbung der Schlachtfärsen zusätzlich Kälber gewonnen werden können. Gleichzeitig kann mit diesen einmal abgekalbten Färsen (Vornutzungsfärsen) sowohl als Schlachttier als auch potentiell Fleischrind-Grundmaterial gerechnet werden. Dies würde den Vorstellungen zur Entwicklung des Fleischrinderbestandes sehr entgegenkommen.

Vom Standpunkt der Weidenutzung her gesehen ist wichtig, dass neben den Zuchtfärsen auch noch die Vornutzungsfärsen geweidet werden. Deren Anzahl könnte auf ca. 100.000 veranschlagt werden, wodurch eine mittlere bzw. gute Weide von etwa 60.000-80.000 ha gebunden wäre.

Zusammengefasst kann also festgestellt werden, dass mit der Entwicklung der Jungrinderaufzucht die Nutzung der Weideflächen in bescheidenem Maße erhöht werden kann.

Neben der quantitativen Entwicklung der auf Weidenutzung basierenden Zuchtfärsenaufzucht müsste größeres Gewicht auf den jeweils günstigsten Standort für die Aufzucht gelegt werden. Die Urweiden in den Hügellgebieten sind zur Zuchtfärsenaufzucht am geeignetsten, und diese sind hauptsächlich in Mitteltransdanubien, Nordungarn und Südtransdanubien (Zselic und Zala) zu finden. Leider kann gegenwärtig noch nicht von solcherart Gebietsaufteilung gesprochen werden. Die größeren Betriebe bemühen sich, ihren eigenen Zuchtnachwuchs zu erzeugen, unabhängig davon, ob sie über die entsprechenden Weideflächen verfügen oder nicht. Diese Situation ist jedoch weder im Sinne der ökologischen Bewirtschaftung noch der Qualität der Zuchttiere.

In den Kleinbetrieben sind die Möglichkeiten zur Zuchttieraufzucht noch weniger gegeben, und für diese ist der Kauf von trächtigen Färsen eine einfachere und billigere Lösung. Da der Anteil der Kleinbetriebe zukünftig noch ansteigen wird, wäre es zweckmäßig, Zentren zur Zuchtfärsenaufzucht (Unternehmen) zu gründen in einer dafür ökologisch geeigneten Region. Das wäre vom züchterischen Standpunkt und auch von der ökologischen Weidenutzung her gesehen günstiger. Im Ausland gibt es für diese Arbeitsaufteilung bereits erfolgreiche und gut funktionierende Beispiele (Alpen als Region zur Aufzucht von Zuchtnachwuchs).

Dieser Themenkreis geht natürlich über die Frage der Weidenutzung hinaus und greift bereits auf die strukturelle Umgestaltung der Rinderhaltung über.

Alternative Tierarten mit Weidenutzung

Neben den herkömmlichen weidenden Tierarten gibt es in den letzten Jahrzehnten zahlreiche neue, früher nicht als Nutztiere gehaltene Tierarten. Mit ihnen werden Versuche durchgeführt, ob sie zur Nutzung von Weideflächen und zur Erzeugung von marktfähigen Produkten geeignet sind.

Unter diesen ist besonders der Rothirsch (Farmhirsch), das Fleischpferd sowie Ziegen usw. erfolgreich. In Zukunft muss man mit einer Erweiterung solcher Initiativen bzw. einer Verbreitung der jetzt vorhandenen rechnen in Abhängigkeit davon, wie sich die neuen Produkte auf dem Markt behaupten.

Von der Weidenutzung her gesehen sind diese Bemühungen sowohl in Quantität als auch in Qualität sehr wertvoll. Sie erhöhen die Nutzung der Weideflächen, obwohl anfangs in nur bescheidenem Maße, d. h. kurz- und mittelfristig werden nur einige tausend ha Weidefläche mehr benötigt. Auf alle Fälle dienen sie aber einer ökologischeren Bewirtschaftung, da sie umweltfreundlich und ohne Chemikalien sind und auch im Rahmen einer Biowirtschaft angewendet werden können.

Zusammengefasst muss die Weidehaltung also in Zukunft differenziert und unter Beachtung der ökologischen Bedingungen und Marktverhältnisse entwickelt werden.

Der Entwicklungsschwerpunkt liegt hauptsächlich auf der Schafzucht, gefolgt vom der Fleischrinderzucht.

Die parallele Entwicklung dieser beiden hervorgehobenen Bereiche wird nicht durch die vorhandenen Weideflächen begrenzt, denn die in der Bodenkultur eingetretenen Veränderungen haben eine Erweiterung der Weideflächen zur Folge. Durch eine kontinuierliche Entwicklung der weidenden Tierarten kann die Ausnutzung der Weideflächen von gegenwärtig 55% sogar auf 80% verbessert werden. Das hat über die reine Produktionsentwicklung hinaus noch einen günstigen Einfluss auf die Landschafts- und Umweltbewirtschaftung und hilft mit, in den benachteiligten Landesregionen den dort lebenden Bevölkerungsgruppe zu einem Arbeitsplatz zu verhelfen.

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Production and evaluation of the quality of meat and milk in the Republic of Croatia

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ABSTRACT

The Republic of Croatia has favourable conditions for the development of animal production. The analysis of the current position takes into account the period from 1990 to 1998, especially from the aspect of meat and milk production. The data show that because of the war in 1991/1992 the number of cattle declined by 46.6%, that of pigs by 25.9% and that of poultry by 41.8% in the period analysed. In the process of the restoration of animal production not only should the number of animals should be increased, but production technology and the choice of appropriate genotypes of animals and the efficiency of production systems should also be improved. In this review activities which influence the enhancement and more rapid development of animal production, such as orientation towards family farming, breeding techniques and government support for the production programmes, are emphasised. With the transition to a market economy the grading of animal products has become a very important task. The Croatian government is drafting new legislation which includes indicators of quality in the payment system. This should influence more rapid progress in the production of some kinds of meat and milk as well as in achieving an increase in product quality.

(Keywords: production, evaluation, meat, milk, quality)

ZUSAMMENFASSUNG

Entwicklung einer qualitätsgerechten Fleisch- und Milchproduktion in der Republik Kroatien

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Kroatien hat gute Voraussetzungen zur Entwicklung seiner Tierproduktion. Die Analyse der Tierproduktion – besonders die Fleisch- und Milchproduktion – erstreckt sich auf den Zeitraum von 1990 bis 1998. Die Daten zeigen, dass infolge des Kriegszustandes gegenüber den Jahren 1991/1992 der Rinderbestand um 46,6 %, der Schweinebestand um 25,9 % und der Geflügelbestand um 41,8 % zurückfiel. Bei der Gelegenheit zur Erneuerung der Tierbestände muss darauf geachtet werden, nicht nur die Bestandszahlen, sondern auch die Produktionstechnologie zu entwickeln, d.h. den

entsprechenden Genotyp auszuwählen und die Rentabilität der Produktion zu verbessern. Schwerpunkte sind also Verbesserung und schnelle Entwicklung der Tierproduktion, die Belegung der Familienbetriebe, Anwendung moderner Zuchtmethoden und Unterstützung einiger Zuchtprogramme. Seit Einführung der Marktwirtschaft spielt eine gute Qualität bei tierischen Produkte eine besonders große Rolle. Die kroatische Regierung berücksichtigte in ihrer neuen Gesetzgebung bereits Qualitätsmerkmale für das Preissystem. Aufgrund der hier aufgeführten Einflüsse ist bei einigen Fleischarten und Milchprodukten eine schnellere und qualitätsgerechtere Entwicklung zu erwarten.

(Schlüsselwörter: Produktion, Entwicklung, Fleisch, Milch, Qualität)

INTRODUCTION

Animal production is an important branch of the economy of Croatia. The majority of production is located on small and medium-sized family farms. The previous socialist system did not pay much attention to private farms, so animal breeding was not developed in an adequate manner at all levels. When presenting the level of development of specific animal breeding, data relating to the number of stock, specificity of production and actual interventions with the aim of its improvement are shown. With regard to their importance this analysis will take into consideration cattle, pig and poultry production.

Production and evaluation of beef production

Despite very favourable natural resources this branch of production in Croatia has not caught up with that in the more developed European countries. However, marked movements have been made in enhancing domestic low productive cattle using predominantly Simmental bulls. This fact contributed to cattle meat being in great demand on the European market during the 60s and 70s (especially in London meat wholesale). The genetic potential of the new domestic, so-termed red-white breed of the Simmental type, which had very favourable traits of meat quality (tenderness, muscle structure, moderate subcutaneous fat and good marbling, a pleasant colour and a very acceptable aroma) contributed to this. The above situation worked in favour of progress in cattle production and the improvement of beef quality (very good conformation, etc.).

The decline in domestic beef production was due to neglect by the socialist regime of production in the individual sector which owned over 80% of all categories of cattle and 97% of cows and pregnant heifers. This resulted in a marked and continuous linear decrease in the total number of cattle up to 1991, when, due to aggression in Croatia, cattle stocks were halved until 1995 (*Table 1*). Taking in account that in 1975 Croatia had over 1 million cattle and 1998 there were less than 450 thousand, it is clear that the situation is alarming despite recent significant moves in the direction of recovery. Due to biological 'slowness' in these animals the state should make even more effort to stimulate the production of cattle meat and milk.

Table 1**Total number of cattle in the period 1990 to 1998 (1000 head)**

Year (1)	Beef (2)			Cows and fertilised heifers (3)			Veal and steers/heifers younger than 1 year (4)			Steers/heifers 1-2.5 years old (5)		
	Total number (6)	On family farms (7)	%	Total number	On family farms	%	Total number	On family farms	%	Total number	On family farms	%
1990	830	623	75.06	492	477	96.95	262	105	40.07	68	33	48.52
1991	757	590	77.93	473	458	96.82	222	95	42.79	54	29	53.70
1992	590	473	80.16	383	378	98.69	159	70	44.02	43	20	46.51
1993	589	465	78.94	370	362	97.83	152	81	53.28	63	18	28.57
1994	519	427	82.27	347	339	97.69	136	66	48.52	32	18	56.25
1995	494	423	85.62	335	327	97.61	103	69	66.99	51	22	43.13
1996	461	399	86.55	311	303	97.42	98	70	71.42	48	32	66.67
1997	451	400	88.69	304	298	98.02	93	73	78.49	51	26	50.98
1998	443	393	88.71	300	294	98.00	112	73	65.18	28	rsen	82.14

Source: statistical yearbooks (*Quelle: Statistisches Jahrbuch*)*1. Tabelle: Rinderbestand in den Jahren 1990-1998 (in 1000 Stück)*

Jahr(1), Rinder(2), Kühe und trächtige Färsen(3), Kälber, Jungochsen, Färsen – jünger als 1 Jahr(4) Jungochsen, Färsen, 1-2,5 Jahre alt(5), Gesamtzahl(6), in Familienfarmen(7)

Nevertheless, in the renewal of cattle stocks it should be taken into account that reconstruction should not focus only on increasing the number of animals but also on improving the technology involved in production and the quality of meat and milk. According to experience so far this could be achieved, with governmental support, by the work of the agricultural advisory department. This will be no easy task, neither financially nor organisationally, as the productive structure is changing toward bigger operations in the form of family type economies. This trend should be encouraged and stimulated by means of appropriate measures. For this purpose attention should be given to several important activities:

- undertaking steps in breeding which may have a rapid impact on the profitability of certain production characteristics,
- selection of the main economic traits,
- application of modern technologies, generally by better organisation of production, by rational usage of the means for its improvement and by improvement of product quality.

In Croatia intensive genetic build-up of the Simmental, brown and Holstein population is currently in progress. *Table 2* shows mean live and slaughter weights of cattle in the period 1990-1997.

Table 2

**Mean live and slaughter weights of cattle in the Republic of Croatia
in the period 1990 to 1997**

Year(1)	Slaughtered (1000 head)(2)	Live weight (kg/head)(3)	Slaughter weight (kg/head)(4)	Total carcass weight (tonnes)(5)
1990	288	390	214	61,632
1991	212	403	221	46,852
1992	157	434	235	36,895
1993	146	425	232	33,872
1994	123	420	230	28,290
1995	118	396	218	25,724
1996	115	415	230	26,450
1997	130	363	203	26,390

Source: statistical yearbooks (*Quelle: Statistisches Jahrbuch*)

2. Tabelle: Durchschnittliches Lebend- und Schlachtgewicht der Rinder in Kroatien von 1990-1997

Jahr(1), Geschlachtete Tiere(2), Lebendgewicht(3), Schlachtgewicht(4), Menge aller Schlachtkörper(5)

Other important measures which could contribute to improvement in production are changes in legislation. In 1992 Croatia adopted as a package all existing laws and bills from the former Yugoslavia for the period before new legislation was to be enforced. It should be stated here that, unfortunately, some regulations were completely absent (e.g. market law for animals and animal products) and that some old regulations such as those on meat and milk quality are still in force.

Regulation JUS E.C1-022/74 on cattle carcass classification is still on force, but there is no use in its application because it is not compatible with the current EU regulations which are used as a base for national regulations in all member countries. This regulation did yield some progress in its time because its use and payment according to classes were obligatory. It is not applicable to the circumstances of today, as it classifies carcasses into only 3 categories (veal, steers/heifers and beef) and in classification, besides conformation and fat coverage, it takes into account colour, structure and consistency of meat and fatty tissue, which give rise to additional complications in this subjective grading system.

A group of experts is presently working with the state office for standardisation and measurements on the matrix for the regulations for the cattle carcass grading system. These regulations should be compatible with the main amendments proscribed by the EU commission for its members. Similar to the case of regulations for the pig carcass grading system, this working group has taken into account certain domestic characteristics which do not put in question its application at EU level. Differences exist only in classification in age categories. Due to the specificity of the Croatian market and the habits of our foreign customers, classification based on categories is basically focussed on the age of the animal at the time of slaughter (veal up to 6 months of age, young steers/heifers from 6 to 12 months, steers/heifers from 12 to 24 or 30 months, and beef above 24 or 30 months). Besides this there are few other sub-categories in the category of steers/heifers: meat of young bulls (12-24 months), heifers and young oxen (up to 30 months) and the sub-category of beef category: meat of bulls (above 24 months) and meat of cows and oxen (above 30 months).

The procedure of classification will continue on the basis of the same traits as in the EU, i.e. on the basis of the evaluation of muscle development (conformation). According to this evaluation carcasses will be classified into 6 classes (S-super; E-excellent; U-very good; R-good; O-medium and P-poor). Besides this, on the basis of fatty tissue content carcasses are evaluated and classified into 5 grades according to subcutaneous fat content and marbling (1-very poor; 2- poor; 3-medium; 4-good and 5-very good).

It is hoped that the drafting enforcing of these regulations will significantly contribute to improvement in cattle production in the sense of improved carcass quality in all categories. European experience shows that the consistent application of objective evaluation (classification) can lead relatively quickly to increased proportions of high quality classes from the population, since this is the only objective and real stimulation for production improvement.

Production and evaluation of raw milk in Croatia

Milk production has a long tradition in Croatia. The mainland part of the country is very suitable for milk production with respect to climate and environmental characteristics. In this area it is basically cow's milk which is produced. In coast areas goat's and sheep's milk are the types of milk generally produced. Before the war in Croatia milk production was established on small non-specialised family dairy farms. At the same time the large state dairy farms were not profitable, and the number of these farms was not sufficient. When the socialist regime decayed Croatia inherited this poor situation.

Table 3

Figures for national production (processed by industry) + imported volumes of some dairy products for 1997, expressed in tonnes (t) or hectolitres (hl)

Product (1)	Industrial milk production in Croatia (2)	Imported (3)
Pasteurised and long life milk (UHT or sterilised) (4)	2,543,707 hl	
Concentrated milk (5)	5,443 t	58,199 t*
Fresh cream (6)	9,247 hl	-
Fermented acidified milk and yoghurt (7)	61,260 t	2,176 t
Butter (8)	2,569 t	315 t
Fresh cheese (9)	8,641 t	
Hard cheese (10)	9,675 t	
Processed cheese (11)	2,636 t	3,203 t**
Powder, 0% and 26% (12)	2,790 t	16,783 t

* Including pasteurised milk, long life milk (UHT or sterilised) and concentrated milk. (*Einschließlichpasteurisierte Milch, H-Milch (UHT oder sterilisiert) und Kondensmilch.*)

** Including fresh, hard and processed cheese. (*Einschließlich Frisch-, Hart- und verarbeiteter Käse.*)

3. Tabelle: In Großbetrieben Kroatiens erzeugte Milchprodukte sowie importierte Milchprodukte in Tonnen (t) bzw. Hektoliter (hl)

Milchprodukt(1), großbetriebliche Produktion(2), Import(3), Pasteurisierte Milch und H-Milch (UHT oder sterilisiert)(4), Kondensierte Milch(5), Sahne(6), Sauermilchprodukte und Joghurt(7), Butter(8), Frischkäse(9), Hartkäse(10), verarbeiteter Käse(11), Milchpulver(12)

The new government began to improve dairy production on the family farm level, but this process is proceeding too slowly. Croatia imports a significant number of dairy heifers from Germany, Austria and the Netherlands, and credits farmers for them. At the same time, the government subsidy is about 25% of the milk price. By virtue of this encouraging process many new specialised dairy farms are now appearing. However, there are still many farms with only two or three cows involved in milk production. As the general economic situation in the country becomes worse this process of improving dairy production is in stagnation. In consequence of all these facts the production of milk in Croatia is not sufficient, and Croatia now imports more milk and dairy products than it exports (*Table 3*).

Croatia has several quite large and well organised dairy plants. The main dairy products produced in Croatia are outlined in *Table 4*.

Table 4

The production of milk by farmers in the past six years

Year(1)	Production (1000 l)(2)
1990	888,927
1995	587,922
1996	592,986
1997	621,034
1998	614,400

4. Tabelle: Milchproduktion auf Familienfarmen in den letzten 6 Jahren

Jahr(1), Milchmenge(2)

Average milk production in Croatia is 3,500 litres of milk per year. The number of cows and heifers was 392,706 in 1998, when total milk production was 900 million litres and the supply of milk to the dairy was 500 million liters (about 55%).

Annual consumption of dairy products is 187.3 litres of milk on a per capita basis. Consumption of milk and dairy products in Croatia in total is presented in *Table 5*.

Table 5

**Consumption of dairy products in Croatia in the past three years
(in thousands of tonnes)**

Year(1)	1996	1997	1998
Liquid milk (2) 19	528.0	554.4	426.7
Cream (3)	33.6	35.3	37.0*
Milk drinks, fermented products(4)	24.0	25.2	
Butter (5)	3.4	3.6	2.0
Cheese (6)	57.6	60.0	33.1
Population (thousands) (7)	4,800	4,800	4,800

*Including cream for consumption

5. Tabelle: Verbrauch von Milchprodukten in Kroatien in den letzten 3 Jahren

Jahr(1), Trinkmilch(2), Sahne(3), Milchgetränke und Sauermilchprodukte(4), Butter(5), Käse(6), Verbrauch pro 1000 Einwohner(7)

As Croatia has transformed from a state economy to a market economy the quality criteria for raw milk have become very important. The Croatian government is drafting new legislation which includes many parameters of quality in the payment system. Milk will be priced according to chemical composition (fat and protein), somatic cell count, total germ, cryoscopy and inhibitors. This new system will be introduced in practice by the end of this year. So far, some dairy plants have already introduced into the milk payment scheme some quality parameters (such as factory premium), as follows: percentage of fat, percentage of solid non-fat and somatic cell count.

Production and evaluation of pig meat

As a consequence of war the total number of pigs and also the total number of sows and fertilised gilts in the period 1990-1998 decreased by 25.9% and 20.3% respectively. According to statistics for 1998 74.9% of all swine categories and 84.5% of sows and fertilised gilts are reared on family farms (*Table 6*). Although a significant proportion of the pig population is located on family farms, these farms are characterised by low capacity.

Table 6

**Total number of pigs, sows and fertilised gilts in the period 1990 to 1998
(in thousands)**

Year (3)	Pigs (1)			Sows and fertilised gilts (2)		
	Total (4)	On family farms (5)	%	Total	On family farms	%
1990	1,573	1,025	65.2	227	177	78.0
1991	1,621	1,025	63.2	229	177	77.3
1992	1,182	852	72.1	176	149	84.6
1993	1,262	890	70.5	189	158	83.6
1994	1,345	970	72.1	194	161	83.0
1995	1,175	826	70.3	178	146	82.0
1996	1,197	871	72.8	176	145	82.4
1997	1,176	878	74.6	180	149	82.8
1998	1,166	874	74.9	181	150	82.9

Source: statistical yearbooks (Quelle: Statistisches Jahrbuch)

6. Tabelle: Gesamtbestand von Schweinen, Sauen und trächtigen Jungsauen von 1990 bis 1998

Schweine(1), Sauen und trächtige Jungsauen(2), Jahr(3), Gesamtbestand(4), auf Familienfarmen(5)

Analysis of the data on slaughtered pigs in the Republic of Croatia shows a dramatic fall in production. The number of slaughter pigs in the period 1990 to 1998 was reduced by 47.5% (*Table 7*).

Table 7

**Mean live and slaughter weights of pigs in the Republic of Croatia
in the period 1990 to 1997**

Year(1)	Slaughtered (1000 head) (2)	Live weight (kg/head) (3)	Slaughter weight (kg/head) (4)	Total carcasses weight (tonnes) (5)
1990	1,278	97	73	93,294
1991	502	100	77	38,654
1992	556	97	74	41,144
1993	706	97	74	52,244
1994	746	94	73	54,458
1995	626	93	74	46,324
1996	580	92	74	42,920
1997	671	90	69	46,299

Source: statistical yearbooks (*Quelle: Statistisches Jahrbuch*)

7. Tabelle: Lebend- und Schlachtgewicht von Schweinen in Kroatien von 1990 bis 1997

Jahr(1), Schlachtschweine in 1000 Stück(2), Lebendgewicht kg/Schwein(3), Schlachtgewicht kg/Schwein(4), Schlachtkörpergewicht (t)(5)

The lean meat content of Croatian swine carcasses is estimated to be between 44% and 46% (classes 'O' and 'R'). This estimate is based on the regulation on the classification and categorisation of swine carcasses, which is compatible with current European regulations. The bases and measurements for the classification of pig carcasses into categories and classes are proscribed by this regulations. Pigs for slaughter and young boars are classified, according to carcass lean meat content, into the (S)EUROP classes.

Research results show that swine carcasses produced on the farms in east Croatia have higher mean muscle percentage than those produced in the rest of the country. On the basis of the current regulations, lean meat percentages were calculated for 1,047 slaughtered pigs and their carcasses were classified into appropriate classes (Tables 8 and 9).

Table 8

Slaughter quality of pig carcasses in eastern Croatia (n=1047)

Indicator (1)	$\bar{x}$	$S_{\bar{x}}$	s	$x_{\min}$	$x_{\max}$
Carcass weight, kg (2)	81.11	0.35	11.76	60	120
Fat thickness, mm (3)	24.16	0.21	6.70	5	48
Muscle thickness, mm (4)	62.53	0.21	7.11	40	85
Lean meat, % (5)	49.43	0.11	3.44	41	68

8. Tabelle: Qualität der Schlachtkörper in Ostkroatien (n=1047)

Merkmal(1), Schlachtkörpergewicht(2), Speckdicke(3), Muskeldicke(4), Fleischanteil(5)

Table 9**Commercial classes (%)**

S	E	U	R	O	P
1.4	5.0	33.5	51.3	8.8	-

Source: Kralik *et al.* (1997)*9. Tabelle: Handelsklassen (%)*

Results of dissection of 505 swine carcasses of various genotypes from 5 large pig breeding farms showing a mean lean meat percentage of 55.47% (*Table 10*).

Table 10**Indicators of pig carcass quality (n=505)**

Indicator(1)	$\bar{x}$	S	V	$x_{\min}$	$x_{\max}$
Carcass weight, kg (2)	85.47	9.11	10.66	67	119
Fat thickness (3)					
- loin, mm (4)	21.10	6.75	32.01	6	40
- crosses, mm (5)	21.71	5.88	27.06	8	40
Muscle tissue, % (6)	55.47	3.91	7.04	44.3	64.3

Source: Kralik and Petričević (1997)

10. Tabelle: Merkmale der Schlachtkörperqualität bei Schweinen (n=505)

Merkmale(1), Schlachtkörpergewicht(2), Speckdicke(3), - in Lendenhöhe(4), - am Kreuzbein(5), Muskelanteil(6)

This record shows that farms with organised selection activities can produce pigs which are significantly leaner than the national average.

Production of poultry meat

This production was developed on industrial principles from 1961 right up until 1990. Development was very intensive. The number of poultry in 1990 was 17,102 million, with approximately equal shares in the state sector and on family farms. There are no data available on numbers of specific species or breeds of poultry. It is estimated that 92-94% of the total number are chickens and only 6-8% are other types of poultry (turkeys, ducks and geese). In the period analysed the number of poultry decreased constantly, and in 1998 it was at a level of only 58% of the total recorded in 1990.

The production of fattened broilers and the number of slaughtered poultry are important indicators of poultry meat production (*Table 11*). The number of slaughtered poultry has decreased together with the decrease in the total number of poultry reared. In comparison with 1990 the number of slaughtered poultry in 1997 had decreased by 45% (*Table 12*). In the same period egg production decreased by 21%. New regulations on the quality of poultry meat are also in the process of being drafted, since current regulations are not compatible with those of the EU countries.

Table 11

Indicators of number of poultry

Year (2)	Poultry (1000 birds)(1)		
	Total (3)	On family farms (4)	%
1990	17,102	8,639	50.51
1991	16,512	8,411	50.94
1992	13,142	6,668	50.74
1993	12,697	6,579	51.81
1994	12,503	6,606	52.83
1995	12,024	6,900	57.38
1996	10,993	6,852	62.33
1997	10,945	6,656	60.81
1998	9,959	6,455	64.81

Source: statistical yearbooks (*Quelle: Statistisches Jahrbuch*)

11. Tabelle: Merkmale des Geflügelbestandes

Geflügelbestand in 1000 Stück(1), (Jahr(2), Gesamtbestand(3), Bestand auf Familienfarmen(4)

Table 12

Mean live and slaughter weights of poultry in the Republic of Croatia and quantity of meat by year in the period 1990 to 1997

Year (1)	Slaughtered (1000 birds) (2)	Live weight (kg/bird) (3)	Slaughter weight (kg/bird) (4)	Total carcass weight (tonnes) (5)
1990	35,308	2.0	1.4	49,431
1991	30,508	2.1	1.5	45,762
1992	26,668	2.1	1.5	40,002
1993	23,016	2.1	1.5	34,524
1994	21,784	2.2	1.6	34,854
1995	18,504	2.3	1.7	31,457
1996	20,521	2.3	1.7	34,885
1997	19,361	2.3	1.7	32,914

Source: statistical yearbooks (*Quelle: Statistisches Jahrbuch*)

7. Tabelle: Lebend- und Schlachtgewicht von Geflügel und die produzierte Fleischmenge pro Jahr von 1990 bis 1997 in Kroatien

Jahr(1), Geschlachtetes Geflügel in 1000 Stück(2), Lebendgewicht kg/Tier(3), Schlachtgewicht kg/Tier(4), Schlachtmenge gesamt (t)(5)

Large poultry production companies – reproduction centres for heavy and light lines of chicken and turkey - are also good bases for faster development of poultry production on

family farms. Croatian poultry production will in future still be developed on the basis of the utilisation of genetic potentials of poultry (hybrids) from foreign selection companies. While the productivity of poultry accompanied by modern technology on the farms of the former state sector is high, less favourable results are achieved on individual farms. Regional distribution of capacities enables the directing of meat and egg production towards family farms. Besides intensive poultry rearing outdoor rearing should also be planned. Diverse production would influence the supply of products according to manner of production and quality. Poultry production offers a great possibility for the alternative production of biologically functional food (eggs with lower cholesterol level, meat enhanced by omega-3 fatty acids etc.). It can be anticipated that farmers will become interested in producing geese, ducks, pheasants etc.

CONCLUSIONS

The Republic of Croatia has good natural circumstances for the development of all animal production systems, which in the period to come will be based on family types of economy and the enlargement of animal production farms, similar to those in existence in countries with more developed animal production.

Advisory and selection services, which are organised at the state level, should exert influence in the manner of application of new technologies in production, the improvement of animal production capacities and the organisation of highly efficient animal production. The authors presume that this will be followed by other means of state support. The rapid adjustment of Croatian regulations to make them compatible with those in force in EU countries is now emerging as one of the primary needs.

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Slovene livestock production under transition in view of future accession to EU

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ABSTRACT

Objective of the paper is to estimate the economic effects of possible pre-accession agricultural policy scenarios for Slovene agriculture with special emphasis on livestock production. Agricultural Policy Analysis Simulator (APAS) and Policy Analysis Matrix (PAM) methodology has been applied to estimate likely market (supply and demand changes), trade flow (self-sufficiency and international trade) and income trends as well as competitiveness and welfare effects of five policy scenarios for period 1997 (base year) till 2003. CEFTA Agreement proved to be poor solution for Slovene agriculture, reducing agricultural output by 16% and income to one third in comparison with baseline. Proposed reform of national agricultural policy would bring producers' losses back, however, situation in comparison with baseline scenario (continuation of current policy) will be quite different, discouraging still beef, poultry and wheat sector, and lowering production in all livestock sectors. Complete adoption of reformed EU CAP according to Agenda 2000 would improve general picture of Slovene agriculture, among livestock foremost cattle production. Beef producers would benefit the most, followed by dairy farmers. EU policy with almost complete liberalised pork and poultry market proved as bad prospect for intensive industrialised farming, far from being competitive on open market.

(Keywords: Slovenia, Agricultural policy, EU, CEFTA, Integration effects)

ZUSAMMENFASSUNG

Die Tierproduktion in Slowenien während der Vorbereitungsperiode zum Anschlusses an die EU

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Im Artikel werden die ökonomischen Effekte der Agrarpolitik in Slowenien, vor allem in der Tierproduktion, in der Vorbereitungsperiode des Anschlusses an die Europäischen Union erörtert. Zwei unterschiedliche Modelle wurden ausgesucht: Der Agricultural Policy Analysis Simulator (APAS) und die Policy Analysis Matrix (PAM), mit denen die Markttendenzen (Angebot und Nachfrage), die Außenhandelsströme (Selbstversorgung), die Einkommenssituation sowie die Konkurrenzindikatoren und die Wohlfahrtseffekte für fünf verschiedene Umstände zwischen 1997 (als Ausgangslage) und 2003 eingeschätzt

werden. Das CEFTA Handelsabkommen könnte die wirtschaftliche Situation des slowenischen Agrarsektors deutlich verschlechtern, der Brutto-Rohhertrag könnte um etwa 16% fallen und das Einkommen um zwei Drittel im Vergleich zur Basissituation (die Fortsetzung der bisherigen Politik) sinken. Der Reformvorschlag der slowenischen Agrarpolitik könnte diese Verluste im allgemeinen ausgleichen, allerdings nur dann, wenn sich die Preis- und Einkommenslage zwischen den Produkten signifikant verändern sollte. Die Rinder-, Geflügel und Weizenproduktion und im allgemeinen auch die Tierproduktion können deutlich reduziert werden. Eine Übernahme der im Rahmen der Agenda 2000 beschlossenen Gemeinsamen Agrarpolitik (GAP) der Europäischen Union könnte die wirtschaftliche Situation im Agrarsektor Sloweniens verbessern, was besonders den Rindersektor betrifft. Die Ergebnisse sind von der Zahlung der Ausgleichszahlungen abhängig. Die GAP könnte auch den Schweine- und Geflügelmarkt insoweit liberalisieren, dass sich die Lage der Produzenten in diesen zwei Sektoren, die in Slowenien noch immer relativ geschützt sind, signifikant verschlechtert. (Schlüsselwörter: Slowenien, Agrarpolitik, EU, CEFTA, Integrationseffekte)

INTRODUCTION

Slovenian agriculture is dealing with two dimensions of European integration. In March 1998 Slovenia started accession negotiations with the European Union (EU). Slovenian adjustment of legislation and other aspects of EU-accession processes have started with a sincere aim to enter the EU. In addition to the EU-accession important impacts are expected from CEFTA agricultural trade liberalisation, signed by CEFTA governments in December 1997. Considering the natural and structural conditions for agriculture, and its socio-political importance, it can be expected that Slovene farmers will have to cope with additional economic problems. The integration of Slovenia into the EU and CEFTA means integration into larger agricultural markets that might exert pressure on the growth and productivity of domestic agricultural production. Even small corrections of prices can drastically change economic attractiveness of various kinds of agricultural production and farm incomes (Hill, 1996; Baldwin et al., 1997).

Slovenian agriculture and agricultural policies are rather different in comparison to the other CEFTA countries (Hungary, Czech Republic, Slovakia, Poland, Bulgaria and Romania). The economic importance (GDP, trade) of agriculture in CEFTA countries is (except in the Czech Republic) by far greater, the production and structural conditions for agriculture are relatively better, and the intensity and the export potentials (especially in Hungary) are much higher than in Slovenia. In CEFTA, the level of producer prices is close to the world market level, and (compared to Slovenia) market protection is relatively low. The budget policy differs as well, and some countries (like Hungary) are using the measures of export subsidies to increase the competitiveness of their exports (OECD, 1996 and 1997).

During pre-accession period Slovene agriculture is therefore faced with export oriented and principally more competitive other CEFTA countries agriculture. At the same time this is (for Slovenian agriculture) preparation period for accession to EU. Common agricultural policy is a moving target, but despite of liberalisation policies with reforms in 1992 and those proposed for 2000 it remains regulated with high protection (price subsidies are replaced by direct budget support). Slovene agricultural policies, therefore, have to survive between Scila of CEFTA liberalisation and Karibda of CAP protectionism. The proposal for national agricultural policy reform tries to respond on

both: on CEFTA liberalisation during 1999-2002 and at the same time on preparation of Slovene agriculture for next stage - accession to EU. The reasoning behind the agricultural policy reform is that the existing mechanisms based mostly on market-price support do not meet the current and, moreover, the future policy requirements (*Buckwell et al.*, 1998). Slovenia has signed several trade agreements (not only CEFTA). Consequently the agricultural market was opened for some important products. The negative price trends in 1997-1999 (Eurostat, var. years; MAFF, var. years) confirmed this process. The policy makers also perceived the obvious ineffectiveness of the present policy like non-competitiveness and income unattractiveness of the branch, lagging behind in structural changes, loss of agricultural land due to forestation, decrease in population density, inflation pressure, threat to the competitiveness of the food industry.

Estimates of the possible economic effects, derived from the obligations of the CEFTA agreement, the proposal of internal reform and both together compared to the expected effects of EU accession are extremely interesting and important both for policy makers, experts and the public in general. Policy makers are concerned mainly to market trends, budget and income changes. From economists point of view also welfare and competitiveness are important issues. Therefore, the objective of this contribution is to estimate consequences of different pre-accession scenarios for Slovene agriculture. The paper is structured as followed: first, the broad CEFTA agreement and national agricultural policy reform are presented. Policy scenarios, within which Slovenia can choose during pre-accession period, with prices and resulting protection coefficients as their most significant characteristics comprise second part. Market projections and resulting trade flows start the presentation of the model results. Estimates of likely income development are shown in separate part, followed by projection of trends in Slovenian agricultural production competitiveness and short welfare analysis. The paper concludes with short policy evaluation and some recommendations for agricultural policy and future research work.

POLICY BACKGROUND

Agriculture and agricultural policy in Slovenia

The significance of agricultural production in the Slovenian economy is relatively small (around 4.5% of GDP and 7% of total employment after transition; SURS, var. years). These figures are likely to continue to decline with further economic development. In Slovenian agriculture the stress of transition was not as dramatic as has been the case with other CEEC countries (*European Commission*, 1995). However, during period 1990 - 1993, trend in total agricultural product (TAP) was consistently declining. The fall in the volume of production can predominantly be attributed to the loss of the Yugoslav market, severe drought problems in these years and difficulties in designing the new agricultural policy framework. The relative share of crops and livestock in agricultural output has not changed substantially, and these represent a half of TAP each.

Slovenia's agro-food trade balance has been traditionally negative and the country is almost certain to remain a net food importer. Agricultural trade represents around 4% of total exports and 8.5% of total Slovenian imports. Slovenia has important surpluses only in hops, meat products and milk. At the same time, Slovenia imports cereals, sugar, oil and red meat. The agro-food trade balance has been worsening throughout the transition period. The most important agricultural foreign trade partners have remained to be countries of the former Yugoslavia (around 55% of exports, 1995-1997 data) and

the European Union (around 45% of imports). Due to high import indices CEFTA countries have also become important.

The most salient features in the composition of Slovenian lands are: the importance of forestry (around 60% of all land is forested), harsh relief (70% of all agricultural land is in less favoured areas) and a considerable share of meadows and pastures in total agricultural land (i.e., the share which ranks Slovenia the third in Europe). These relatively unfavourable production conditions diminish the competitiveness of Slovenian agriculture and limit the range of possible production orientations.

In Slovenia, 93% of all agricultural land (UAA) is privately owned or leased. Privately owned land is mostly divided between 112,000 small family farms (*1991 data, Eurostat definition*) with an average farm size of 4 ha UAA. The development of private farming during the entire post-war period was hindered by an agricultural policy that favoured state agricultural enterprises. The Law on a Public Agricultural Land Pool, enacted in 1953, fixed the maximum holding size to 10 hectares of agricultural land.

The majority of family farms are oriented to labour intensive production. This is especially true for the predominant form of farming - combined milk and beef cattle production. A considerable share of production is used for home consumption or for direct sale from home. The production potential of traditional family farms is limited and average yields lag far behind those of the European Union countries. Part-time farms prevail (only around 20% of private farms in Slovenia earn their income exclusively from an agricultural occupation).

Agricultural enterprises have evolved from the formerly "social" agricultural estates. In 1990 public farm sector operated on merely 7% of agricultural land, but contributed 30% to TAP. This farm structure predominates in pig and poultry production but is less important in beef, dairy and arable sectors. The levels of land and labour productivity achieved by these farms come close to comparable figures in West European agriculture. Their "long-run" economic performance is, however, uncertain. This uncertainty arises from the Law on Denationalisation, under which all previously nationalised farmland shall again belong to original owners. It is estimated that agricultural enterprises will have to return some 40% of their farmland.

Before gaining independence in 1991, Slovenia did not have its own agricultural policy. Agricultural market and price policies had entirely been within the domain of the federal government. Local governments (republics) had some competencies only in the field of structural policy. The most important step towards an independent agricultural policy was the launch of The Development Strategy for Slovenian Agriculture (*MAFF, 1993*) that defined the key objectives of agricultural policy (the objectives are basically not in dispute with those of the CAP as defined in the Treaty of Rome).

The set of objectives should be achieved with different instruments of agricultural policy. Like the CAP in the pre-MacSharry period, the Slovenian policy is mainly based on the market-price support. The policy of administrative pricing for some key products (wheat, sugar, milk) and foreign trade protectionism have been the two main levers used to keep Slovenian agricultural prices significantly above world market level. The prices of some products are relatively high even if compared to the EU prices (wheat, sugar beet, pork, eggs), while others still remain lower than in any member state (milk, apples, pears, peaches and, in certain years, potatoes). For wheat and sugar, the Government also has complete monopoly over the market (being the only buyer and seller of wheat). As other former socialist countries, Slovenia applies numerous forms of budget support measures to reduce production costs (input subsidies). However, the influence of

budgetary support on agricultural development in Slovenia is relatively low (not least because indirect forms of support prevail in the budget structure).

CEFTA agreement

Slovenia is a member of CEFTA agreement since 1996. As there are substantial price differences between Slovenia and other CEFTA countries for certain agricultural products, Slovenia has tried to exempt agriculture from the generally accepted liberalisation of CEFTA trade. A compromise was reached in September 1997, on CEFTA Summit, where Prime Ministers agreed on further steps towards liberalisation. Hence, Slovenia has signed Protocol 6 of the CEFTA Agreement which covers all the main trade regulations and which will bring about important changes for some key agricultural products. The Protocol came into force from the 1st April 1998 and its implementation is divided in two stages: 1998-2000 and post 2000. For some products (including beef and sheep) import quotas will remain in force until the year 2000.

The CEFTA trade regimes for stable agro-food products in Slovenia

The status of trade (1)	Commodities(2)	Tariffs applied(3)
A list Duty Free and Quota free commodities since 1 st April 1998	Breeding animals Horses Durum wheat Oil seeds	0% 0% 0% 0%
A1 list Duty Free and Quota free commodities since 1 st January 2000 - previous preferential quota	Sheep & goats (live animals and meat)	Very limited quota 0% (year 2000)
B list Common preferential tariffs - since 1 st April 1998	Wheat Barley Flour Pastry Poultry meat Some vegetables and fruits	15% 18% 15% 20% 28% 5-10%
B1 list Common preferential tariffs since 1 st April 1998 very limited quotas until 1 st January 2000	Live animals (cattle, pigs, poultry) Carcass beef and pork Beef and pork meat All canned meat Hops	10-15% 15% 20% 15-18% 5%
C list Bilateral preferences to Slovenia	Potato, cheese, eggs, apples, oils, different meat products, soft drinks wine, beer	Limited quotas, or partial liberalisation
D list Bilateral preferences from Slovenia	The same products as on list C Some preferences for maize	Limited quotas, or partial liberalisation 5% for Czech and Slovak Republics. 50000 t for Hungary

Source: Protocol 6 to the CEFTA Agreement

List A contains agro-food products for which the customs duty has been abolished upon the entry into force of the Agreement, i.e. on April 1st 1998. The States signatories to the CEFTA Agreement have liberalised the trade for only less sensitive products. These are mainly products that are not produced by producers of continental Europe. Only sheep and goats (live animals and meat) shall be mentioned here as products having an important production and market share in Slovenian agriculture. Special import quotas shall be applied for this group of products up to the year 2000, and hence no particular effects of the Agreement are expected on this market till 2000.

List B contains agro-food products for which the customs duty shall be reduced upon the entry into force of the Agreement, i.e. on April 1st 1998. Sub-list B1, as a part of *List B*, contains the products with quantitative limitations until the year 2000, and tariffs being gradually reduced as provided for in *List B*. Some key products of Slovenian agro-food sector can be found in *List B* (wheat is particularly important; see results below). The quotas for the products included in *List B* are limited at such a low level that, until the year 2000, there will be no noticeable change in visible trade. The tariffs, as a rule, are rather low except maybe for the slaughtering industry.

Lists C are lists of agricultural and food products for which other CEFTA countries have to reduce import tariffs for products originating from Slovenia to the level determined in lists C, without any quantitative limitation or within the quotas provided for in Annex C, which is operative as from April 1st 1998. The products listed in individual lists C are particularly products from the food-processing industry. By contrast, *Lists D* are lists of agricultural and food products for which Slovenia has to reduce import tariffs to the level determined in list D, without any quantitative limitation or within the quotas provided for in Annex D which is operative as from April 1st 1998. Both *List C* and *List D* constitute a bilateral agreement between signatories to the CEFTA Agreement, and hence *Lists D* differ with regard to individual countries. Thus, Slovenia effectively opens the market for non-processed oils and in addition, to a great extent, the maize market.

Due to existing protection and price differences, the most important impacts of Protocol 6 for Slovenian agriculture are believed to be the opening up of the wheat and some coarse grain markets in 1998 and the opening of the beef and sheep market in the year 2000. It is interesting that the trade with dairy products and sugar shall remain protected and that the CEFTA countries have attached greater importance to trade with raw materials than to trade with processed products, which mostly continue to be protected.

Reform of agricultural policy

Proposal for national agricultural policy arose in 1998, foremost under the frame of Slovenian harmonisation for future accession to EU, but also as direct response to first effects of Protocol 6 to the CEFTA agreement. According to the reform document, the general objectives of the domestic agricultural policy will not change. The main goal of the reform is to change the mechanisms and instruments of policy. The reform is oriented to the shift from market-price support to the structural (budget) policy. In the document, the policy-makers recognised that agriculture can no longer be assisted only by high prices. Slovenia has opened its market to foreign trade flows and will continue to be even more open in the future. It is shown that the budget measures could be more transparent, better controlled and directed, and also easier to adapt to the EU requirements, since the CAP is likewise undergoing a process of reforming its operating

policy mechanisms in agriculture (*Europäische Kommission, 1995; European Commission, 1999*). The reform is particularly oriented towards environment and rural development issues, without neglecting the economic goals of productivity and competition. The reformed agricultural policy will be much more target-oriented and therefore essentially more efficient. In addition to the provision of environmental goods, agriculture will also have an important macroeconomic impact. The price reduction will bring about lower prices of food, lower prices of raw materials for the food-processing industry, and hence better competitiveness in domestic and foreign markets.

Reform of agricultural policy has a pragmatic approach, advocating a gradual reform of the agricultural market policy towards the full liberalisation, speaking about strategically conducted income policy. This means that - as laid down in the first important strategic document (Development Strategy of Agriculture in Slovenia of 1993) - the farm income "has to be retained and its parity level pursued". The final goal of the reform is the adjustment of the possible agricultural income level by the probable accession year (2003) to that achieved in the EU. The document points out that the reform should provide a "soft landing" on the common market, allowing for the attainment of agricultural policy goals at a higher level and guarantee much greater benevolence of the rural areas towards European integration. The document also recognises that approaching the EU prices and income levels is a kind of a price that Slovenia has to pay for accession to the EU. The reform should lay down Slovenia's negotiation platform. To a great extent, the proposed policy is a policy that Slovenia desires to bring along into the EU or, better to say, which Slovenia wants to impose on accession.

The concept of the reform is structured by several programmes that cover the policies and administration of the Ministry for Agriculture, Forestry and Food. The main changes are included in the Programme of Agricultural and Food Industry Reform. This programme is based on the following foundations ('pillars'):

- *Market and price policy* (pillar I) should bring about a gradually decrease of foreign trade protection, along with retaining (and adjusting) parity income levels (together with the second pillar). In the reform paper the following measures are put forward: break-up of the state monopoly in the bread wheat market; establishment of the EU conform intervention mechanisms in the internal market; gradual (and only partial) liberalisation of the milk and dairy products market; decreasing importance of foreign trade protection, co-ordinated with income policy.
- *SPELAA* (Pillar II: Slovene Programme for Environmental and Landscape Assistance for Agriculture). Programme comprises an introduction of de-coupled direct payments per ha (eco 0, eco 1, eco 2, eco 3) with different functions and purposes. Eco 0 are general direct payments per ha of different amounts depending on the use of land (grassland, arable land, permanent crops) according to minimum environmental protection criteria. Eco 1 will provide supports for agriculture in the less-favoured areas (harmonised with the EU policy). Eco 2 should bring special programmes for the maintenance and preservation of the cultural landscape. Local authorities prepare special support programmes for individual parts of their territory with typical landscape patterns. Eco 3 are direct payments for environment friendlier farming. The farmers who opt for organic farming, endangered breeds (or other programmes) can obtain special support per ha. Eco 2 and 3 should be harmonised with EU agricultural environmental and structural programmes.

- *Agro-food modernisation programme* (pillar III). With this programme, the government tries to prepare Slovenian agriculture and food industry for accession under conditions of increased competitiveness in EU. The agricultural production and related food processing should be restructured; the efficiency and competitiveness increased; additional income activities on farms supported with different programmes (which should be mainly in line with the EU policies): the programme of farm restructuring (investment support, young farmers, reconstruction, additional income activities); land reform (consolidation of arable land, regulation of pastures, rounding-off, reclamation arable land, irrigation); the programme for modernisation and adjustment of the food-processing industry.
- *Rural development programme* (pillar IV). From the present projects of integrated rural development and village renovation (CRPOV), an EU-comparable approach and projects of integrated rural development will be developed. The programme will be included in the general concept of regional policy and harmonised with the policy of EU structural funds.

With the reform proposal, MAFF has proposed a significant increase in the funds earmarked for agriculture (they should be tripled compared to 1998 funds). Although the government adopted and welcomed the reform it turned down the proposal for increased budget funds. Although the 1999 proposed budget for agriculture is 18% higher in nominal terms (12% in real terms taking into account inflation), this is not in line with the proposal of the reform. The government has also commissioned the MAFF to prepare the implementing plan of the reform by 30 June 1999, whereby it will elaborate the programmes in greater detail. The process of adoption of the agreed pre-accession assistance for the period 2000-2002 is under way.

METHODOLOGY AND SCENARIOS

Methodology

Agricultural Policy Analysis Simulator (APAS) and Policy Analysis Matrix (PAM) models have been used for the purpose of this study. Both models have been developed in the framework of ACE Phare project. Food balances for Slovenia and model calculations for different activities (*AIS*, 1998) served as main data sources, together with some publications of European Commission (*EC*, 1998), previous studies estimating effects of European integration (EU and CEFTA) on Slovenian agriculture (*Erjavec et al.*, 1997; 1998), as well as several expert estimations.

APAS model gives the possibility to simulate in easy and understandable way market effects of different policies as well as time trends. With elasticities incorporated in the modelling exercise one can simulate demand and supply side for different activities. Spreadsheet based simulation give the opportunity to calculate simultaneously also many derivatives of these calculations (international trade and self-sufficiency, value of production, number of animals and acreage sown, different types of cultivated land etc.)

On the other hand PAM analysis, linked to APAS model, offer possibility to study many policy oriented indicators, as well as for management (producers) interesting issues, not only in one time period but with much more important time perspective (PAM is no more completely static model). Main output of PAM analysis in this case are revenues, costs and profits, valued both at market and social prices, income, protection coefficients (NPC and EPC) and indicator of competitiveness (DRC).

Combining both APAS and PAM it was possible to estimate welfare effects in a simple and straightforward way (Tsakok, 1990).

For pre-accession period, projected to last until year 2003, two versions of calculations were conducted. First set of results relates to pure price effects of different agricultural policy scenarios, assuming no change on supply and demand side as consequence of technical progress in production or trends in consumption (tp 0) but only as implication of price and income changes, reflected through effects of own and cross price as well as income elasticities. Since this is an option with more political than practical value, parallel set of results relates to more realistic situation, taking into account also technical progress (tp 1), namely current and/or estimated trends in yields level, number of animals an acreage sown (linked not only to price changes) as well as changes in consumer behaviour (demand side).

For purpose of this contribution pre-accession period is period from 2000 till year 2002 (inclusive). Year 2002 is assumed to be the last year of national agricultural policy, since January 2003 is officially stated date of Slovenian accession to EU as proposed by national government strategy and all pre-accession tasks have to be finished till that date. Therefore, emphasis in this chapter is given to comparison of many interesting indicators, expected in the case of continuation of current national agricultural policy till assumed final pre-accession year, and the figures projected under several policy scenarios.

The policy scenarios are based mainly on expert opinion about most likely determined price level, considering also market volume and development as well as consumer preferences about product quality. Policy measures are taken over the mechanism of incentive prices, where direct payments and structural measures are taken into account (their price effects) with the help of multipliers (between 0,2 and 0,7) according to the literature and expert opinion. This is the most speculative part of the research where the authors give full attention how to present the real situation and trends.

Scenarios

CEFTA Agreement on agriculture as obligatory policy option and Reformed national agricultural policy as response to it and an attempt for better preparation on later accession are in focus of interest in this paper. These are two realistic options for studying, while additional two scenarios chosen in the work – accession to the full Agenda 2000 CAP and complete price liberalisation - serve mainly for comparison purpose. These four scenarios are presented in comparison with the unrealistic option of the prolongation of current national agricultural policy (baseline scenario). Scenarios under investigation in this paper are, therefore:

- *CEFTA scenario* - *CEFTA*. Implications of fully implementation of CEFTA Agreement on Slovenian agriculture, with switch to the prices, which could be realised in year 2000 without reaction in policy structure (expert opinion on border prices plus agreement allowed tariffs, Erjavec *et al.*, 1998).
- *Reform of domestic agricultural policy scenario* - *REF*. Agricultural policy with introduction of de-coupled acreage payments and bigger investment programs to partially offset negative effects of lower CEFTA prices on farmers' incomes (CEFTA price level plus new policy measures). Reformed Slovenian agricultural policy is still to great extent only proposal and is, therefore, a not likely to happen scenario in pre-accession period, at least not completely.

- *Baseline scenario - BS.* Continuation of agricultural policy from 1997/1998 (prolongation of the price level), which does not seem to be realistic option and is included for comparison purposes.
- *Adoption of full Agenda 2000 scenario - EU+.* Reformed CAP of EU according to Agenda 2000 as fictive option for having possibility to compare how much virtual REF Slovenian policy is harmonised with reformed CAP, looking from effective (output) point of view (the scenario is made by EU accession price level (expert opinion) plus direct payments plus structural payments).
- *Price Liberalisation scenario - PL.* Complete liberalisation in international trade in forthcoming years with one stage switch from BS to world prices in year 2000 - simulation of bottom line prices' effects on Slovenian agriculture.

Incentive price levels and protectionism level

Different price levels are the most significant characteristics of five policy scenarios and therefore have high influence on all indicators presented in the paper. Incentive prices in *Table 1* are calculated as market prices, increased by expected effect of support policy (Hertel, 1989) on production (management) decisions applying multiplier approach. Therefore demand prices are in most cases lower than incentive prices for producers.

Table 1

Incentive prices for different scenarios in 2002

	<i>BS</i>	<i>CEFTA</i>	<i>REF</i>	<i>EU+</i>	<i>PL</i>
	<i>EUR/t</i>	<i>BS = 100</i>			
Milk(1)	285	90	99	103	53
Beef(2)	2658	78	96	111	60
Pork(3)	1695	96	100	88	76
Poultry(4)	1156	98	98	86	68
Wheat(5)	167	68	92	93	68
Maize(6)	90	99	127	162	114
Potatoes(7)	107	91	97	105	84
Sugar beet(8)	45	96	103	93	42

Source (*Quelle*): European Commission, 1999; OECD, 1996; Erjavec et al., 1997 and 1998; Bojnec et al. 1997; AIS, 1998

1. Tabelle: Motivierende Preise für verschiedene Lösungsmöglichkeiten für 2002

Milch(1), Rindfleisch(2), Schweinefleisch(3), Geflügelfleisch(4), Weizen(5), Mais(6), Kartoffeln(7), Zuckerrüben(8)

From *Table 1* one can see the negative price effects of CEFTA agreement on Slovene agriculture, exemption could be only industrialised animal production (pork and poultry - agreement did not touch these sectors importantly) as well as coarse grains sector, which is already open for imports. However, the CEFTA agreement will not bring the full price liberalisation as assumed with PL scenario. The only exception being coarse grains sector where the export price level in CEFTA countries is lower than the world market price level. Anyhow, coarse grains sector is a special story in Slovenia due to its

interrelation with livestock production. Increase of maize price is not expected to reflect in much higher domestic market supply (what is projected with our model). This should be born in mind in results interpretation.

Proposal of reform of agricultural policy (REF scenario) would in most cases outweigh negative effects of lower CEFTA prices. It would therefore have positive effect on supply side, exemption could be foremost wheat production (now highly protected) and beef sector. Maize (stable prices and additional acreage payments) producers would be main beneficiaries of REF policy on output (revenues) side.

The EU accession with complete compensation payments (EU+) would significantly increase the combined revenues effect in Slovenian agriculture. However, there are different effects by the products. Exemption would be currently highly protected sectors (intensive livestock production, wheat and sugar sector). Under the actual policy less protected products like beef and maize could benefit more than any other sectors.

Nominal protection coefficients (NPCs) as simple price ratio of national market price to social price (better: market revenue to social revenue) are presented in *Table 2*. Since in our case on supply side we operate with incentive prices rather than market prices, NPC is close to familiar OECD NAC_p indicator.

Table 2

Nominal and effective protection coefficients in 2003 for different scenarios

	<i>BS</i>	CEFTA	REF	EU+	PL
Milk(1)	1,54	1,44	1,52	1,59	1,03
Beef(2)	1,64	1,28	1,57	1,81	1,01
Pork(3)	1,36	1,31	1,35	1,19	1,03
Poultry(4)	1,23	1,20	1,20	1,06	0,84
Wheat(5)	1,57	1,12	1,46	1,47	1,12
Maize(6)	0,95	0,95	1,20	1,54	1,08
Potatoes(7)	1,38	1,27	1,35	1,44	1,18
Sugar beet(8)	1,67	1,60	1,72	1,57	0,75

2. Tabelle: Geplante Subventionen im Jahre 2003 für die verschiedenen Lösungsmöglichkeiten

Milch(1), Rindfleisch(2), Schweinefleisch(3), Geflügelfleisch(4), Weizen(5), Mais(6), Kartoffeln(7), Zuckerrüben(8)

With mostly lower CEFTA prices than current, NPCs under CEFTA scenario will be reduced, extent of reduction depends on distortion of both Slovenian and CEFTA markets. Interpretation of coefficients is similar for other scenarios under consideration - trends are the same as for price changes. High subsidies could be observed in most sectors. Exception is only coarse grains sector (relatively low prices in comparison with high domestic input costs) as well as poultry production with very low protection. Under CEFTA scenario the most important changes will happen in beef and wheat sectors, while all other will not be influenced to a distortive extent. Proposal of reform policy (REF) would in most cases offset negative impact of price reduction under CEFTA

scenario. Currently highly subsidised sectors would be protected at nearly the same degree while other sectors would be better off than with no changes (BS). REF policy in Slovenian most important sectors still means less protection than EU Accession scenario, exceptions being pork and poultry sectors.

Under PL scenario social and market prices would be close to equal. Therefore, divergence mostly depends on net trade of products and/or transportation and marketing costs. Due to generally higher input costs (mainly due to unfavoured production structure) than admitted on competitive market, protection coefficients would be higher than 1. However, as it will be seen later, in several sectors revenues would not cover even tradable costs, implying very negative income.

RESULTS

Market Trends

Mainly due to significant price changes, assumed by policy scenarios, variations on supply as well as demand side can be predicted even in short time period. It is difficult to estimate, how the policy makers will react on CEFTA changes and what will be the final result of the reform. Probably there will be mixture of several scenarios, i.e. different scenarios will likely to become reality for various products. Comparison of all five or above all scenarios BS, CEFTA and REF give us range of results, within which one can expect real situation in near future (*Table 3*).

Table 3

Projected supply and demand under various policy scenarios in 2002

	<i>BS</i>		<i>CEFTA</i>		<i>REF</i>		<i>EU+</i>		<i>PL</i>	
	<i>S</i>	<i>D</i>	<i>S</i>	<i>D</i>	<i>S</i>	<i>D</i>	<i>S</i>	<i>D</i>	<i>S</i>	<i>D</i>
	<i>(000 t)</i>		<i>BS = 100</i>							
Milk(1)	588	490	97	102	97	102	100	100	80	115
Beef(2)	58	54	92	110	96	110	104	97	80	115
Pork(3)	53	82	101	99	97	99	92	103	92	103
Poultry(4)	62	53	99	99	95	99	91	103	80	107
Wheat(5)	142	308	87	110	94	105	91	106	89	106
Maize(6)	352	561	103	97	111	97	122	95	107	89
Potatoes(7)	181	218	96	97	99	99	103	97	100	100
Sugar beet(8)	286	512	100	98	101	99	95	99	74	112

3. Tabelle: Geplantes Angebot und geplante Nachfrage unter verschiedenen politischen Umständen im Jahre 2002

(Zeichenerklärung in Tabelle 2.)

In accordance with expectation supply vary faster than demand. Supply is more sensible on price changes and price changes on supply side are in most cases higher than on demand side. Wheat and beef production will face the highest effect of price reduction on supply under CEFTA scenario. Potato and milk production will also be reduced. Due to cross effects maize production is expected to increase in comparison with BS

scenario. On demand side beef consumption is expected to increase the most due to price reduction, followed by wheat demand, which will be at lower prices (for poor quality) competitive also as feed components.

Under reform policy (REF scenario) maize production will increase even more, but wheat production will not decrease so much as under CEFTA scenario due to the high acreage payments. Pork and poultry production will be reduced to higher degree, while beef production will be better off than in the case of CEFTA which is again the result of the new payments introduced by reform. Consumption will be almost untouched in comparison with BS, exceptions are beef and wheat (increase till 2002 due to low prices).

Lower protection of pork and poultry sector and lower prices of wheat and sugar beet would result in lower production of these sectors under the Agenda 2000 accession conditions. Due to the high arable payments which favour more productive producers maize should increase at the highest level of all products. One can notice that both more protectionist scenarios (REF and EU+) keep the production on the level close to baseline, which means that due to the CEFTA partial price liberalisation would come to the significant reduction in production potential, and that also with significantly higher agricultural budget it is not possible to bring the production to the much higher level that exists at the moment. However, changes in policies bring some important shifts between the products.

Trade flows

Policy makers in Slovenia are strongly concerned about the level of self-sufficiency (food security objective of the domestic agricultural policy). Since this is in direct relation with demand and supply, one can predict changes and trends from these two parameters. The same is true for quantity of internationally traded commodities. But since they are even more important for politicians than the first two, they are presented ones more in *Tables 4 and 5*.

Table 4

Expected levels of self-sufficiency in 2002 under various policy scenarios

	<i>BS</i>	<i>CEFTA</i>	<i>REF</i>	<i>EU+</i>	<i>PL</i>
Milk(1)	120	114	114	121	84
Beef(2)	107	90	94	115	74
Pork(3)	65	66	63	58	58
Poultry(4)	118	117	112	103	88
Wheat(5)	46	37	41	40	39
Maize(6)	63	66	71	80	75
Potatoes(7)	83	82	83	88	83
Sugar beet(8)	56	57	56	54	37

4. Tabelle: Zu erwartendes Niveau der Selbstversorgung im Jahre 2002 unter verschiedenen politischen Umständen

(Zeichenerklärung in Tabelle 2.)

Table 5**Projected quantities of net international trade (000 t)**

	<i>BS</i>	<i>CEFTA</i>	<i>REF</i>	<i>EU+</i>	<i>PL</i>
Milk(1)	9	9	6	2	-7
Beef(2)	4	-6	-4	8	-16
Pork(3)	-28	-27	-30	-35	-35
Poultry(4)	9	9	6	2	-7
Wheat(5)	-165	-214	-190	-196	-198
Maize(6)	-209	-186	-157	-107	-125
Potatoes(7)	-38	-37	-37	-26	-37
Sugar beet(8)	-226	-218	-222	-235	-361

5. Tabelle: Geplante Nettomenge im internationalen Handels (1000 t)

(Zeichenerklärung in Tabelle 2.)

In general, no important changes in international trade flows and levels of self-sufficiency will occur in short term, covered by pre-accession period. Complete application of CEFTA Agreement (without changes in national policy) would bring to important decrease in self-sufficiency of wheat and beef, which could not be covered by the higher budget support of proposed reform. Wheat production is less attractive than under baseline even with the most optimistic EU accession scenario. Different pattern is significant for beef sector, where possibility of whole premium package of CAP offers at least little chance to become net exporter again. Growing level of self-sufficiency in sugar sector from nineties is stopped. Estimates for industrialised livestock production (pork and poultry) are very speculative, depending on world market conditions and due to liberalised regimes in EU also on its competitiveness. Level of self-sufficiency is expected to decline in these sectors. As already mentioned several times, EU policy would benefit foremost maize production.

Agricultural Income

Value of production (gross production) is product of quantity produced and product (incentive) price. When summed for all products this procedure give us crude estimate of total value of production for agricultural sector. Our study does not cover the whole Slovenian agricultural production. However, products under consideration account for more than 75% of total value of production and these are also products which will face the most significant changes in next years. Therefore changes and trends in value of production for whole agricultural sector are close to shifts for products under investigation. Values of production, calculated with APAS, are presented in *Table 6*.

Value of production (valued at incentive prices) would fall for more than 15% under CEFTA scenario in comparison with BS, with beef and wheat sector in very serious crisis. Milk and potato production would also face very significant reduction. Proposal of reform (REF) policy at aggregate level leave production value in comparison with baseline almost untouched. Here we can see that policy makers with the reform try to compensate for negative effects of price liberalisation created by CEFTA agreement. However, high differences exist between sectors, which were already explained by other indicators.

Table 6**Trends in value of production under various scenarios (nominal values)**

	<i>BS</i>	CEFTA	REF	EU+	PL
	<i>mio EUR</i>	BS=100			
Milk(1)	167	88	96	104	43
Beef(2)	154	71	92	115	48
Pork(3)	90	97	96	81	69
Poultry(4)	72	97	93	78	55
Wheat(5)	24	59	86	85	61
Maize(6)	32	102	140	198	122
Potatoes(7)	19	88	96	108	84
Sugar beet(8)	13	96	104	89	31
Agric. total* (9)	571	84	99	106	59

* Including apple and grape production. (*Einschließlich Apfel- und Weintraubenproduktion.*)

6. Tabelle: Tendenzen für Produktionswerte unter den verschiedenen Umständen

(*Zeichenerklärung in Tabelle 2.*)

Agenda 2000 (EU+) policy could be in terms of farmers' revenues a better solution for Slovenian agriculture when policy applied completely. The picture between sectors is almost opposite in comparison with CEFTA scenario. In the case of fully price liberalisation (PL), value of production would be almost halved, mostly due to lower prices. When looking to income expectable by producers (*Table 7*), even figures in *Table 6* seem to be too optimistic.

Table 7**Likely agricultural income situation in 2003 (in EUR/hd or ha)**

	<i>BS</i>	CEFTA		REF		EU+		PL	
	<i>EUR</i>	EUR	ΔBS	EUR	ΔBS	EUR	ΔBS	EUR	ΔBS
Milk(1)	491	332	-159	454	-37	554	63	-13	-504
Beef(2)	51	-108	-159	21	-30	119	68	-243	-294
Pork(3)	9	6	-3	10	1	-17	-26	-31	-40
Poultry(4)*	8	2	-6	2	-6	-402	-410	-728	-736
Wheat(5)	124	-102	-226	68	-56	75	-49	-99	-223
Maize(6)	-231	-235	-4	-55	176	187	418	-140	91
Potatoes(7)	465	287	-178	412	-53	569	104	139	-326
Sugar beet(8)	584	493	-91	644	60	448	-136	-564	-1148
Agric. total** (9)	130,2	42,7	-87,5	132,4	2,2	156,7	26,5	-120,9	-251,1

* Per 1000 heads. (*Pro 1000 Personen.*), ** Mio EUR, including apples and grapes. (*Mill. EUR, einschließlich Apfel und Weintrauben.*)

7. Tabelle: Wahrscheinliches Einkommen der Landwirtschaft im Jahre 2003 (in EUR pro Kopf oder ha)

(*Zeichenerklärung in Tabelle 2.*)

Effects of different scenarios, discussed so far, are even more significant when looking expected income position. The most interesting projections are presented in *Table 7*. CEFTA scenario reduces total income in comparison with baseline on only one third! Reform would leave total income almost untouched, while the most optimistic EU accession scenario bring an important improvement of total agricultural income. Uncompetitiveness of Slovene agriculture can be noticed easily from PL scenario, where only potato production would conditionally remain income attractive.

Differences between commodities are significant. CEFTA does not have important impact on pork and poultry sector (along with price reduction also inputs will be cheaper), and also not on maize and sugar beet. All drastic effects are, however, even intensified in wheat and beef and to a lesser extent at potato. In milk sector reduction of income is mostly result of lower beef prices as by-product of milk production, but with important income effect.

Reform scenario does not compensate equally for all CEFTA effects. Due to its decoupled nature product hierarchy is re-established on basis different from current policy with a potential biased protection. Income loss in beef is nearly compensated (with implications also in dairy sector) as result of exposed landscape function of agriculture. In wheat sector compensation is not complete to offset loss of income. In maize, effect is very positive, but still not big enough to bring to positive income, leaving this crop further mainly as important source of nutrients for livestock on own farms, and still not to become important on markets. Nevertheless, trends are more important than absolute values, showing some opportunities of Slovene agriculture.

EU accession scenario bring a little different picture that is expected in comparison with REF scenario. Two different groups of effects can be observed. The first one is market opening with negative effects foremost on pork and poultry (currently higher price level than EU) and another one different nature of budget support with beef even more privileged in EU. Important discrepancies exist between reform proposal and nature of CAP direct payments. Proposed reform, due to its production independence, supports also products like potato and sugar beet, which are not eligible for any support in CAP. For this reason reform is probably necessary to be evaluated again.

Under free market condition positive income is possible to achieve only in potato production, already operating in similar situation.

Competitiveness

Domestic resource cost ratios (DRC) for all products under investigation are presented in *Table 8*. They support the statement about the uncompetitive position of Slovenian agriculture. However, variations are high and allow politicians to draw some important conclusions.

Maize, poultry and potatoes production seems to be most competitive production orientations of investigated commodities. These (un)competitive structure seems to be pretty stable for all scenarios, the only exception being poultry production with higher DRC ratio in EU+ and PL (product and input prices relations are discouraged). Beef, pork and sugar beet production is far from being competitive regardless of scenario under consideration. Milk production is somewhere between, with lowest result under EU+ scenario due to increased yields as result of favourable price and additional headage payment.

Table 8**DRC ratios for most important products in Slovenia - projection for 2003**

	BS	CEFTA	REF	EU+	PL
Milk(1)	1,58	1,84	1,65	1,49	2,19
Beef(2)	3,61	3,53	3,56	3,92	3,82
Pork(3)	1,90	1,77	1,77	2,99	2,97
Poultry(4)	1,32	1,24	1,24	2,02	2,02
Wheat(5)	1,81	2,05	1,86	1,85	2,05
Maize(6)	1,44	1,44	1,41	1,41	1,42
Potatoes(7)	1,45	1,51	1,46	1,42	1,56
Sugar beet(8)	2,09	2,11	2,08	2,13	2,76

8. Tabelle: Einheimische materielle Quellen für die wichtigsten Produkte in Slowenien – Plan für das Jahr 2003

(Zeichenerklärung in Tabelle 2.)

Welfare

Welfare analysis has been conducted after APAS and PAM calculations have been finished. Main differences between scenarios in welfare terms are summarised in table 10. CEFTA scenario halves market price support. Reform of agricultural policy could bring this losses for producers over the doubling of existing agricultural budget back. EU accession could increase the level of support in comparison with baseline scenario and reform proposal. However, consumer prices are not going down so much as in CEFTA case. The welfare analysis gives the picture about the shift from consumers to the taxpayers support as it can be seen in reform proposal and, to lesser extent, EU accession. It has to be pointed out that budget cost is not approximation of the whole amount of agricultural budget costs, since it covers only production side and only direct measures on ten sectors.

From results obtained it is also clear that current policy is very expensive from consumer point of view. CEFTA could reduce taxation of consumers significantly. The same is true also for reform scenario, where it can be observed one of the most important positive effects of this reform. With the accession we can expect also some positive price effect in terms of consumers. However, this price effect is not so dramatic as in both other scenarios.

The changes in producer surpluses were discussed above in the presentation of the income results. It can be seen that reform covers the negative price effect from the CEFTA partial trade liberalisation. EU accession brings in general additional surplus to producers. Anyway, it is not much higher than under BS and REF scenario.

From this general welfare analysis is interesting to see also the net efficiency of different scenarios. Here, only the CEFTA scenario reduces the net effect of baseline scenario, which is understandable, according to the increase in budget support by REF and EU+ scenarios. The reform proposal is more efficient in bringing the support to producers in comparison with the accession scenario.

Table 9

Main welfare indicators in year 2000 (nominal values in mio EUR and BS=100)

	<i>BS</i>	<i>CEFTA</i>		<i>REF</i>		<i>EU+</i>	
Market Price Support(1)	47,0	26,3	56	25,5	54	43,1	92
Budget Cost(2)	47,0	26,3	56	103,4	220	84,6	180
Consumer Surplus(3)	-225,2	-142,1	63	-142,2	63	-204,5	91
Prod. Surplus (4)	193,5	121,9	63	195,0	101	220,4	114
Efficiency Losses:(5)							
- Production(6)	25,4	10,7	42	21,4	84	39,7	156
- Consumption(7)	-20,7	-7,7	37	-16,1	78	-30,4	147
Net Effect(8)	4,7	2,9	62	5,3	113	9,3	198

9. Tabelle: Die hauptsächlichen Lebensniveau-Kennziffern für das Jahr 2000 (Nennwert in Mill. EUR und BS = 100)

Preissubventionen(1), Staatshaushalt(2), Verbraucherüberschuss(3), Produktionsüberschuss(4), Rentabilitätsverluste(5), in der Produktion(6), im Verbrauch(7), Nettoergebnis(8)

CONCLUSION REMARKS

The results show that the CEFTA agreement will have significant impact on Slovene agriculture. Prices will drop, production will slightly decrease, self-sufficiency will decline in some sectors, income will decrease to the quarter of baseline scenario, competitiveness will not improve significantly. Changes will happen predominantly in wheat and beef sector. However, CEFTA opening of the Slovene agricultural markets does not have the same scope of effects like full price liberalisation under PL scenario.

Due to the expected fall in income on some particularly important agricultural markets and because of strategic consequences of changed internal agricultural price relations, the CEFTA Agreement urges the change of Slovenian agricultural policy towards a radical reform of support programmes. The era of intensive agricultural price protection is drawing to a close in Slovenia and domestic agricultural policy will have to integrate new and coherent policy instruments in order to effectively resolve various structural discrepancies in Slovenian farming. In addition, all efforts should be focused on preparing domestic agriculture for the possible full Slovenian membership in the EU. To overcome distortions caused by market price support and later by the introduction of the Common Agricultural Policy, Slovenia will have to commence the adjustment of its agricultural policy. A shift in the importance from the market and price policy to structural (budget) policy should be particularly emphasised. The most significant alteration in the functioning of the Slovenian agricultural policy is probably the introduction of various (if possible de-coupling) income payments. Structural policy should be more target-oriented. Measures to increase competitiveness in the food industry are also required. Furthermore, particular attention should be paid to the introduction of supplementary activities on the farm, promotion of environmentally-friendly production, farm tourism and generally to rural development issues.

How can the reform of agricultural policy be assessed? Could the reform reach the above mentioned directions? The qualitative and quantitative evaluation of the reform bring us to the conclusion that there is no doubt that proposed agricultural policy reform means an important shift on the conceptual or substantive level of agricultural policy. The reform does not change the goals of agricultural policy but it evaluates them differently. The reform does, for example, not mention explicitly the goal about food safety, although it is partly covered in the emphasis it places on the multi-functionality of agriculture. The later places major importance on the environmental and social goals of agriculture through which the reform tries to ensure greater acceptance, thereby higher funds for agriculture support, and thereby also development of rural areas.

A decision to change agricultural policy mechanisms means the most radical switch of the reform. The agricultural policy has been abolishing (be it by force or not) the concept of price support as the only policy mechanism, replacing it with the budgetary support policy. It pursues its goals, first, by the introduction of de-coupled direct payments which the reform relates to the payment of environmental services, and second, by substantial supports to the restructuring of agriculture and food industry and wider vertical regional programmes (inclusion of multi-sector policies). Some of these programmes are modelled in accordance with corresponding EU programmes of support whilst others try to avoid difficulties encountered during the pre-accession period. This holds particularly for some contestable EU measures, such as compensation payments.

The reform can be assessed as a step in the right direction, although many issues remain unclear and the reform itself is held back by insufficient budgetary funds. The final assessment of the reform will not be possible before its implementation plan is prepared and the final decision about the funds available is made. No greater difficulties are expected in the field of investment assistance (the greatest difficulty being the total value of the earmarked funds), what cannot be said about the realisation of the SPELAA programme and the programme of regional assistance, which are administratively demanding, require multi-year financial planning, and, on top of this, call for substantial funds. Although the concept changed markedly the way of thinking of agricultural policy makers, it does not yet guarantee that its realisation will not be over-simplified and eventually return to increasingly unsuitable market-price measures.

The empirical results show that one of the main objective of the reform of agricultural policy is to cover the negative income effects due to the CEFTA agreement. However, reform is less production coupled and could bring significant shift between the products. Cereals with higher yields could get more than now administrative protected wheat production. Reform is also much more radical in bringing the support on the budget side than EU Agenda 2000 decision. The main problem of the reform is its cost for taxpayers. It is unlikely that the government will double the budget for agriculture. This is mainly political decision which could be supported with the argument that the reform is much more efficient way to support agriculture than existed price subsidies. However, for producers the best solution among the scenarios presented is full accession to the CAP funds. Farm incomes could increase significantly. On the other side there are still negative effects for consumers with much higher food prices than in the case of CEFTA or reform scenarios.

The comparison between EU accession and reform scenario results open the question if - due to important differences in economic effects of both scenarios - some new evaluation of the reform is necessary. There is a problem if better economic solution like reform de-coupled payments will not mean worsening the negotiation

position of Slovene agriculture. The introduction of the CAP similar compensatory payments is possible alternative to the reform concept in the second pillar. The alternative has to be discussed not only in economic but also in political terms of "national optimisation of the EU subvention". Further research is necessary.

Slovene agriculture is uncompetitive and due to unfavourable production structure, implying high input costs, competitiveness is not likely to improve significantly in no one scenario under consideration. In view of expected policy changes this will (together with profitability results) threaten implications for some sectors, foremost pork and poultry. Situation in beef sector is not better, however, this sector is likely to be subsidised enough to survive. The most promising situation is likely to be achieved by best dairy farmers. All competitiveness results have to be taken with special caution due to many uncertainties behind calculations. They also relate to average productive producers like all other indicators, leaving possibility for much better results achievable by most successful farmers. The models and discussion bring us to the final remarks that the main task in the pre-accession period is to increase competitiveness of Slovene agriculture.

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SECTION 1

CATTLE AND SHEEP BREEDING SCIENCE



Measures in Slovenian cattle production at integration into the European Union

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ABSTRACT

The paper deals with the role and economic status of cattle production in Slovenian agriculture. The number of cattle and cows for market milk production decreased by 23% and 24.3% during the last twelve years. Nevertheless, in the same period milk production increased nearly by 8%. The purchase of milk per cow increased by more than a half. One of the most important measures for adjustment to the European Union are such conditions that the number of cattle could increase to 500,000 and of cows to 200,000. Number of suckler cows and at the same time beef production should be stimulated by payments.

(Keywords: cattle production, milk, meat, economic measures)

ZUSAMMENFASSUNG

Maßnahmen in der slowenischen Rinderzucht in Rahmen der Integration in die Europäische Union

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Die vorliegende Arbeit erörtert die Rolle und die ökonomische Lage der Rinderzucht in der slowenischen Landwirtschaft. Die Zahl der Rinder und der Milchkühe hat sich in letzten zwölf Jahren um 23 und 24,3% verringert und dennoch ist die Milchproduktion in derselben Zeit um 8% angestiegen. Gleichzeitig ist die verkaufte Milchmenge pro Kuh um 50% angestiegen. Die wichtigsten Maßnahmen im Rahmen des Beitrittes zur EU ist die Sicherung solcher ökonomischer Grundlagen, die zur Erhöhung der Rinder- und Kuhzahl auf 500 000 bzw. 200 000 führen. Subventionen werden vor allem für die Erhöhung der Zahl der Mutterkühe und damit für der Rindfleischproduktion verwendet. (Schlüsselwörter: Rinderzucht, Milch-, Rindfleischproduktion, ökonomische Maßnahmen)

INTRODUCTION

The cattle production is one of the most important agricultural branches in Slovenia because it makes about 35% of all agricultural income. The present economic and market conditions in the Slovenian cattle production are most close to the conditions in the European Union hence the adjustment to the European legislation will not be moot. The main problem of the Slovenian cattle production is unfavorable farm size (average

Slovenian farm size is 4.2 ha) and 72% of agricultural land are less suitable for cultivation due to harsh relief and altitude. Therefore, there are less than 20% of pure farms with farming as the only source of income in Slovenia. All other farms have to find extra income in additional activities or regular employment.

The suitable number of cattle will mean self supply with milk and beef as well as maintaining of grass land, populated countryside and attractiveness of Slovenia for tourists.

Present State And Further Development Of Cattle Production Until The Integration Into The European Union

The integration into the European Union (EU) will not cause essential changes in the cattle production but certain measures should be taken to ease the integration.

Table 1

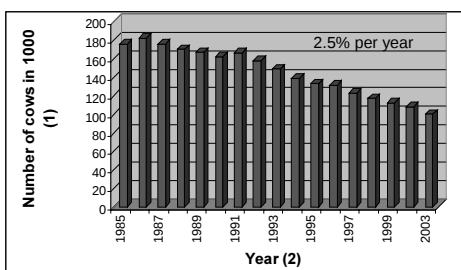
Number of cattle in Slovenia, quantity of purchased milk per cow (market milk) and total quantity of purchased milk

Year (1)	All cattle, number (2)	All cows, number (3)	Cows for market milk, number (4)	Suckler cows and cows for nonmarket milk, number (5)	Market milk per cow, l (6)	Purchased milk, million l (7)
1985	577 206	253 751	175 696	78 055	1990	349.6
1986	580 949	252 980	181 861	71 119	1990	362.0
1987	556 200	245 376	176 209	69 167	2057	362.4
1988	548 611	245 197	169 648	75 549	2316	392.8
1989	546 000	242 741	166 513	76 228	2155	358.8
1990	546 048	255 034	161 992	93 042	2206	357.3
1991	532 902	230 664	165 713	64 951	2306	382.1
1992	483 865	220 023	158 124	61 899	2351	371.8
1993	477 551	210 609	148 802	61 807	2222	330.7
1994	477 400	213 703	138 500	75 203	2563	355.0
1995	495 535	215 161	132 532	82 629	2962	392.5
1996	486 198	212 293	130 522	81 771	2966	387.1
1997	445 724	192 141	122 728	69 413	3067	376.4
1998*	453 097	184 408	117 000	67 408	3256	381.0
1999*	460 000	187 000	112 000	75 000	3446	386.0
2000*	470 000	190 000	108 000	82 000	3620	391.0
2003*	500 000	200 000	100 000	100 000	4000	400.0

*Projection (*Prognose*), Source (*Quelle*): Statistical report of Slovenia, Annual reports of Cattle Breeding Service

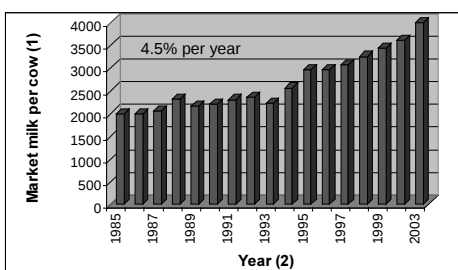
1. Tabelle: Rinderbestand in Slowenien, Menge der verkauften Milch/Kuh (Milch für den Markt), Gesamtmenge der verkauften Milch

Jahr(1), Rinderbestand gesamt(2), Gesamter Kuhbestand(3), Anzahl Milchkühe(4), Anzahl der Mutterkühe und Milchkühe zur Selbstversorgung(5), Vermarktete Milch/Kuh(6), Vermarktete Milch gesamt(7)

Figure 1**Number of cows for market milk production in Slovenia**

1. Abbildung: Anzahl der Milchkühe in Slowenien, die für den Markt produzieren

Bestand der Milchkühe(1), Jahre(2)

Figure 2**The quantity of purchased milk per cow per year**

2. Abbildung: Menge der vermarkteten Milch pro Kuh und pro Jahr

Vermarktete Milch/Kuh(1), Jahre(2)

Table 1 shows that the number of cattle in Slovenia decreased by nearly 23% from 1985 to 1997, which means 1.9% per year. It is the critical point of number of cattle to use the grass from the land that has been overgrowing. The number of all cows decreased even quicker in the same period, namely by 24.3% or 2% per year. The number of cows for milk purchase decreased the most rapidly, by 30% or 2.5% per year. Nevertheless, milk purchase increased from 350 mil. to 376 mil. of liters, which is nearly 8%. It means that milk purchase per cow increased very quickly, from 1,990 liters in 1985 to 3,070 liters in 1997. The increase was 54% in twelve years, which is favorable even though the milk purchase per cow in the West European countries is still much higher. But the best farms, that are included in AP recording, have with 5570 l milk in standard lactation already achieved the level of average West European farms.

Measures and interventions that will be required at integration into the EU until 2003 will also help to increase the number of cattle up to 500,000 and the number of all cows up to 200,000. The number of cows for market milk production will decrease to 100,000 cows. Milk will not be purchased from another 100,000 cows. Most of those cows will be suckler cows and less than a quarter of them will give milk for self supply only.

Table 2 displays beef production which differs significantly from milk production. The beef yield in the Slovenian slaughter houses (market meat) increased by 10.4% from 1985 to 1990 following by rapid decrease (35.4%) to reach the lowest level in 1994 with only 31.58 thousand tons of meat

The mentioned amount was warning as it represented only 85% of self supply. The government introduced extra payments with no great effect due to BSE in England. In 1998 the beef production increased by 2.26 thousand tons, which was 7.1%. The structure of slaughter is unreal because it shows that 80% of slaughtered animals were young cattle while the percentage of slaughtered calves and cows is too low. It means that many calves and cows were slaughtered at home.

Considering favorable natural conditions the beef production should show a surplus of 15% according to agrarian economists (Kavcic et al., 1996) before the integration into the EU. Beef production should increase till 2003 to reach 39 thousand tons.

Table 2

Produced beef in Slovenia (thousands of tons)

Year (1)	Σ Beef (2)	Veal from calves under 6 months (3)	Beef from young cattle under 3 years (4)	Beef from cows and other cattle (5)
1985	44,29	0.49	38.38	5.42
1986	42,14	0.31	37.21	4.61
1987	47,88	0.56	43.11	4.21
1988	45,31	0.44	41.39	3.48
1989	43,83	0.43	40.17	3.22
1990	48,90	0.64	43.58	4.68
1991	46,60	0.60	38.10	7.89
1992	37,80	0.56	32.10	5.13
1993	35,65	0.97	29.62	5.06
1994	31,58	0.63	28.58	4.38
1995	33,43	0.83	27.63	4.97
1996	32,37	1.16	25.70	5.52
1997	33,71	1.31	26.88	5.52
1998	33,84	1.67	26.88	5.29
1999*	35.00			
2000*	36.00			
2003*	39.00			

2. Tabelle: Rindfleischproduktion in Slowenien (in tausend t)

Jahr(1), Fleisch gesamt(2), Kalbfleisch von Kälbern unter 6 Monaten(3), Fleisch von Jungrindern unter 3 Jahren(4), Rindfleisch von Kühen und anderen Rindern(5)

Necessary measures in cattle production until the integration into the european union

Economic conditions in last twelve years were in cattle production worse in comparison with pig production and poultry that can be proved by decreased number of cattle and especially of beef production. Therefore the most important measures are those which will enable the increase of number of cattle up to half a million of animals and consequently the usage of grass land.

Because the 120% of self supply with milk is provided by lower and lower number of cows for market milk production such tendency is probable till the integration into the EU. The number of cows for market milk production will be about 100,000 at the time of integration into the EU.

Measures and payments should primarily stimulate beef production and export of meat and meat products as well as the increase of number of animals, export of breeding animals, and the increase of export of milk and milk products. In future the

production in aggravated conditions in mountainous regions and in Karst should be stimulated as well.

Table 3 shows what measures should be stimulated and the amounts of payments with regard to the production conditions. Those payments are significantly lower than in the EU and should be brought into line with those in the EU until 2003. Special attention should be paid to the number of suckler cows on which the amounts and quality of produced beef will depend in future. The criteria of suckler cows should consider the quality of beef. It means that payments will be awarded for suckler cows of beef breeds, crossbreeds with beef breeds and dual purpose breeds sired with beef breed bulls or with beef type bulls of dual purpose breeds.

Amounts of market milk, beef and suckler cows should be negotiated with the EU before the integration into the EU. The amounts will be determined on the base of available areas for meadows and pastures.

Table 3

Payments for production and exports in cattle production in Slovenia in 1999

Payments (1)	Lowlands (2)	Highlands (3)	Mountainous and Karst region (4)
Production for breeding or slaughter, DEM/kg gain (5)		0.25	0.4
Suckler cows production, DEM/cow (6)	180	215	240
Dairy cows for market milk production, DEM/cow (7)		100	150
Mountain pastures for cattle, DEM/animal (8)			55
Fattening of calves to higher mass, DEM/kg (9)	150	150	150
Slaughter of primiparus cows, DEM/kg (10)	200	200	200
Pohorje beef, DEM/kg (11)		200	200
Export payments (12)			
- breeding animals, DEM/animal (13)	700	700	700
- beef and beef product exports, DEM/kg (14)	0.75-2	0.75-2	0.75-2
- milk, DEM/l (15)	0.09-0.145	0.09-0.145	0.09-0.145
- cream, butter, cheese, DEM/kg (16)	0.18	0.18	0.18

3. Tabelle: Produktions- und Exportwerte der Rinderproduktion in Slowenien 1999

Finanzieller Wert(1), Tiefebene(2), Hochland(3), Bergland und Karstregion(4), Zucht- oder Schlacht-tierprodukte DEM/kg Einnahme(5), Mutterkühe DEM/Kuh(6), Milchkühe DEM/Kuh(7), Rinder von Bergweiden DEM/Rind(8), Mastkälber DEM/kg(9), Schlachtwert von "primiparus" Kühen DEM/kg(10), Rindfleisch DEM/kg(11), Exportwerte(12), Zucht-tiere DEM/Tier(13), Rindfleisch und Rindfleischprodukte DEM/kg(14), Milch DEM/kg(15), Sahne, Butter, Käse DEM/kg(16)

In view of production increase and improvement of beef quality special attention should be paid to trade marks like veal "Golden grain", beef "Pohorje beef" and others. Veal trade marks should stimulate fattening of calves to higher body mass so that lower

number of fattened calves produce more veal. Some quality traits of veal from weightier calves exceed the quality of veal from lighter calves.

Before the integration into the EU, we plan to establish some new trade marks for beef produced in sustainable economic conditions in Karst, highlands and mountainous regions. In Slovenia more consumers ask for products produced in sustainable way due to frequent cases of harmful additives found in animal foods.

Legislation concerning milk quality and beef carcass quality, which has already been harmonized with the EU, was passed in 1994 so we are not behind the EU in this respect while the screening of legislation concerning milk and beef production is in progress.

More attention should be focused on export of breeding animals and beef, to reach the former level. Also the organisation of cattle breeders will have to be harmonised to EU legislation. Slovenia lag behind in structural changes. So the most important measures that will have to be taken are those that will stimulate increase farm size and so the number of cattle on the farm.

CONCLUSIONS

- Economic conditions in cattle production lagged behind the conditions in other branches of animal production in the last twelve years.
- Consequently the number of cattle and beef production decreased by 23% in the mentioned period.
- Due to favourable prices of milk in comparison with beef the amounts of market milk even increased by 8% in this period while the purchase of milk per cow increased by 54%.
- The objective of intervention measures and payments in the last years was to increase the number of cattle, especially suckler cows as well as to increase and improve quality and amounts of beef production.
- Special attention is and will be paid to sustainable beef production of diverse trade marks that will be asked for in future.
- Legislation on quality of milk and beef has already been harmonized with the EU. Other legislation concerning cattle production has been screened as well.

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Prediction of carcass composition from measurements of wholesale carcasses

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ABSTRACT

Carcass data from 238 brown bulls were analysed to estimate the possibilities for prediction of carcass composition from measurements of wholesale carcasses. Measurements included carcass weight, carcass length, chest depth, longissimus dorsi muscle area between the 7th and 8th ribs and carcass conformation and fatness notes. Actual tissues weights and proportions were obtained from carcass dissection into lean, fat, tendon and bone. Using carcass weight, carcass length, chest depth, EUROP conformation and fatness notes, it was not possible to accurately predict proportion of carcass tissue of progeny tested Brown bulls (r^2 of 0.142, 0.104, 0.061, 0.230 for lean, fat, tendon and bone). Also inclusion of longissimus muscle area did not significantly improve the coefficient of determination. Accuracy of predicting carcass tissue weight was higher, (r^2 of 0.867, 0.191, 0.076, 0.355 for lean, fat, tendon and bone), but only the prediction of lean weight was sufficiently accurate.

(Keywords: beef, carcass, prediction, tissue weight, tissue proportion)

ZUSAMMENFASSUNG

Schätzung der Schlachtkörperzusammensetzung durch Verwendung meßbare Kriterien beim Rind

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Die Schlachtkörperdaten von 238 Bullen der Rasse Braunvieh wurden analysiert, um die Schätzung der Körperzusammensetzung mit den Schlachtkörpermerkmalen der EUROP-Klassifizierung zu überprüfen. In die Untersuchung wurden folgende Schlachtkörpermerkmale einbezogen: Schlachtkörpergewicht, Schlachtkörperlänge, Brusttiefe, Fläche des Muskels longissimus dorsi zwischen 7 und 8 Rippe, Fleischfülle und Verfettungsgrad. Die Menge der einzelnen Gewebe und deren relative Anteile im Schlachtkörper wurden durch Zerlegen der Schlachthälften ermittelt. Die Gewebeanteile lassen sich bei dem Schlachtkörpergewicht, der Schlachtkörperlänge, der Brusttiefe, der Fleischfülle und dem Verfettungsgrad nur sehr ungenau schätzen (r^2 erreichte 0.142, 0.104, 0.061, 0.230 für Fleisch-, Fett-, Sehnen-, und Knochenanteil). Auch das Einbeziehen der Muskelfläche des longissimus dorsi in das Modell trug nicht zur wesentlichen Verbesserung der Schätzgenauigkeit bei. Die Gewebemengen lassen sich mit höherer Genauigkeit schätzen als die Gewebeanteile (R^2 erreichte 0.867, 0.191, 0.076, 0.355 für Fleisch-, Fett-, Sehnen- und Knochenmenge), aber nur die Werte für die Fleischmenge erreichten eine bessere Genauigkeit.

(Schlüsselwörter: Rind, Schlachtkörper, Schätzung, Gewebemenge, Gewebeanteile)

INTRODUCTION

Carcass composition is one of the most important factors that defines their market value. Accurate predictions of carcass composition is required by the breeders and beef industry as well. For the breeders, it is not important only because of payment, but also because of possibilities to use this data for selection purposes. In many countries the data from commercial fatteners and slaughterhouses are used for prediction of sire breeding value. Accuracy of estimated breeding value can be compensated by higher number of progeny tested bulls and by including their relatives. In Slovenia in future all cattle shall be numbered, hence it will be possible to obtain carcass weight, conformation and fatness notes.

The purpose of this work was to estimate the possibilities for prediction of carcass composition from measurements of wholesale carcasses.

MATERIALS AND METHODS

The data for this study were collected from 238 Brown bulls fattened from 1992 to 1996 at progeny testing station in Logatec. Bulls were fed with mixture of maize and grass silage ad libitum and concentrate. They were slaughtered in three different commercial slaughterhouses. After slaughter carcasses were weighted and conformation (EUROP) and fatness (1,2,3,4,5) were noted (*Pravilnik o...*, 1994). Carcass length was measured from cranial part of symphysis pubis to cranial part in middle of the 1st rib and chest depth from ventral part of neural canal of backbone to ventral part of the sternum at 5th rib. Carcass halves were cut into quarters between the 7th and 8th ribs and muscle *longissimus dorsi* area was measured on the cross section. Carcass halves were dissected into lean, fat, tendon and bone and percentage of tissues were calculated. Percentage and quantity of four tissues were first estimated on the basis of carcass weight, carcass length, chest depth, conformation and fatness notes. In the second step longissimus muscle area was added to independent variables. The stepwise regression procedure (SAS, 1989) was used to examine the effectiveness of carcass measurements in prediction of tissue weight and proportion in the carcass, including all independent variables and their quadratic terms.

MODEL:

$$\hat{Y}_{ij} = b_0 + b_1 * X_1 + b_2 * X_2 + \dots + b_i * X_i + e_{ij}$$

$\hat{Y}_{ij}$ = dependent variable, kg or % of body tissue in the carcass

b_0 = constant

$b_1 \dots b_i$ = partial regression coefficients

$X_1 \dots X_i$ = independent variables

e_{ij} = estimation error

RESULTS AND DISCUSSION

In *Table 1* the results of carcass grading are represented. Most of the carcasses were graded into R and U conformation classes and only a small part into class O. Carcasses were graded into three fatness classes, but majority of them were graded into fatness class 3.

Table 1**Number of graded carcasses**

	E	U	R	O	P	Σ
5	0	0	0	0	0	0
4	0	2	4	0	0	6
3	0	87	122	11	0	220
2	0	0	10	2	0	12
1	0	0	0	0	0	0
Σ	0	89	136	13	0	238

1. Tabelle: Die Zahl der bewerteten Schlachtkörper

Live weight at slaughter was on average 586 kg with the coefficient of variation of 6.7 % (Table 2). The greatest variability was found for quantity and percentage of fat and tendon and for longissimus muscle area.

Table 2**Means and coefficients of variation**

	n	$\bar{X}$	MIN	MAX	SD	CV
Live weight at slaughter, kg (1)	238	586	488	705	39	6.7
Carcass weight (kg) (2)	238	322	266	376	24	7.6
Carcass length (cm) (3)	238	136.1	127.0	151.0	4.0	3.0
Chest depth (cm) (4)	238	42.0	36.6	49.5	2.1	5.0
Longissimus muscle area (cm ²) (5)	238	61.1	38.7	85.3	10.0	16.4
Lean (%) (6)	238	68.7	61.1	74.8	2.4	3.5
Fat (%) (7)	238	13.0	5.6	21.4	2.4	19.3
Tendon (%) (8)	238	1.7	0.8	2.7	0.3	17.2
Bone (%) (9)	238	16.6	13.4	19.9	1.2	7.5
Carcass halves: lean (kg) (10)	238	106.8	83.4	132.5	9.7	9.1
fat (kg) (11)	238	20.2	8.3	33.2	4.1	20.9
tendon (kg) (12)	238	2.7	1.5	4.1	0.4	16.4
bone (kg) (13)	238	25.7	20.5	32.1	2.4	9.6

2. Tabelle: Mittelwerte und Variationskoeffizienten

Lebendgewicht(1), Gewicht des Schlachtkörpers(2), Länge des Schlachtkörpers(3), Brusttiefe(4), Fläche des Muskels longissimus dorsi(5), Fleischanteil(6), Fettanteil(7), Sehnenanteil(8), Knochenanteil(9), Fleischmenge in der Schlachthälfte(10), Fettmenge(11), Sehnenmenge(12), Knochenmenge(13)

Prediction of carcass tissue proportion

For predicting tissue proportion we first used carcass weight, carcass length, chest depth and EUROP grades for conformation and fatness. The included independent variables in the model are presented in Table 3. It can be seen that included independent variables explained only a small part of tissue variability. Carcass length, as well as chest depth were not included in the model for estimation of lean and fat proportion. The highest r^2 (0.23) was estimated for

bone proportion. Engelhardt (1991) reported much higher determination coefficient for tissue proportion for Simmental and Black and White bulls, estimated on the basis of carcass weight and conformation and fatness notes (for lean 0.21 and 0.46; for fat 0.39 and 0.45; for bone 0.49 and 0.42). Engelhardt noted also higher residual standard deviation for lean and fat, but not for bone. The main reason for small proportion of explained variation in the present investigation is likely in carcass distribution among conformation and fatness classes. Most of the carcasses were graded into conformation classes U and R and fatness class 3.

Table 3

Coefficient of determination (R^2) and residual standard deviations (RSD) for model selected by stepwise procedures for predicting carcass tissue proportion

	Proportion of carcass tissue, % (1)			
	Lean (2)	Fat (3)	Tendon (4)	Bone (5)
Carcass weight (6)	l	-		q
Carcass length (7)	-	q	q	q
Chest depth (8)	-	-	-	q
EUROP conformation (9)	l	q	-	l
EUROP fatness (10)	q	q	-	q
R^2	0.142	0.104	0.061	0.230
RSD	2.271	2.333	0.284	1.096

l, q -Linear term or quadratic term of independent variables included in the model. (Linearer oder quadratischer Teil der unabhängigen Variablen.)

3. Tabelle: Determinierung (R^2) und Schätzfehler der Vorhersage (RSD) für das mit der „stepwise“ Prozedur ausgewählte Modell für die geschätzten Gewebeanteile der Schlachthälfte

Gewebeanteil der Schlachthälfte(1), Fleisch(2), Fett(3), Sehnen(4), Knochen(5), Gewicht der Schlachthälfte(6), Länge der Schlachthälfte(7), Brusttiefe(8), EUROP Fleischklasse(9), EUROP Fettklasse(10)

In the second step we included longissimus muscle area in the model. r^2 for lean proportion increased to 0.168, but it was only a low proportion of explained variation. RSDs also decreased, but the decrease was rather negligible. Johnson et al. (1992) did not find any significant correlation between longissimus muscle area at 10th rib and lean percentage, but the correlation between longissimus muscle area and lean quantity was as high as 0.68. Engelhardt (1991) reported correlation coefficient between longissimus muscle area at 8/9 rib and lean percentage 0.29, fat percentage -0.12 and bone percentage -0.24. Much higher correlation coefficient found Hartjan (1993), who reported correlation coefficient between longissimus muscle area in loin region and lean, fat and bone percentage 0.50, -0.16 and -0.52. As can we see in Table 4 the inclusion of longissimus muscle area did not increase r^2 significantly.

Prediction of carcass tissue weight

Also for predicting tissue weight we first used carcass weight, carcass length, chest depth and EUROP grades for conformation and fatness. r^2 for predicting carcass lean weight, compared with lean percentage increased significantly. The most important predictor was carcass weight. Bulls had to be slaughtered at optimal fatness, so this strait correlation between carcass weight and lean weight is not surprising. Also r^2 for fat weight doubled

compared with fat percentage, but was with 0.194 still rather low. For bone weight higher r^2 and lower RSD was estimated than for fat weight.

Table 4

Coefficient of determination (R^2) and residual standard deviations (RSD) for model selected by stepwise procedures for predicting carcass tissue proportion

	Proportion of carcass tissue, % (1)			
	Lean (2)	Fat (3)	Tendon (4)	Bone (5)
Carcass weight (6)	l	l	q	q
Carcass length (7)	-	q	q	q
Chest depth (8)	-	-	-	q
EUROP conformation (9)	l	q	-	l
EUROP fatness (10)	q	q	-	q
Longissimus muscle area (11)	l	l	q	q
R^2	0.168	0.124	0.098	0.240
RSD	2.271	2.316	0.279	1.092

l, q - Linear term or quadratic term of independent variables. (*Linearer oder quadratischer Teil der unabhängigen Variablen.*)

4. Tabelle: Determinierung (R^2) und Schätzfehler der Vorhersage (RSD) für das mit der „stepwise“ Prozedur ausgewählte Modell für die geschätzten Gewebeanteile der Schlachthälfte

Gewebeanteil der Schlachthälfte(1), Fleisch(2), Fett(3), Sehnen(4), Knochen(5), Gewicht der Schlachthälfte(6), Länge der Schlachthälfte(7), Brusttiefe(8), EUROP Fleischklasse(9), EUROP Fettklasse(10), Fläche des Muskels longissimus dorsi(11)

Table 5

Coefficient of determination (r^2) and residual standard deviations (RSD) for model selected by stepwise procedures for predicting carcass tissue weight

	Proportion of carcass tissue, % (1)			
	Lean (2)	Fat (3)	Tendon (4)	Bone (5)
Carcass weight (6)	q	q	l	l,q
Carcass length (7)	-	-	q	q
Chest depth (8)	-	-	-	q
EUROP conformation (9)	q	q	-	-
EUROP fatness (10)	q	q	-	q
R^2	0.867	0.191	0.076	0.355
RSD	3,548	3.701	0.429	1.961

l, q - Linear term or quadratic term of independent variables. (*Linearer oder quadratischer Teil der unabhängigen Variablen.*)

5. Tabelle: Determinierung (R^2) und Schätzfehler der Vorhersage (RSD) für das mit der „stepwise“ Prozedur ausgewählte Modell für die geschätzten Gewebeanteile der Schlachthälfte

Gewebeanteil der Schlachthälfte(1), Fleisch(2), Fett(3), Sehnen(4), Knochen(5), Gewicht der Schlachthälfte(6), Länge der Schlachthälfte(7), Brusttiefe(8), EUROP Fleischklasse(9), EUROP Fettklasse(10)

After addition longissimus muscle area in the model, r^2 for lean, fat and tendon slightly increased and RSD decreased, but the differences were even smaller than those for tissue proportion.

Table 6

Coefficient of determination (R^2) and residual standard deviations (RSD) for model selected by stepwise procedures for predicting carcass tissue weight

	Proportion of carcass tissue, % (1)			
	Lean (2)	Fat (3)	Tendon (4)	Bone (5)
Carcass weight (6)	q	q	l	l,q
Carcass length (7)	l	q	q	q
Chest depth (8)	-	-	-	q
EUROP conformation (9)	q	q	-	-
EUROP fatness (10)	q	q	-	q
Longissimus muscle area (11)	q	l	q	-
R^2	0.875	0.207	0.108	0.355
RSD	3.461	3.673	0.423	1.961

l, q - Linear term or quadratic term of independent variables. (*Linearer oder quadratischer Teil der unabhängigen Variablen.*)

6. Tabelle: Determinierung (R^2) und Schätzfehler der Vorhersage (RSD) für das mit der „stepwise“ Prozedur ausgewählte Modell für die geschätzten Gewebeanteile der Schlachthälfte

Gewebeanteil der Schlachthälfte(1), Fleisch(2), Fett(3), Sehnen(4), Knochen(5), Gewicht der Schlachthälfte(6), Länge der Schlachthälfte(7), Brusttiefe(8), EUROP Fleischklasse(9), EUROP Fettklasse(10), Fläche des Muskels longissimus dorsi(11)

Johson et al. (1992) reported that longissimus muscle area contribution to improvement of r^2 in predicting lean percentage with carcass weight and backfat thickness was higher than in predicting lean weight. This improvement was also more evident in heavier carcasses. Similar findings were reported by Fan et al. (1992) as well.

CONCLUSIONS

Using carcass weight, carcass length, chest depth, EUROP conformation and fatness notes, it was not possible to predict accurately proportion of carcass tissue of progeny tested Brown bulls. Also inclusion of longissimus muscle area did not significantly improve the coefficient of determination. Precision of predicting weight of carcass tissue was higher, but only the prediction of lean weight was sufficiently accurate.

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Comparison of urea content in milk, measured in different laboratories

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ABSTRACT

Urea content was determined by the analysis of ten milk samples with 2 to 3 successions in each of the 6 laboratories (3 in Slovenia, 3 in Czech Republic). Determination method was different, but the principle of urea determination in these laboratories was based on enzymatic and/or photometric method. The average urea content varied from 2.38 mmol/l in the laboratory E to 3.43 mmol in the laboratory D. The highest standard deviation was found in the laboratory A, and the lowest in the laboratory F. The highest VC percent was noticed in the laboratory E (51.0%) and laboratory A (44.7%). The analysis results for the difference in urea content in milk measured in different laboratories indicated the lowest difference between the laboratories A and C, and the highest between the laboratories D and E. Standard deviation of differences ranged from 0.12 and 0.46. With *t*-test we examined the differences between laboratories, which were in almost all instances highly statistically significant. We also calculated the correlation coefficients among laboratories, ranging from 0.96 to 0.99, and were highly statistically significant. We determined regression coefficients among these laboratories and with linear regression equation predicted values for each laboratory if a certain trait was measured in any of the other laboratories.

(Keywords: cows, milk, urea content, determination methods)

ZUSAMMENFASSUNG

Vergleichende Untersuchung des Harnstoffgehaltes der Milch in unterschiedlichen Labors

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In sechs Labors (drei in Slowenien und drei in Tschechien) wurde der Harnstoffgehalt von zehn Milchproben mit zwei bis drei Wiederholungen bestimmt. Es wurden unterschiedliche Methoden benutzt, alle basierten auf enzymatischer oder photometrischer Basis. Der durchschnittliche Harnstoffgehalt variierte von 2,38 mmol/l im Labor E bis 3,43 mmol/l im Labor D. Die höchste Standardabweichung wurde im Labor A, die niedrigste im Labor F festgestellt. Der höchste Variationskoeffizient wurde in Labor E (51%) und Labor A (44,7%) festgestellt. Die höchste Differenz zwischen zwei Labors bestand zwischen Labors D und E, die niedrigste zwischen A und C. Die Standardabweichungen der Differenzen zwischen den Labors variierte von 0,12 bis

0,46. Die t-Teste zeigten hoch signifikante Unterschiede zwischen den meisten Labors. Die berechneten Korrelationskoeffizienten in den Labors variierten von 0,96 bis 0,99 und waren statistisch hoch signifikant. Es wurden auch lineare Regressionskoeffizienten berechnet, um den Harnstoffgehalt der Milch aus den Daten in einem Labor auch in anderen Labors schätzen zu können.

(Schlüsselwörter: Kuh, Milch, Harnstoffgehalt, Methode)

INTRODUCTION

Urea content in milk and serum of cows is very closely related. Both contents change when daily ratio of cows is changed. They are either increased or decreased in the same amount. Urea content in milk and in serum is dependent on protein supply, but where energy supply plays its major part. If energy supply is sufficient, the ammonia in the rumen changes to microbe proteins, which are for the animals, of very high quality. Surplus of ammonia is in the form of urea through liver secreted to blood stream and from here to milk. If the energy and protein supply is sufficient, urea content varies from 15 and 25 mg/dl (Paulicks, 1992). If there is a protein surplus and /or lack of energy in the ration, urea content in milk increases, reaching more than 25 mg/dl. And when there is a lack of proteins in the ration of dairy cows, and/or protein surplus, then urea content drops below 15 mg/dl.

Undesired consequences for the animals occur in the case of surplus of proteins in daily ration, and the increased urea content can cause (Nagel, 1994):

- Liver damages and health problems
- Productive and reproductive disorders
- Increased somatic cell count
- Increased veterinary aid expenses
- Increased nitrogen release and thus air pollution
- Increased feed costs due to irrational protein intake
- Increased energy need of the ration
- Increased losses in milk production process

Urea content in milk is an important parameter that indicates correctly balanced protein and energy diet of dairy cows. To use the results of urea content in milk for the estimation of correct energy and protein supply in the ration, these results have to be accurate. Several authors report that urea content indicates, in many instances, the correct protein and energy supply in the ration of dairy cows (Herzog, 1994 ; Herre, 1998). The analysis result of urea content in a sample of milk from the pool provides the estimation of herd ration regarding the relation between proteins and energy supply. Prediction promptness varies from 60% when milk from the pool is analysed (showing the herd ration situation), and up to 80% when the results are obtained for separate dairy cows (Hanuš, 1995). Usually milk analysis for urea content are performed by different methods and procedures, on various machines, often adjusted for the determination of urea content. Punctuality and correctness of urea content determination procedures are often estimated by succession. For the usage of the obtained results of urea content in milk, the most important are the punctuality and correctness of the results, analyses estimation and the efficiency of machines used for the determination of urea content in milk (number of samples – analysis per hour). These three criteria were deciding factors for the development of new methods of routine determination

of urea content in milk, the so called UREAKVANT, which was developed in the Czech Republic (Hanuš, 1998).

In Germany, after the acceptance of urea content determination in milk on Milkoscan using infrared procedure, the accuracy of the results were compared to the analysis performed on Autoanalyzer – previously used for the determination of urea content in milk. The comparison of Autoanalyzer analysis with reference method was very good. The average deviation was less than 2 mg urea per 100 ml of milk. 93% of samples with protein surplus, and 74% samples with a lack of proteins in the ration were measured correctly (Herre, 1998). For the majority of animals the Autoanalyzer protein supply was correct. Yet the results of Milkoscan method compared to the reference method, the deviation was much higher or it varied. Especially in the case of protein surplus in the ration, where the average urea content was 11.5 mg/100 ml lower than the actual value. In the group of samples with protein surplus, where urea value exceeded 30 mg/100 ml, only 43% of samples were correctly measured. In the other 57% milk samples urea content was incorrect. In the case of lack of protein supply, where urea content was lower than 15 mg/100 ml, only 64% samples were measured correctly. Due to the fact that the results of urea content were correctly measured by milkoscan only for the good half (54%) of samples, this method and procedure is at the moment not suitable for the urea content determination in milk. For the interpretation and exploitation of the analysis results, better and more expensive analysis should be used as they will be more accurate than the cheaper analysis giving incorrect results (Herre, 1998).

In 1998 Hanuš compared four different procedures performed in three laboratories. Correlation coefficients among these four methods ranged between 0.76 (the comparison of enzymatic method on Ureakvant and infrared method on FOSS 4000) and 1.00 (the comparison of enzymatic method with NADH and enzymatic UV method COBAS MIRA).

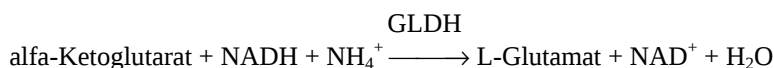
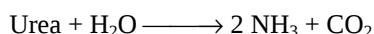
MATERIALS AND METHODS

In the reference laboratory of the Biotechnical Faculty, Department of Animal Science, 10 different samples of milk were prepared in 6 successions and sent to 6 different laboratories with the purpose to determine urea content in milk. Milk samples were preserved by bronopol. The analysis for urea content were performed in the mentioned 6 laboratories, where different methods for the urea content determination were used. The following methods for the urea content determination in milk were used:

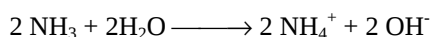
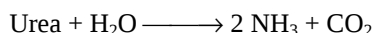
- A: *In the laboratory A* milk analysis for urea content with 3 parallel measurements were performed. The analysis were carried out on biochemical analyzer COBAS MIRA and by enzymatic UV test (ureaza method/GLDH).
- B: *In the laboratory B* milk analysis were performed in 2 successions on UREAKVANT 2 (SD<1.5%; w=±3mg) – enzymatic method and conductivity measurement.
- C: *In the laboratory C* milk analysis were carried out in 2 successions using UREAKVANT 1 (SD<1.5%; w=±3mg) by enzymatic method and conductivity measurement.
- D: *In the laboratory D* milk analysis were carried out by using photometric method on milkoscan 133 B.
- E: *In the laboratory E* the analysis were performed with 3 successions using enzymatic UV method.

F: In the laboratory F the analysis were carried out in two successions and enzymatic method on CL-10 (Eurochem). (SD=1.7% ; w=4.2%).

Principle of the enzymatic method



Principle of measurement with enzymatic method on CL-10



Milk analysis results for urea content were processed using SAS programme. Simple statistical parameters were estimated ($\bar{x}$, SD, CV). Differences in mean values among the laboratories were compared by using the method of difference. We calculated the correlation and determination coefficient, as well as the regression coefficient.

RESULTS AND DISCUSSION

Table 1 presents statistical parameters for urea content, measured in different laboratories. The results indicate that the average urea content is the lowest in the laboratory E (2.38 mmol/l), with the highest variability coefficient (51.0%): The highest urea content was measured in the laboratory D (3.43 mmol/l), where urea content was determined photometrically on milkoscan. Variability coefficient was the lowest in this laboratory (33.5%). Standard deviation ranged from 0.98 in the laboratory F, where urea content was measured by enzymatic method on CL – 10, and 1.43 in the laboratory A, where urea content was determined by using enzymatic method on biochemical analyzer COBAS MIRA.

Table 1

Statistical parameters for urea content (mmol/l), measured in different laboratories

Laboratory (1)	Number of samples (2)	$\bar{x}$	SD	CV%	Min	Max
A	10	3,19	1,43	44,7	1,35	5,09
B	10	3,29	1,19	36,3	1,70	4,90
C	10	3,21	1,14	35,4	1,70	4,85
D	10	3,43	1,15	33,5	1,78	4,66
E	10	2,38	1,21	51,0	0,91	4,41
F	10	2,90	0,98	33,7	1,59	4,26

1. Tabelle: Statistische Parameter des Harnstoffgehaltes (mmol/l), gemessen in verschiedenen Labors

Labor(1), Anzahl der Proben(2)

Table 2 presents the difference in results for urea content in milk in different laboratories. The average difference ranges from 0.015 between the laboratories A and C, and 1.052 between the laboratories D and E. Standard deviation for differences (SD_d) shows the random error of differences among laboratories, expressed absolutely. Standard deviation for differences ranges from 0.12 (B – C) and 0.46 (A – F). The variability coefficient for differences (VC_d) is also the indicator of differences among the laboratories and is expressed relatively. Variability coefficient for differences in four comparisons among the laboratories exceeds the value of 10% and in seven comparisons this coefficient is lower than 7%. The successions of results is specially expressed in the examples where VC_d is lower than 7%. Differences among the laboratories were tested by t-test. In almost all instances of the tested differences, these differences are statistically highly significant. Statistically insignificant are the differences among the laboratories A and B, A and C, A and D, and B and C.

Table 2

The analysis of different results for urea content in milk, measured in different laboratories (n=10)

Difference	$\bar{d}$	SD _d	VC _d	t _{exp}	t _{tab}
A – B	- 0,095	0,24	7,52	1,22898	n.s.
A – C	- 0,015	0,33	10,34	0,1437	n.s.
A – D	- 0,237	0,33	10,34	2,2411	n.s.
A – E	0,815	0,31	9,72	2,6316	*
A – F	0,290	0,46	14,42	8,3217	****
B – C	0,080	0,12	3,65	1,9979	n.s.
B – D	- 0,142	0,18	5,47	2,4411	*
B – E	0,910	0,182	5,53	15,8261	****
B – F	0,385	0,22	6,69	5,4241	****
C – D	- 0,222	0,21	6,54	3,375399	**
C – E	0,830	0,17	5,30	15,44186	****
C – F	0,305	0,20	6,23	4,8328	****
D – E	1,052	0,33	9,62	10,096	****
D – F	0,527	0,25	7,29	6,7391	****
E – F	- 0,525	0,279	11,72	5,9436	****

2. Tabelle: Analyse der unterschiedlichen Meßergebnisse zum Harngehalt der Milch in verschiedenen Labors (n=10)

Table 3 presents correlation coefficient, determination and regression coefficients for the differences among different laboratories. The lowest correlation coefficient is established for the difference between the laboratory D and E (r=0.96) and the highest for the difference between the laboratory A and B. All the correlation are statistically highly significant. The determination coefficients are showing similar picture, where the determination coefficients R vary between 0.926 (D – E) and 0.997 (A – B). Table 3 also presents the partial regression coefficients; a 1 and b 1 are partial regression coefficients when the laboratory X value is an independent variable, and laboratory Y

value dependant variable. Regression coefficients a_2 and b_2 are partial regression coefficients, when the values of laboratory Y are independent variables, and the values of laboratory X dependant variable.

Table 3

Correlation, determination and regression coefficients for differences in urea content among laboratories

Difference X - Y	r	a_1 (X - Y)	a_2 (Y - X)	b_1 (X - Y)	b_2 (Y - X)	R
A - B	0,99873***	0,6248	-0,7392	0,8339	1,1961	0,99746
A - C	0,99262***	0,6853	- 0,8079	0,7899	1,2474	0,98530
A - D	0,98976***	0,8886	- 1,0289	0,7958	1,2311	0,97964
A - E	0,98588***	- 0,2917	0,4286	0,8359	1,1627	0,97196
A - F	0,99694***	0,7215	- 1,0305	0,6829	1,4553	0,99389
B - C	0,99578***	0,0875	- 0,0638	0,9490	1,0449	0,99158
B - D	0,98835***	0,3008	- 0,2327	0,9516	1,0265	0,97683
B - E	0,98864***	- 0,9230	0,9728	1,0039	0,9736	0,97741
B - F	0,99804***	0,2103	- 0,2429	0,8188	1,2165	0,99609
C - D	0,98346***	0,2425	- 0,1309	0,9936	0,9734	0,96719
C - E	0,99151***	- 1,0111	0,9950	1,0565	0,9305	0,98309
C - F	0,99332***	0,1594	- 0,1413	0,8551	1,1539	0,98668
D - E	0,96233***	- 1,1031	1,2599	1,0149	0,9125	0,92608
D - F	0,98560***	0,0221	0,0724	0,8398	1,1568	0,97140
E - F	0,98988***	1,0001	- 1,1783	0,7997	1,2253	0,97985

Regression equation (*Regressionsgleichung*): $y = a + bx_i$

x_i = Individual measurement in the laboratory. (*Individuelle Messung im Labor.*)

a, b = Regression coefficient (*Regressionskoeffizient*)

y = Estimated value of measurement i in the laboratory prediction, if the factors a and b are known. (*Schätzwerte der Messung i in der Laborschätzung, wenn die Faktoren a und b bekannt sind.*)

3. Tabelle: Korrelations-, Determinations- und Regressionskoeffizienten des Harngehaltes in der Milch zwischen den einzelnen Labors

CONCLUSIONS

- Systematic difference between laboratories is shown in the difference in mean values. As they are statistically significant it means that the laboratories are not adjusted or due to different methods or other reasons, give different results.
- Systematic environmental effects can be excluded:
 - by the adjustment of laboratories, based on their joint reference laboratory,
 - systematic error can be excluded with the regression coefficient estimation, factors a and b ,
 - with the estimated straight line and consideration of estimated values, we can get the values that are comparable among the laboratories.

- Differences are higher if the methods are different (enzymatic, photometric), e.g. D – E and C – E.
- Standard deviation of differences (SD_d) indicate random error for the difference between the laboratories, expressed absolutely. This fact is supported by variability coefficient (VC_d), showing the relative difference. In absolute and relative difference we can notice that the successions of the results is the highest where SD_d and VC_d are having low values. Thus we can see the highest successions between B and C, B and D, B and E, B and F, C and D, C and E and C and F, where VC_d has low values, below 7%. The successions is worse especially between the laboratories A and F ($VC_d=14.42$), E and F ($VC_d=11.72$), A and C, as well as A and D, where VC_d is higher than 10% in all instances.
- Correlation coefficients and determination coefficients are among the laboratories and within the same samples relatively high, all above 0.98, except between the laboratories D and E, where the correlation coefficient is 0.96. Correlation coefficients indicate the possible successions among laboratories as mentioned in VC_d estimation. The estimations of separate laboratories show relatively high values of correlation coefficients that are higher than 0.96, and determination coefficients, that are higher than 0.92.

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Fertility of sheep and goats in Slovenia

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ABSTRACT

Trait and parameter definitions for the evaluation of fertility in sheep and goats in Slovenia are discussed. Fertility results for sheep and goats in controlled Slovenian herds for the period 1995-1999 are presented. The average litter size in 1998 was 1.45 (born)/1.36 (live) in sheep, and 1.73 (born)/1.67 (live) in goats. The number of lambs born per ewe per year was 1.97 in sheep and 1.7 in goats.

(Keywords: sheep, goats, fertility, lamb production, performance recording)

ZUSAMMENFASSUNG

Fruchtbarkeit von Schafen und Ziegen in Slowenien

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In vorliegender Arbeit werden die Fruchtbarkeitsparameter von Schafen und Ziegen diskutiert. Dargestellt werden die Fruchtbarkeitsleistungen in den kontrollierten Herden in den Jahren 1995 bis 1999. 1998 betrug bei Schafen die durchschnittliche geborene Lämmerzahl 1,45/1,36 lebenden, und bei Ziegen durchschnittlich 1,73 geborene/1,67 lebenden Ziegenlämmern. Die Zahl der geborenen Lämmer pro Jahr betrug 1,97, der Ziegenlämmer jährlich 1,7.

(Schlüsselwörter: Schafe, Ziegen, Fruchtbarkeit, Leistungsprüfung)

INTRODUCTION

Performance recording for sheep and goats in the Slovenian small ruminant breeding programme was initiated in 1989. The information system is gradually being built and upgraded (Drobnič *et al.*, 1995). After the basic production module and the milk recording module (Kompan *et al.*, 1997), the module for the evaluation of reproductive efficiency is under development.

The two most numerous sheep breeds in use in Slovenia are the Jezersko-Solcava and the Improved Jezersko-Solcava Sheep breeds (JS and JSR), which are meat breeds fertile throughout the year and suitable for the frequent lambing management system. The Bovec Sheep and Improved Bovec Sheep breeds (B and VFB) are dairy breeds and are seasonally fertile. The goats are used predominantly for milk production.

Fertility is evaluated at two levels: level one is to assess the productivity of an individual flock, and level two is to assess the productivity of an individual female. This article focusses on evaluating the reproductive efficiency of flocks: specifically, lamb production, based on regularly collected data.

DEFINITION OF FERTILITY TRAITS

Exact definition of fertility traits and evaluation parameters is a premise and a basic requirement for ongoing monitoring of fertility within a breeding programme. Fertility traits and reproductive efficiency evaluation parameters have been described by many authors and can be found in most sheep production textbooks. However, in practice it is often the case that certain data are not available or not always available. In such cases the formulas are 'stretched', and trait and parameter definitions are no longer clear.

In Slovenia sheep and goats are produced predominantly under extensive conditions. As a consequence, it is not always straightforward to define how to define certain production evaluation parameters. That is, 'extensive conditions' implies that the data collected are frequently of limited quality in terms of availability and accuracy. In general, some data elements are generally more dependable than others. Consequently, parameters that are based on these data are also more reliable. When interpreting results, it needs to be clear how reliable a certain parameter is.

Often, when data are missing, 'calculated' surrogate values are used. Depending on the proportion of measured against 'guessed' values, the reliability of a parameter value varies. Sometimes some breeders provide most of the data, while others will be almost entirely estimated. There is poor comparison between the parameters for two such breeders. Likewise, comparing a certain breeder against the national average may be questionable. Furthermore, some data are easier to collect accurately than others, and may generally be more worthy of trust.

Of course, breeders must at all times be encouraged to provide high quality data. Well designed practices, an understanding of the impact of accurate data on the information produced, regular revision and control of data collecting practice, animal identification, and the benefit of regular access to their own results and results for flocks raised in similar conditions will motivate breeders to recognise the benefit of high quality data records. However, reproductive efficiency evaluation parameters within a breeding programme are expected to measure reproductive efficiency in a way that can be used within the national breeding programme, taking into account the existent conditions: flocks of various sizes, different breeds, both meat and dairy, and different management technologies, and different levels of production intensity.

Lamb production efficiency evaluation parameters

The basic requirements for any parameter set to describe sheep fertility, specifically lamb production, are: firstly, to provide evaluation of the productivity of animals, to evaluate overall productivity, and to give an insight into factors affecting the results achieved; secondly, to ensure a reasonable level of reliability throughout the breeding programme population, the parameters must be based on records of a certain minimal level of quality; thirdly, to ensure comparability among flocks; lastly, to ensure comparability with other populations, mainly by providing clear definitions of the parameters in use.

The parameters of productivity describe the output of the production unit - the flock. From the perspective of lamb production, the output is the total weight of lamb at the time of sale. More specifically, the lamb output is: the total weight (or number) of male lambs selected for breeding stock or test * breeding value factor + the total weight (or number) of female lambs selected for breeding stock * breeding value factor + the total weight of slaughter lambs * carcass classification value. Evaluation of this

parameter assumes that the three 'values' are known - but they are not fixed. The parameters discussed can be summarised as follows.

Summary of parameters describing fertility of females in sheep (and, accordingly, goats)

Productivity in a defined time period ('year')	
a) Total lamb output	unkn. comp.
b) Total lamb weight at time of sale	unstandardised
c) Total lamb weight at standardised age	unstandardised
d) Lamb weight per female per year	reliability
e) Number of lambs reared per female per year	reliability
f) Number of lambs born per female per year	reliability
g) Number of lambs born alive per female per year	reliability
h) Lamb weight per fertile female per year	+
i) Number of lambs reared per fertile female per year	+
j) Number of lambs born per fertile female per year	+
k) Number of lambs born alive per fertile female per year	+
l) Number of litters per year per female / fertile female (in the observed year)	+
m) Period between parities per female / fertile female (in the observed year)	+
n) Age at first lambing	+
o) Period between flock entry and first lambing	+
Litter size traits:	
p) Number of lambs born per litter	+
q) Number of lambs born alive per litter	+
r) Number and percentage of stillborn lambs	+
s) Number of lambs reared per litter	+
t) Losses: number and percentage of lambs lost in rearing	+

The parameter 'total lamb weight at time of sale' works for a particular keeper, but lacks comparability for general use within the breeding programme. It needs to be corrected to a uniform age at weighing. Keepers sell lambs at very different ages. There are two possible solutions: either correcting the weight to a 'standard' age (e.g., with linear interpolation), or asking the keepers to weigh lambs at a certain approximate age (or weight). The first, due to large variation of sale age, is highly inaccurate, while the second is impractical for the keeper.

The parameter 'total lamb weight at standardised age' still needs to be normalised to a female, to exclude the flock size effect, and to a time period. The time period is usually a year, and due to seasonal productivity of the large proportion of the population, the time period is usually taken to be November - October, referred to as the 'year'. The number of females in the flock is the average flock size (females only) throughout the year, or the total number of days spent on stock divided by 365:

$$\frac{\text{sum (each female (31 October or culling date, whichever is sooner minus 1 Nov. following yr or flock entry date, whichever is later))}}{\text{divided by 365.}}$$

The parameter 'lamb weight per female per year' (d), and also e, f and g, are highly informative parameters, recommended as good measures of lamb crop (e.g., *Brown et al., 1989, Wickham et al., 1982*) and also used as a measure of productivity in pigs (*Kovac et al., 1992*). Unfortunately, it is based on records that are at present of low reliability in the Slovenian sheep and goat breeding programme, and thus the parameter is unreliable. Culling date, needed to calculate the average flock size, is one of the data records not collected with sufficient reliability. Flock entry date, on the other hand, is sufficiently reliable because breeding stock replacement has been associated with breeding stock premiums (although the breeding stock replacement premium scheme has been discontinued in 1999). Where replacement females are selected from the breeder's own flock there arises the problem of defining when 'a ewe becomes a ewe'; that is, from what age on she is considered to be part of breeding stock and a debit to the breeding stock account. Despite the fact that the parameters d, e, f and g cannot at present be evaluated with sufficient reliability, this highly informative value calls for efforts to overcome the problems in the near future, either by improving the present data collecting mechanisms, or by introducing auxiliary ones.

Table 1

Sheep fertility results in controlled flocks in Slovenia in 1998

Breed (1)	No. of flocks (2)	No. of litters (3)	No. first litters (4)	Age at lambing (yrs) (5)	Parity (6)	Age at first lambing (7)	Period between parities (8)	Lambings per fertile ewe per year (9)	Litter size (born) (10)	Litter size (live) (11)	Lambs born per fertile ewe per year (12)
Total (13)	192	6262	1230	3.46	3.69	477	268	1.36	1.45	1.36	1.97
Jezersko-Solcava	71	1920	299	3.82	4.18	488	261	1.40	1.27	1.21	1.78
Improved JS	75	3005	596	3.13	3.58	443	238	1.53	1.60	1.48	2.45
Texel	2	37	5	4.15	3.46	728	383	0.95	1.65	1.49	1.57
B. Krajina Z.	13	126	19	5.20	4.63	556	238	1.53	1.13	1.09	1.73
Bovec	19	698	177	3.45	3.11	492	351	1.04	1.36	1.33	1.41
Improved B	7	156	33	3.55	3.26	428	362	1.01	1.58	1.47	1.60
Istrian Z.	5	276	100	3.27	2.51	607	370	0.99	1.31	1.28	1.30

1. Tabelle: Fruchtbarkeitsergebnisse bei Schafen in den kontrollierten Herden Sloweniens im Jahre 1998

Genotyp(1), Anzahl der Herden(2), Geborene Lämmer gesamt, Stück(3), Gesamtzahl der Lämmer bei 1. Ablammung(4), Durchschnittl. Ablammungsalter pro Mutterschaf, Jahre(5), Parität(6), Alter der Mutterschafe bei 1. Ablammung, Tage(7), Zeitraum zwischen den Paritäten, Tage(8), Zahl der Ablammungen pro Mutterschaf/Jahr(9), Anzahl der geborenen Lämmer pro Geburt(10), Anzahl der lebenden Lämmer/Geburt(11), Lämmerzahl pro Mutterschaf/Jahr(12), Gesamt(13)

An alternative to d, e, f and g which is less informative but more reliable is to base the parameter on females which have lambed: number of lambs per fertile female per year (h, i, j and k). This parameter excludes information on unproductive ewes. However, it is

based on sufficiently reliable records and provides good means for between-flock and year-to-year comparison of results.

The parameters l to t are simple, analytical parameters which assist in the explanation of the composite parameters. They are based on reliable records and provide solid ground for analysing factors that affect lamb production in sheep and goats.

FERTILITY OF SHEEP IN SLOVENIA

Data for controlled flocks from 1995 to April 1999, with special focus on the year 1998, have been analysed in accordance with the parameter definitions described. Fertility is evaluated in herds with over 20 dairy or over 30 meat animals. Fertility is also observed in all herds included in the gene preservation programme. In the period 1995 to April 1999 26,700 lambings were recorded, and in 1998 4972 ewes in controlled herds produced 6262 litters. In 1998 (Table 2) 25% were first lambings and 75 % repeated lambings. The mean age at lambing was 3.46 years, varying from 3.13 (Jezerko-Solcava) to 5.20 (Bela Krajina Zackel). The latter breed was included in the breeding programme in 1997 and the results are less reliable. The average parity of ewes at lambing was 3.7, 2.5 in Istrian Zackel and 4.6 in the Belo Krajina Zackel Sheep breed. The age at first lambing varied, and was generally lower in the breeds with all-year breeding, and higher in the breeds with seasonal breeding. The total average was 477 days.

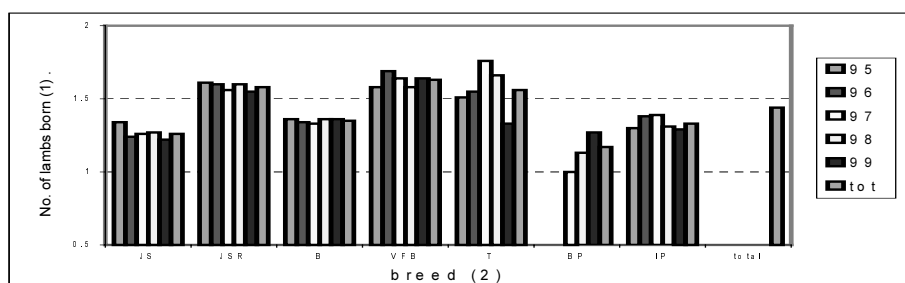
Litter size

Parameters used to evaluate litter size are number of lambs born per litter, number of lambs born alive, and, derived from the two, number and proportion of lambs lost.

The average litter size for 1998 was 1.45 lambs born and 1.36 born alive. These values are slightly higher than the results for the last five years (1.44 and 1.35 respectively). It is possible to notice a slight trend of increasing litter size throughout the last five years. The percentage of stillborn lambs remained constant during this period, at 3.2 %, this being the same as in 1998.

Fig. 1

Litter size (number of lambs born) in Slovenian sheep breeds over the years



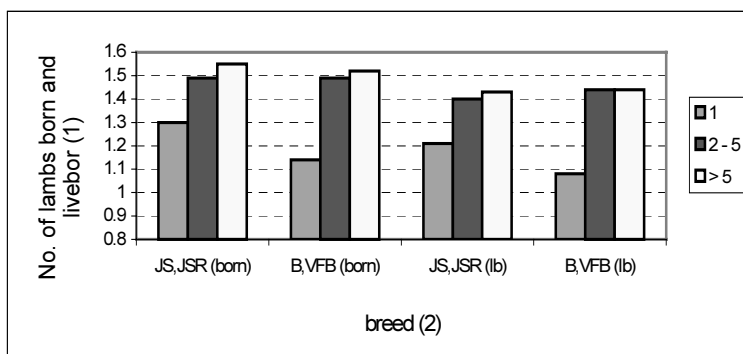
1. Abbildung: Anzahl der geborenen Lämmer bei den slowenischen Schafzassen in den Jahren 1995 bis 1999

Anzahl der geborenen Lämmer(1), Genotyp(2)

The differences in litter size among breeds which had been expected were observed (*Fig. 1*). The highest litter size was attained among the crossbreeds ('improved breeds'). Litter size is generally higher in larger flocks, as is the number of lambs born alive, and the rate of losses is lower. This trend is observed in both meat and dairy sheep breeds. As expected, litter size increases with parity in the ewes.

Fig. 2

Litter size (lambs born alive) in the Jezersko-Solcava and Improved Jezersko-Solcava (JS, JSR) and Bovec and Improved Bovec (B, VFB) breeds from 1995 to April 1999



2. Abbildung: Anzahl der lebend geborenen Lämmer der Genotypen Jezersko-Solcava und Veredelte Jezersko-Solcava (JS, JSR) und Bovec und Veredelte Bovec (B, VFB) in den Jahren 1995 bis 1999

Anzahl der lebend geborenen Lämmer(1), Genotyp(2)

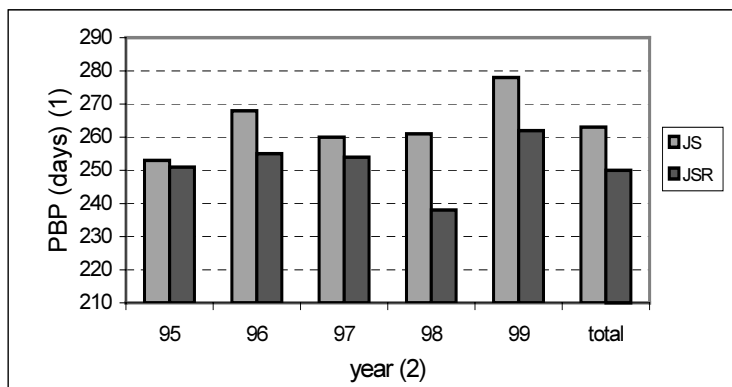
Period between parities and number of lambings per ewe per year

Period between parities is an important measure of fertility in flocks where year-round breeding is practised. All dairy sheep breeds, and also some meat breeds, are seasonally fertile, and this can only be changed by means of treatment of an 'artificial' nature. In these breeds the period between parities is invariably close to 365 days, and the parameter is hence somewhat less informative. A more prolonged period merely reflects absence of lambing in individual ewes.

In meat breeds, specifically in flocks in which continuous, year-round breeding takes place, the period between parities (PBP) is one of the most important indicators of productivity. In these breeds PBP is affected by technology (i.e., service and weaning), and other, mainly environmental effects. Therefore, managerial decisions will contribute to attempts to attain optimal PBP. The average gestation period in sheep is 150 days, and this sets theoretical limits to PBP. The average PBP recorded in 1998 in controlled Slovenian flocks is 246 days for meat breeds.

Fig. 3

Period between parities in the Jezersko-Solcava (JS) and Improved Jezersko-Solcava Sheep (JSR) breeds from 1995 to April 1999



3. Abbildung: Zeitraum zwischen den Paritäten beim Genotyp Jezersko-Solcava (JS) und Veredelte Jezersko-Solcava (JSR) in den Jahren 1995 bis April 1999

Zeitraum zwischen den Paritäten (PBP) Tage(1), Jahr(2)

Fig. 3 shows PBP for the Jezersko-Solcava and the Improved Jezersko-Solcava breeds in 1998. Slightly lower PBP was recorded in the Improved Jezersko-Solcava (238 days in 1998, 250 in the last five years), and in the pure breed Jezersko-Solcava (261 days in 1998 and 263 in the last five years). There was no substantial change of the period between parities with increasing age in these ewes, nor was substantial change observed with growing flock size, PBP perhaps being slightly longer in larger flocks.

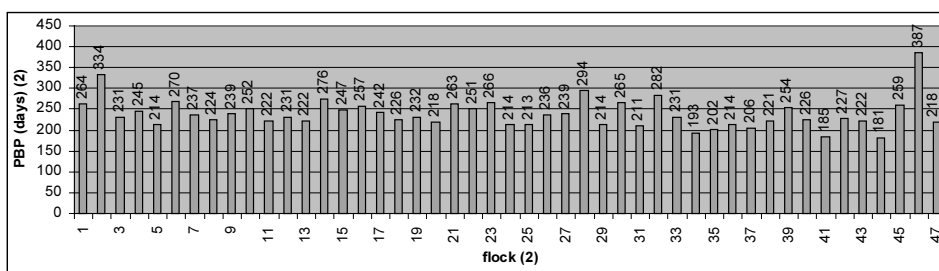
Fig. 4 shows PBP for 1998 across flocks of the Improved Jezersko-Solcava breed. It is evident that flock PBP is highly variable. PBP values for some flocks deviate even up to a duration of one year or longer. These are breeders with small herds who reduce labour input by seasonal breeding and thus concentrate lambings into a short period. Flocks with a short PBP typically have lambings distributed almost evenly throughout the year, although there is a slight recess in the summer months. Evidently, some breeders are striving to intensify production, while part others practise extensive breeding.

The Belokranjska Pramenka breed was recognised as an autochthonous breed for the gene conservation programme, and was introduced into the Slovenian breeding programme in 1997. The number of animals of this breed in controlled flocks is thus still relatively low; 121 lambings in 13 flocks were recorded in 1998.

The number of lambings per ewe per year is derived from the period between parities as an inverse value ($365/\text{PBP}$). As such, this value has the same informative message as the PBP, but it illuminates the situation from a different perspective. In 1998 the average Jezersko-Solcava ewe produced 1.4 litters per year, and the Improved Jezersko-Solcava 1.53. The values are slightly increased compared to the five-year averages (1.39 and 1.46 litters per ewe per year). The average for all sheep in the breeding programme in 1998 was 1.36, including all sheep breeds.

Fig. 4

Period between parities in the Improved Jezersko-Solcava breed across flocks in 1998



4. Abbildung: Zeitraum zwischen den Paritäten beim Genotyp Veredelte Jezersko-Solcava in den verschiedenen Herden im Jahre 1998

Zeitraum zwischen den Paritäten (PBP) Tage(1), Herde(2)

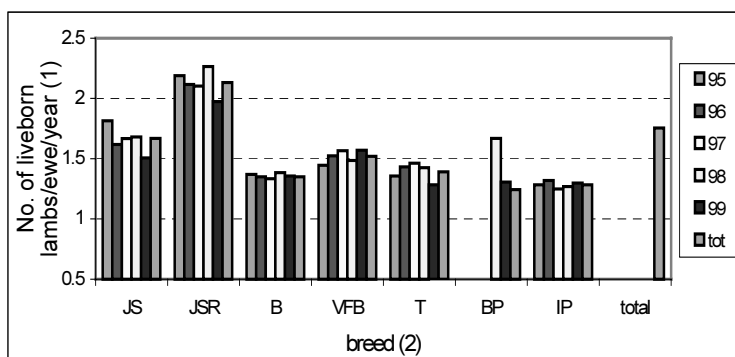
Number of lambs per ewe per year

The parameter 'number of lambs born per ewe per year' is composed on the basis of the parameters relating to litter size (number of lambs born) and number of litters per ewe per year. It is a more integral indicator of reproductive productivity of breeding animals.

Fig. 5 shows the number of young born alive per ewe per year for the entire controlled population in the last five years. The Improved Jezersko-Solcava Sheep ranked by far the highest with 2.13 young born alive per ewe per year, followed by the Jezersko-Solcava with 1.6. The value recorded for the Texel (1.39) fell between those for the Bovec Improved (1.5) and the Bovec Sheep (1.3). The extensive Zackels produced 1.2 lambs per ewe.

Fig. 5

The number of liveborn lambs per ewe per year across breeds from 1995 to April 1999



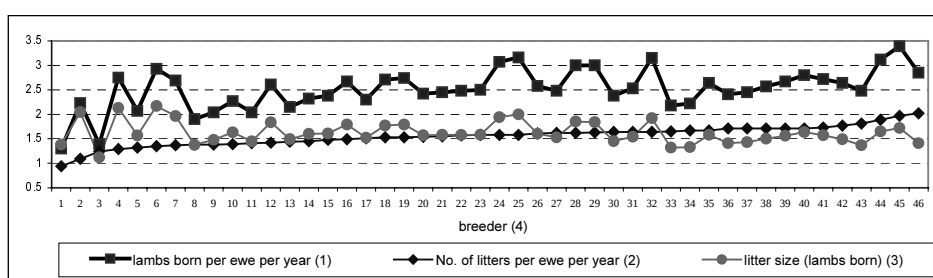
5. Abbildung: Anzahl der lebend geborenen Lämmer pro Mutterschaf bei den verschiedenen Genotypen in den Jahren 1995 bis 1999

Anzahl der lebend geborenen Lämmer/Mutterschaf/Jahr(1), Genotyp(2)

Litter size is a trait with low heritability, and selection yields slow improvements. Assuming fixed feeding and health conditions, the breeder has little influence on the number of young born in the litter. Fig. 6 offers an illustration of how the period between parities (or number of litters per ewe per year) affects the number of young born per female per year. Breeders within the same breed (the figure shows Improved Jezersko-Solcava) achieve highly varying results.

Fig. 6

The influence of the number of lambings per ewe per year and litter size on the number of lambs born per ewe per year, demonstrated across the flocks of the Improved Jezersko-Solcava breed



6. Abbildung: Einfluss der Ablammungszahl pro Mutterschaft/Jahr auf die Lämmerzahl pro Ablammung, gezeigt an den Herden der Veredelten Jezersko-Solcava

Geborene Lämmer pro Mutterschaft/Jahr(1), Zahl der Ablammungen pro Mutterschaft/Jahr(2), Geborene Lämmer pro Ablammung(3), Züchter(4)

FERTILITY OF GOATS IN SLOVENIA

Goat keeping in Slovenia is mainly aimed at milk production. The flocks included in the milk recording scheme involve the goat breeds Saanen and Alpine. In 1999 breeders started to show interest in the Boer meat breed. Second to milk yield, fertility is a very important output in goat production, even in dairy breeds. The dairy breeds Saanen and Alpine are seasonally fertile, while the meat breed Boer is continuously fertile.

Fertility is monitored in herds with over 20 dairy or over 30 meat animals. In 1998 114 goat flocks were included in the recording scheme, producing 1089 litters. The results are shown in Table 3. The average age of goats at kidding was 4 years, and 17 % produced their first litters in that year. The youngest breed was the Boer. The breed has recently been introduced into Slovenia and was included in the breeding programme in 1998. The population is still low, located in a few flocks.

The average parity of goats in Slovenia in 1998 was 3.62. The average period between parities (PBP) was 371 days, which is to be expected for seasonal breeding. The meat breed Boer had a PBP of 281 days. The average litter size was 1.73 (born) and 1.67 (born alive). The goats produced 1.7 kids per female per year. The result for the Boer differed, at 2.29 kids per female per year.

Table 2
Goat fertility results in controlled flocks in Slovenia in 1998

Breed (1)	No. of flocks (2)	No. of litters (3)	No. first litters (4)	Age at lambing (years) (5)	Parity (6)	Age at first lambing (7)	Period between parities (8)	Lambings per fertile ewe pre year (9)	Litter size (born) (10)	Litter size (live) (11)	Lambs born per fertile ewe per year (12)
Total (13)	1081	114	1089	186	4.00	3.62	528 1.45	371	1.73	1.67	1.70
Saanan	259	38	259	36	4.40	3.96	490 1.34	385	1.77	1.74	1.68
Alpine	761	64	762	124	4.00	3.67	544 1.49	367	1.70	1.64	1.69
Boer pasma	51	12	58	24	2.09	1.47	505 1.38	281	1.76	1.71	2.29

2. Tabelle: Fruchtbarkeitsergebnisse bei Ziegen in den kontrollierten Herden Sloweniens im Jahre 1998

Genotyp(1), Anzahl der Herden(2), Geborene Ziegenlmmer gesamt, Stck(3), Gesamtzahl der Ziegenlmmer bei 1. Ablammung(4), Durchschnittl. Ablammungsalter pro Mutterziege, Jahre(5), Paritt(6), Alter der Mutterziegen bei 1. Ablammung, Tage(7), Zeitraum zwischen den Paritten, Tage(8), Zahl der Ablammungen pro Mutterziege/Jahr(9), Anzahl der geborenen Ziegenlmmer pro Geburt(10), Anzahl der lebenden Ziegenlmmer/Geburt(11), Lmmerzahn pro Mutterziegen/Jahr(12), Gesamt(13)

The number of kids born and reared per female per year depends on a number of environmental effects, for instance nutrition, the milking and mothering abilities of the dam, fitness of the young, health, stress, technology, management and other factors. Heritability is generally low, but varies between breeds. The environmental circumstances affect the number of ovaries ovulating and undergoing conception, and also the number of young born, born alive and weaned. *Figures 7 and 8* show the number of kids born and born alive per litter in 1998 for both breeds. It is evident that breeders attain highly varying results, even within the same breed.

CONCLUSIONS

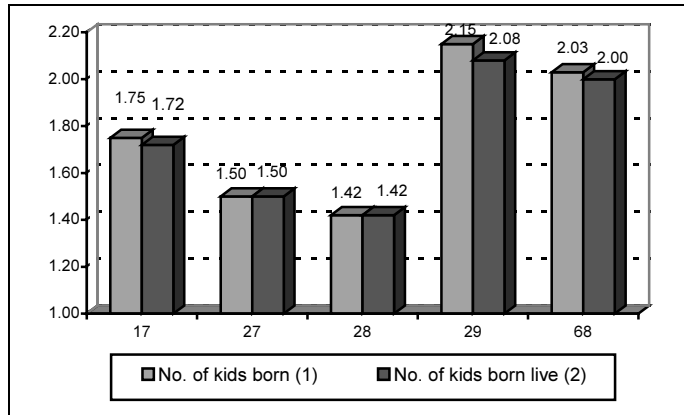
The initial review of lamb production evaluation parameters and the investigation of applicability to the Slovenian small ruminant breeding programme gave a list of parameters that may be used with a sufficient level of confidence. It also showed that the most informative parameters are not adequately reliable due to the unsatisfactory or uncertain quality of certain data records. The deficiencies exposed in data flow indicate where effort towards improvement needs to be applied.

Lamb production in sheep and goats, analysed in accordance with the parameter definitions described, has generally shown slight improvements over the past five years. However, the results indicate that there is still margin for improvement. Besides selection, which gives slow but long-term improvement, good flock management, proper nutrition and health condition can bring results in the short term. There are also expectations in the improvement of information about animals, which would help the

keeper to respond more promptly with management action. It is up to the breeder to be accurate with data recording and the extension service to assist other breeders and the breeding programme office to provide reliable measures of herd productivity.

Fig. 7

Number of kids born and liveborn in a litter in 1998 in the Saanen goat

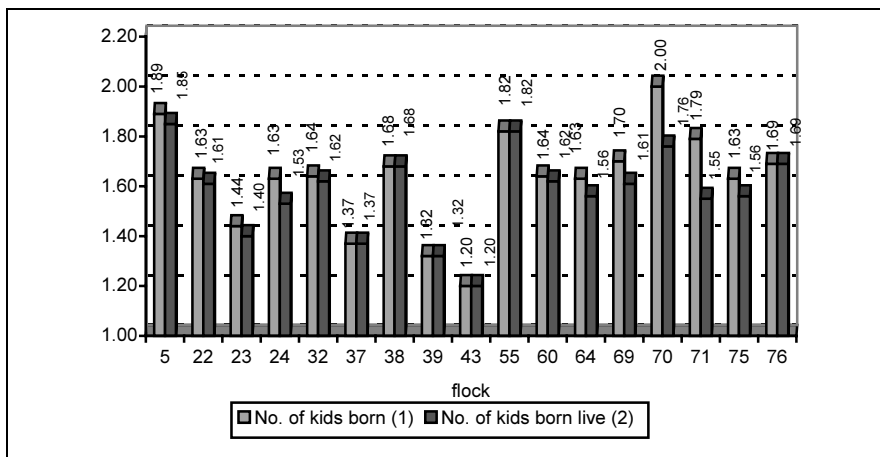


7. Abbildung: Zahl der geborenen und lebend geborenen Ziegenlmmer pro Ablammung bei den Saanen-Ziegen im Jahre 1998

Anzahl geborene Ziegenlmmer(1), Anzahl der lebend geborenen Ziegenlmmer(2)

Fig. 8

Number of kids born and liveborn in a litter in 1998 in the Alpine goat



8. Abbildung: Zahl der geborenen und lebend geborenen Ziegenlmmer pro Ablammung bei den Alpen-Ziegen im Jahre 1998

Anzahl geborene Ziegenlmmer(1), Anzahl der lebend geborenen Ziegenlmmer(2)

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Zusammenhang zwischen dem S/EUROP Standard und einigen Schlachtparametern bei Schafen

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ZUSAMMENFASSUNG

Die Autoren verglichen bei den Genotypen Ungarisches Merino und Ile de France in ihren Untersuchungen die Schlachtparameter bzw. die mit Hilfe des Computertomographen bestimmte Kotelettfläche mit den Ergebnissen des S/EUROP-Standard. Sie stellten fest, dass die gegenwärtig angewandte Klassifizierung zur Beurteilung des Tierwertes gut geeignet ist, aber machen auch auf Fehler aufmerksam. Sie schlagen die Erarbeitung und Einführung eines neuen objektiveren Systems vor, dessen einer Ausgangspunkt die Untersuchung der Körperzusammensetzung mit dem Computertomographen (CT) ist.

(Schlüsselwörter: Schaf, S/EUROP, Körperzusammensetzung, CT, Schlachtung)

ABSTRACT

Examination of the relation between S/EUROP carcass classification for sheep and certain slaughter parameters

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In this study the authors compared the slaughtering characteristics of Hungarian Merino and Île de France sheep with their S/EUROP classification results. They established that the classification system presently used is well-suited for application in the evaluation of carcass commercial value, but at the same time also point out errors in this system. The development and introduction of a new, more objective method is recommended.

(Keywords: sheep, S/EUROP, tallow, conformation, CT, slaughter)

EINFÜHRUNG

Unter den Schafprodukten spielt das Fleisch in der menschliche Ernährung eine beachtliche Rolle. Die Weltproduktion an lebenden Schafen und Schaffleisch (mit Knochen) gelangt zu 10-15% in die Handelsketten, in denen seit langer Zeit in vielen

Ländern - darunter auch in Ungarn - auch heute noch die Grundlagen eines ehrlichen Geschäftsbenehmens fehlen. Mit anderen Worten: Zu einer gewissen Schlachtkörperqualität gehört die entsprechende Klassifizierung und der dafür vorgesehene Preis (*Toldi*, 1994), was angestrebt werden sollte. In den Mitgliedsländern der Europäischen Union (des weiteren: EU) wird für Schaf-Schlachtkörper bereits das S/EUROP Qualifizierungssystem angewandt, das den oben erwähnten Erwartungen entspricht und in der Praxis zuverlässig und einfach angewendet werden kann. Da Ungarn zu Beginn des 2. Jahrtausend erwartungsgemäß Mitglied der EU wird, muss es seine Agrarpolitik deren Richtlinien angleichen. Auch das Anpassen der Klassifizierung der Schaf-Schlachtkörper ist Teil dieser riesigen Umgestaltung. In naher Zukunft wird in den Ländern der EU eine maximale Transportdauer für lebende Tiere eingeführt. Dadurch wird es dringend, bis zum EU-Beitritt anstatt des jetzt dominierenden Exportes an lebenden Tieren auf den Export von Schlachtkörpern überzugehen. Voraussetzung dazu ist jedoch die Klassifizierung nach EU-Standard vor dem Verkauf (*Mucsi*, 1997).

Die vom ITOVIC (Forschungsinstitut für Ziegen- und Schafzucht) und INRA (Forschungsinstitut der französischen Landwirtschaft) vorgeschlagene Methode zur Handelsklassifizierung von Lammschlachtkörpern (*Roy et al.*, 1971) bzw. die zur Klassifizierung von erwachsenen Schafen erarbeitete Methode (*Dumont et al.*, 1972) ist nur für eine subjektive Beurteilung geeignet. Die französischen Forscher betonten jedoch schon damals, dass es sehr nützlich wäre, die Unterschiede zwischen der subjektiven und der objektiven Beurteilung aufzudecken und die Daten nach der Zerteilung zu vergleichen. Eine Methode dazu ist, den Schlachtkörper nach dem Schlachten hinter der letzten Rippe zu teilen und die langen Rückenmuskeln mit dem Planimeter zu messen.

Durch unsere Untersuchungen wollten wir Antwort auf die Frage erhalten, inwieweit das gegenwärtige Beurteilungssystem die tatsächliche Körperzusammensetzung der Tiere widerspiegelt. Dabei richteten wir uns nach den Handelsklassen in Westeuropa und verglichen an den Schlachtkörpern von schweren Lämmern die objektiveren Untersuchungsdaten des CT mit denjenigen der subjektiven S/EUROP-Daten.

MATERIAL UND METHODE

Bei unseren Versuchen wurden insgesamt 60 Schafe mit Computertomograph aufgrund der Aufnahme der Kotelettfläche hinter der letzten Rippe laut S/EUROP-Standard auf die Schlachtparameter untersucht. Die von uns untersuchten und geschlachteten Versuchstiere waren jeweils 30 Tiere beiderlei Geschlechts vom Genotyp Ungarisches Merino und Ile de France mit einem Lebendgewicht von 28-35 kg. Somit standen 4 Versuchsgruppen zu Vergleichszwecken zur Verfügung (*Tabelle 1*).

Nach der CT-Untersuchung wurden die Tiere geschlachtet und zerlegt, wobei Kopf und Füße abgenommen wurden. Danach wurden die Innereien entfernt sowie das Pansen- und Nierenfett mit einer Genauigkeit von 0,01 kg gewogen. Die warmen Schlachtkörper wurden laut der standardisierten Vorschriften beurteilt und dem australischen Standard gemäß zerteilt. Die Teile wurden ebenfalls mit 0,01 kg Genauigkeit gewogen.

Bei der S/EUROP Klassifizierung dominieren die Anteile der Fleischstücke I. Klasse. Deshalb wurden bei der Bestimmung der Zusammenhänge die Daten von Keule, Rücken - oberer Abschnitt (Rippenkotelett) und unterer Abschnitt (Lendenkotelett) - sowie die Schultern berücksichtigt.

1. Tabelle**Charakteristik der Versuchsgruppen**

	Tierzahl	Schlachtgewicht, kg (6)		Kotelettgewicht, kg (7)	
	(5)	Durchschn. (8)	Abweichg. (9)	Durchschn.	Abweichg.
Ung. Merino, männl. (1)	15	31,07	2,65	14,47	1,97
Ung. Merino, weibl. (2)	15	29,26	1,89	13,48	1,08
Ile de France, männl. (3)	15	33,74	3,64	15,86	1,93
Ile de France, weibl. (4)	15	32,25	1,99	15,18	1,22

Table 1: Characteristics of the groups examined

Hungarian Merino ram(1), Hungarian Merino ewe(2), Ile de France ram(3), Ile de France ewe(4), Number of animals(5), Slaughter weight, kg(6), Weight of carcass, kg(7), Mean(8), SD(9)

Die statistische Analyse wurde mit der Software SPSS for Windows 8.0 durchgeführt. Nach Errechnen der statistischen Grundparameter wurden die paarigen Korrelationswerte bestimmt.

ERGEBNISSE UND BEWERTUNG

Als erstes wurden die Zusammenhänge zwischen den Körperproportionen und den Schlachtparametern untersucht. Die erhaltenen Daten der Fleischstücke I. Klasse sind in

2. Tabelle**Werte für Keule und Schulter in den Versuchsgruppen**

	Gewicht Keule, kg (5)		Gewicht Schulter, kg (6)	
	Durchschn. (7)	Abweichung. (8)	Durchschnitt	Abweichung
Ung. Merino, männl. (1)	2,43	0,29	1,26	0,15
Ung. Merino, weibl. (2)	2,30	0,20	1,18	0,12
Ile de France, männl. (3)	2,74	0,32	1,51	0,15
Ile de France, weibl. (4)	2,65	0,19	1,42	0,11

Table 2: Haunch and shoulder characteristics in the groups examined

Hungarian Merino ram(1), Hungarian Merino ewe(2), Ile de France ram(3), Ile de France ewe(4), Weight of haunch, kg(5), Weight of shoulders, kg(6), Mean(7), SD(8)

3. Tabelle

Werte für das Rippen- und Lendenkotelett in den Versuchsgruppen

	Gewicht Rippenkotelett, kg		Gewicht Lendenkotelett, kg	
	(5)		(6)	
	Durchschnitt (7)	Abweichung (8)	Durchschnitt	Abweichung
Ung. Merino, männl. (1)	0,78	0,16	0,60	0,12
Ung. Merino, weibl. (2)	0,70	0,09	0,57	0,09
Ile de Fance, männl. (3)	0,81	0,17	0,63	0,12
Ile de France, weibl. (4)	0,73	0,09	0,66	0,09

Table 3: Long and short chop characteristics in the groups examined

Hungarian Merino ram(1), Hungarian Merino ewe(2), Ile de France ram(3), Ile de France ewe(4), Weight of long chop, kg(5), Weight of short chop, kg(6), Mean(7), SD(8)

Aus den Daten der Tabelle ist zu sehen, dass bei der französischen Rasse - obwohl das Schlachtkörpergewicht fast gleich ist - die wertvollen Fleischteile ein größeres Gewicht haben.

Zwischen der S/EUROP Qualifizierung und den Fleischteilen I. Klasse wurde ein enger Zusammenhang festgestellt ($P \leq 1\%$) - (Tabelle 4).

4. Tabelle

Klassifizierung der Körperproportionen, Korrelationen zwischen Keule, Schulter, Rippen- und Lendenkotelett

	S/EUROP Standard	Keule	Schulter	Rippenkotelett	Lendenkotelett
S/EUROP Standard (1)	1	0,669 **	0,624 **	0,431 **	0,439 **
Keule (2)		1	0,827 **	0,742 **	0,665 **
Schulter (3)			1	0,565 **	0,546 **
Rippenkotelett (4)				1	0,695 **
Lendenkotelett (5)					1

** : $P \leq 0,01$

Table 4: Values for conformation classification: correlations between the weight of haunch, shoulder long and short chop

S/EUROP classification(1), Haunch(2), Shoulder(3), Long chop(4), Short chop(5)

In der Tabelle 5 wurden die Zusammenhänge zwischen Genotyp und Geschlecht sowie den untersuchten Parametern dargestellt.

5. Tabelle**Zusammenhänge zwischen Genotyp und Geschlecht
sowie den Parametern der Körperproportionen**

	S/EUROP Standard (3)	Keule (4)	Schulter (5)	Rippen- kotelett (6)	Lenden- kotelett (7)
Genotyp (1)	0,621 **	0,547 **	0,689 **	0,170	0,251
Geschlecht (2)	0,169	0,264 *	0,341 *	0,309	0,035

*: $P \leq 0,05$, **: $P \leq 0,01$ *Table 5: Connections of breed, sex and conformation parameters**Breed(1), Sex (2), S/EUROP classification(3), Haunch(4), Shoulder(5), Long chop(6), Short chop(7)*

Wir können also feststellen, dass die Körperproportionen der Rasse Ile de France nachweisbar günstiger sind ($P \leq 1\%$). Das trifft auch auf Keulen und Schultern zu. Das Gewicht des Koteletts (Rippen- und Lendenkotelett) spiegelte nicht die Werte des S/EUROP Standardes wider. Geschlechtliche Zusammenhänge konnten nur beim Gewicht von Keule und Schulter nachgewiesen werden ($P \leq 5\%$).

Bei der CT-Untersuchung wurde von den Versuchstieren aller 10 mm eine Querschnittsaufnahme gemacht. Aufgrund der nach der letzten Rippe angefertigten Aufnahme wurde die Fläche des langen Rückenmuskels mit Hilfe des CTPC Postprozessprogrammes bestimmt. Die erhaltenen Werte wurden mit den Werten des S/EUROP Standardes (Tabelle 6) verglichen.

6. Tabelle**Klassifizierung der Körperproportionen, Korrelationen zwischen der mit CT
gemessenen Fläche sowie dem Gewicht von Rippen- und Lendenkotelett**

	S/EUROP Standard	Kotelettfläche lt. CT (2)	Rippen- kotelett	Lenden- kotelett
S/EUROP Standard (1)	1	0,654 **	0,431 **	0,439 **
Kotelettfläche lt. CT (2)		1	0,784 **	0,712 **
Rippenkotelett (3)			1	0,695 **
Lendenkotelett (4)				1

: $P \leq 0,01$ *Table 6: Values for conformation classification: correlations between the weight of long and short chopS/EUROP classification(1), CT values(2), Long chop(3), Short chop(4)*

SCHLUSSFOLGERUNGEN

In Kenntnis unserer Ergebnisse können wir sagen, dass - obwohl der Wert des Tieres durch das individuelle Gewicht von Keulen und Schultern gut ausgedrückt wird - nach neuen und objektiveren Werten gesucht werden muss. Dazu wären hauptsächlich die Daten der Körpermaße (Rumpflänge und -breite) geeignet. Der mit dem Computertomographen ermittelte Zusammenhang zwischen der Körperzusammensetzung und dem Kotelettgewicht ist nachweisbar vorhanden, erfordert aber noch weitere Untersuchungen.

Wir schlagen anstatt der gegenwärtigen subjektiven Beurteilung ein objektiveres Beurteilungssystem vor, das dem bei Schweinen angewandten ähnlich ist und bei dem die Methode der digitalen Bilddarstellung, d.h. die CT-Aufnahmen eine bedeutende Rolle spielen.

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Milk yield and milk traits in Slovenian sheep breeds

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ABSTRACT

The results for milk recording in Slovenian recorded sheep flocks were studied for the period of last 4 years. 3044 lactations of controlled sheep were analysed. Milk recording is performed according to the regulation of ICAR. Milk yield in Slovenian sheep breeds is evaluated by the method A4. Milk yield is recorded in 3 dairy sheep breeds which are included in Slovenian selection program for small ruminants. It was found out that the number of controlled ewes is increasing from year to year, also the number of included new breeders is increasing and this facts influence on production results. In the observed period a decreasing trend of total milk yield in lactation was noticed. Milk yield also has slightly decreased in separate breeds in the observed period. The lowest milk yield was noticed in Istrian pramenka and the highest milk yield had improved Bovška breed. In the same period, a trend of increasing average fat content was noticed. There were no significant differences in protein content, but the lactose content has decreased. The average fat content in separate breeds increased in Bovška breed (by 0,7%) and in improved Bovška breed (by 0,3%), meanwhile it has decreased in Istrian pramenka (by 0,3%). The lactose content has decreased in Bovška breed and in improved Bovška breed, but in Istrian pramenka it has stayed the same through the years.
(Keywords: sheep, milk, milk content, recording, Slovenia)

ZUSAMMENFASSUNG

Milchleistung und Milcheigenschaften der slowenischen Schafrassen

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Die Ergebnisse der Milchleistungsprüfung in Schafherden in der letzten vier Jahren in Slowenien wurden ausgewertet. Es wurden 3044 Laktationen untersucht. Die Milchleistungsprüfung verläuft nach ICAR Empfehlungen, A4 Kontrolle. Die Milchleistungsprüfung wurde bei drei Milchrassen, die in das slowenische Schafzuchtprogramm einbezogen sind, durchgeführt. Die Zahl der kontrollierten Schafe und Herden hat sich jedes Jahr erhöht. In der untersuchten Periode ist ein Trend zur Verminderung der Milchleistung zu beobachten. Die höchste Milchleistung erreichte die gezüchtete Bovška Rasse, gefolgt von den Rassen Bovška und Istrien Pramenka. In der untersuchten Periode erhöhte sich der Fettgehalt, während sich der Laktosegehalt verringerte, aber der Proteingehalt unverändert blieb. Der Fettgehalt stieg bei der Bovška Rasse um 0,7% und bei der veredelten Bovška Rasse um 0,3% an, während er bei der Istrien Pramenka Rasse

um 0,3% zurückfiel. Der Laktosegehalt verringerte sich bei der Bovška- und der veredelten Bovška-Rasse, während er bei der Rasse Istrien Pramenka konstant blieb.
(Schlüsselwörter: Schafe, Milch, Milchinhalt, Kontrolle, Slowenien)

INTRODUCTION

70% of agricultural land in Slovenia is classified into land category with limited factors. More than 60% of agricultural land are grassland (meadowland) and pastureland which can be used only by ruminants and horses. Conditions for production on most of this land are difficult and they are poorly suited for farming.

In the last decades this land has been given up and overgrown with bushes and small trees. Sheep and especially goat breeding was reduced after the year 1945 and this contributed to overgrowing the agricultural land in mountainous and alpine land. In the last decades around 300.000 ha of agricultural land has been overgrown (*Kompan, 1996*).

Today, smaller farmers decide for sheep breeding on mountain, alpine and karst regions, where they have stopped with cattle breeding. Delivering of milk on mountain and alpine farms has become questionable owing to small herds and high costs. In this case sheep breeding substitutes cattle breeding although the tradition of cattle breeding is still quite strong and it impedes sheep breeding. In many places sheep breeding is the last alternative before overgrowing the farms (*Kompan, 1998*).

Sheep's milk is a substance of high biological value, whose chemical composition, particularly the protein content, is of great technological and economic importance for the dairy industry (*IDF Bulletin, 1981*).

In most regions of the world, sheep are raised for meat, wool or hide production and are never milked. However, in the region bordering south western Asia, southern Europe and northern Africa – the Mediterranean region and the Middle East ewe milk is widely practised (*Boyazoglu and Treacher, 1978*). One of the Mediterranean dairy sheep breed, Istrian pramenka, is also bred in Karst and primorska region in Slovenia. Due to specific climate in this area, with summer droughts and lack of pasture, traditional technology of dairy sheep and goat breeding with season lambings in January and February developed. Milking of these sheep takes place from April until July, mostly in the mountains. The other dairy sheep breed in Slovenia is bred in Bovec region where are specific harsh climate conditions (*Kompan et al., 1995*).

Contrary to cow's milk, ewe's milk is seldomly used for direct human consumption. Traditionally, ewe's milk is consumed in the form of products, such as cheese and yoghurt. This converted dairy output consists of a variety of local specialities, ranging from high-quality luxury products in the northern Mediterranean region, to those that form an important popular component of everyday consumption (e.g. yoghurt and feta-type cheese). In agro-economically under-privileged areas, where sheep milking is practised (e.g. the Sahel region and North Africa), the milk of small ruminants can be considered as an indispensable source of animal protein (*Boyazoglu, 1982*).

Many factors have influence on quantity, composition and characteristics of the milk. Some of these factors are genetic (amongst breeds, flocks and individuals), fiziological (period of lactation, age, state of health) and some of them are environmental (nutrition, climate, season, the method of milking, management with the animal etc.). The composition of the milk determines its nutritional value, quality for suitability into milk products etc. Due to high contents of dry matter, especially fat and proteins, sheep milk has almost twice

the cheesemaking efficiency then cow's or goat's milk. Table 1 shows approximate composition of cow's, goat's and sheep milk (Rogelj, 1996).

Table 1

Approximate composition of cow's, goat's and sheep milk

Component (%) (1)	milk (2)		
	cow's (3)	goat's (4)	sheep (5)
Dry matter (6)	12,7	13,8	18,5
Fat (7)	3,8	4,4	7,2
Proteins (8)	3,5	4,1	5,7
Lactose (9)	4,8	4,4	4,3

Source (Quelle): Rogelj, 1996

1. Tabelle: Zusammensetzung der Milch von Kühen, Ziegen und Schafen

Komponente(1), Milch(2), Kühe(3), Ziegen(4), Schafe(5), Trockensubstanz(6), Fett(7), Protein(8), Laktose(9)

MATERIALS AND METHODS

Milking and milk recording

Slovenia has been a member of International Committee for Animal Recording (ICAR) since 1986. Therefore milk recording has to be performed according to the regulation of ICAR which allows several methods. Milk yield in Slovenian sheep breeds is evaluated by the method A4.

Data for milk yield are collected at dairy ewes which are recorded according to the rules of the Slovenian selection program for small ruminants. The following dairy breeds are included in this program: Bovška (B) and Istrian pramenka (IP) dairy breeds, a subpopulation of Bovška breed is improved with East-Friesian dairy breed (VFB).

Daily milk yield was recorded once monthly during the evening and morning milkings. Milk yield in lactation was calculated by summing milk yield during the suckling period and milk yield during the milking-only period. Milk yield during the suckling period was calculated on basis of lamb weight gain from lambing to weaning. Milk yield during the milking period was obtained by multiplying daily milk records by the number of days between weaning and first recording day, for the first period, and by the number of days since the preceding milk recording day for subsequent recording days. Only lactations with at least three monthly records were included in the analysis (ICAR, 1992).

The aim of the study was to analyze milk yield and selected milk traits (fat-percentage, protein-percentage, lactose-percentage, dry matter-percentage) in Slovenian sheep breeds. Data analysed were obtained from the central database of the Slovenian selection program for small ruminants (Drobníč and Kompan, 1995).

Analysed sheep breeds

In 1998 dairy sheep breeds presented 23% of the total number of recorded sheep in Slovenia. Sheep milk is produced in a much smaller quantity then cow's milk in Slovenia. The most important product obtained from the sheep milk is cheese.

The prevailing recorded dairy sheep breed in Slovenia is Bovška breed (61% in 1998). The rest are represented in much smaller proportions, 22% of Istrian pramenka and 14% of Bovška improved and those left are crossbreeds.

In 1981, Biotechnical Faculty in Slovenia imported a small flock of ewes and rams of East-Friesian sheep. They were imported to improve prolificacy, milk yield and quality of wool in a subpopulation of Slovenian native Bovška sheep.

East-Friesian sheep are considered to be the world's highest producing dairy sheep, kept in very small flocks (1-5 ewes) in their region of origin. They are highly specialized animals and do not do well under extensive conditions and larger flocks. The pure-bred East-Friesian adapt poorly to the dryland and high temperature conditions of the Mediterranean and para-Mediterranean ecosystem (*Boyazoglu et al.*, 1979).

The rearing of pure-bred East-Friesian sheep in Slovenia didn't succeed. Crosses between Bovška sheep and East-Friesian sheep also didn't do well under Slovenian husbandry conditions. Improved Bovška sheep didn't attain much higher milk yield than the native Bovška sheep and there were quite a lot of health problems because of harsh climate conditions in the Bovec region. Widening of improved Bovška breed into new rearings has to be careful for poor conditions of rearing, maintenance and feeding, because of high losses, but milk production results are often lower than in pure-bred Bovška breed. Improved Bovška sheep has kept just in some intensive rearings, where they have chances for producing and conserving food. The most breeders returned to native Bovška sheep breeding.

RESULTS AND DISCUSSION

Milk yield in recorded sheep

Milk recording results of Slovenian sheep breeds were analysed for the studied period. 3044 lactations of controlled ewes have been evaluated. The number of recorded ewes has increased by the years from 489 to 974 (*Table 2*). The number of sheep breeders in Slovenian selection program is still increasing. These facts influence on production results which could be unpredictable. *Table 2* shows the average milk yield in lactation of all recorded ewes in the period between the years 1995 and 1998. Total milk yield in lactation decreased from 227 kg in 1995 to 199 kg in 1998. The fat-percentage increased from 5,8 to 6,4. In various sources (EAAP, 1983) was mentioned that the content of fat is reputed to vary from about 6% to just under 8%. The average fat content in all recorded sheep in Slovenia was under 6% in the years 1995 and 1996. The same sources mentioned that the protein content is estimated at 5-6%. The protein content in Slovenian sheep was around 5%. The content of lactose in Slovenian sheep decreased during the observed period from 4,8 to 4,3%.

From 1995 to 1998, there is a trend of decreasing total milk yield (*Figure 1*). The reason for decreasing milk yield is probably due to including more number of native breed Istrian pramenka in Slovenian selection program for small ruminants and also because of including more number of new breeders in the Selection program.

Due to the same reason, the components of the milk probably ranged. There is an increasing trend of the average fat content in milk and a decreasing trend of the average lactose content in the observed years (*Figure 2*).

Milk yield by breeds

During the observed period, the number of recorded Bovška sheep increased more than twice (*Table 3*). Data show that the average total milk yield per ewe decreased by 17 kg in the mentioned period (*Table 3*, *Figure 3*). *Table 3* also shows that content of fat increased

notably. There were no significant differences in content of proteins, except in the year 1996. The content of lactose decreased from 4,8 to 4,3%. Lactation length was the longest in the year 1998 (227 days).

Table 2

Average milk yield in lactation of all recorded ewes in the period

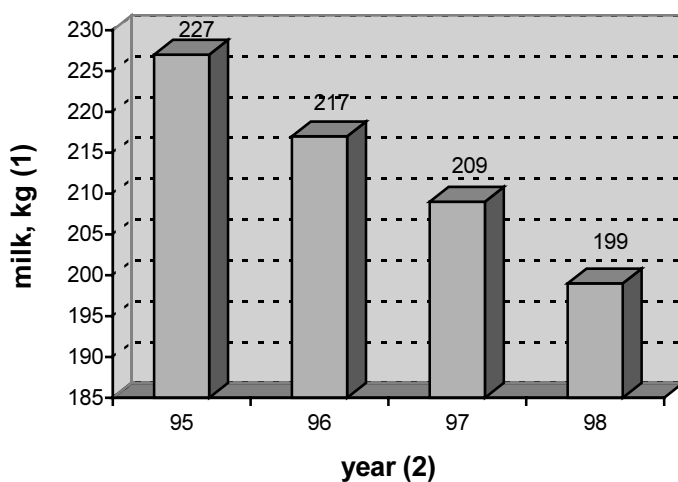
Year (1)	No. of ewes (2)	Total milk yield, kg (3)	Fat, % (4)	Proteins, % (5)	Lactose, % (6)	Dry matter, % (7)	Lactation, days (8)
1995	489	227	5,8	5,1	4,8	15,7	202
1996	743	217	5,9	4,7	4,4	14,7	191
1997	838	209	6,2	5,1	4,4	15,8	187
1998	974	199	6,4	4,9	4,3	15,6	194

2. Tabelle: Durchschnittliche Milchleistung der untersuchten Schafe in einer Laktation

Jahr(1), Anzahl der Mutterschafe(2), Milchleistung kg(3), Fett %(4), Protein %(5), Laktose %(6), Trockensubstanz %(7), Laktationstage(8)

Figure 1

The average total milk amount of all recorded ewes in Slovenia in years 1995-1998

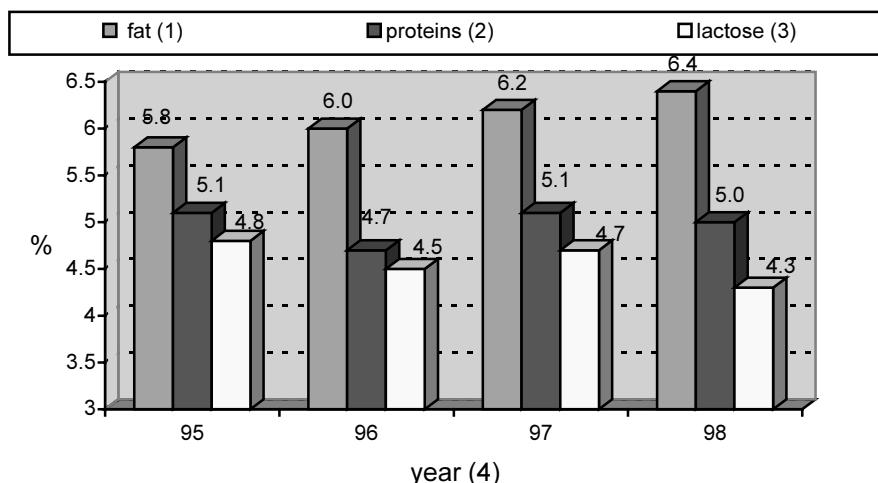


1. Abbildung: Durchschnittliche Milchleistung aller kontrollierten Schafe in Slowenien von 1995-1998

Milch(1), Jahr(2)

Figure 2

The average contents of fat, proteins and lactose of all recorded ewes in Slovenia in years 1995-1998



2. Abbildung: Durchschnittlicher Gehalt an Fett, Protein und Laktose bei allen kontrollierten Schafen in Slowenien von 1995-1998

Fett(1), Protein(2), Laktose(3), Jahr(4)

Milk yield by breeds

During the observed period, the number of recorded Bovška sheep increased more than twice (Table 3). Data show that the average total milk yield per ewe decreased by 17 kg in the mentioned period (Table 3, Figure 3). Table 3 also shows that content of fat increased notably. There were no significant differences in content of proteins, except in the year 1996. The content of lactose decreased from 4,8 to 4,3%. Lactation length was the longest in the year 1998 (227 days).

Ogrizek (1948) estimated milk yield in lactation of Bovška sheep only from 65 to 80 kg. But Mlekuž (1996) mentioned that milk yield in the last years has increased due to better feeding, management and health. He also mentioned that some breeders milk about 200 kg of milk and lambs suck it still about 50 kg. Sheep are rarely feed with concentrates. On the pastures, they are often without water and they get salt only once a week. These facts quite often limit their milk yield. He also mentioned that the fat content is around 6,5%.

The number of milk recorded improved Bovška sheep also increased in the period between 1995 to 1998. Table 4 shows that the average total milk yield decreased from 259 to 253 kg, although the milk yield was almost 300 kg in the year 1996 (Figure 3). Table 4 shows also the content of fat, proteins, lactose and dry matter in milk of the recorded sheep. The fat content increased by 0,3% in the mentioned years, and the lactose content decreased by 0,4%.

Table 3

Average milk yield of recorded Bovška sheep in the period between years 1995 and 1998

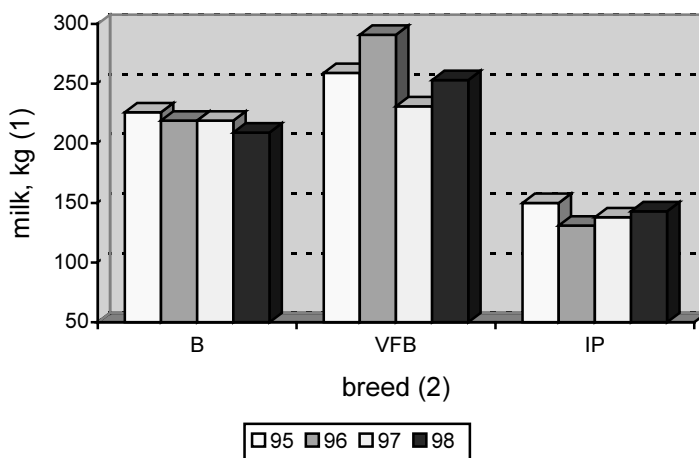
Year (1)	No. of ewes (2)	Total milk yield, kg (3)	Fat, % (4)	Protein, % (5)	Lactose, % (6)	Dry matter, % (7)	Milking days (8)
1995	261	226	5,6	5,1	4,8	15,5	181
1996	477	219	5,8	4,7	4,6	15,0	173
1997	566	219	6,1	5,1	4,4	15,6	178
1998	598	209	6,3	4,9	4,3	15,4	227

3. Tabelle: Durchschnittliche Milchleistung der untersuchten Bovska-Schafe von 1995-1998

Jahr(1), Anzahl der Mutterschafe(2), Milchleistung kg(3), Fett %(4), Protein %(5), Laktose %(6), Trockensubstanz %(7), Laktationstage(8)

Figure 3

Average milk yield of recorded ewes by the separate breeds in years 1995-1998



3. Abbildung: Durchschnittliche Milchleistung von kontrollierten Schafen unterschiedlicher Rassen von 1995 - 1998

Milch(1), Rasse(2)

Results of milk yield in improved Bovška sheep could be comparable with results which Gootwine and Goot (1995) obtained. In several Mediterranean countries, local dairy breeds (Awassi) have been crossed with East-Friesian rams to improve fertility and milk yield. Gootwine and Goot found out that milk yield of the Awassi, Awassi X EF (F1), F1XF1 (F2) ranged from 223 to 248 kg. The East-Friesian had the lowest milk yield (161 kg, only 65% of the milk yield of the Awassi breed).

Table 4

Average milk yield of recorded improved Bovška sheep in the period between years 1995 and 1998

Year (1)	No. of ewes (2)	Total milk yield, kg (3)	Fat, % (4)	Protein, % (5)	Lactose, % (6)	Dry matter, % (7)	Milking days (8)
1995	86	259	5,8	4,9	4,8	15,5	229
1996	122	291	6,1	4,8	4,5	15,4	233
1997	138	231	6,0	5,0	4,6	15,6	218
1998	133	253	6,1	5,0	4,4	15,4	227

4. Tabelle: Durchschnittliche Milchleistung der veredelten Bovska-Schafe von 1995-1998

Jahr(1), Anzahl der Mutterschafe(2), Milchleistung kg(3), Fett %(4), Protein %(5), Laktose %(6), Trockensubstanz %(7), Laktationstage(8)

The number of recorded Istrian pramenka also increased by 171 ewes from 1995 to 1998 (Table 5). Data show that milk yield of Istrian pramenka was much lower than milk yield of Bovška and improved Bovška sheep in this period (Figure 3). The milk yield of Istrian pramenka decreased in the mentioned period by 7 kg. The content of fat was higher at Istrian pramenka then at Bovška and improved Bovška sheep, although it decreased by 0,3% in the mentioned period. The content of lactose was lower at Istrian pramenka then at the others.

Kompan (1996) mentioned that in average breeding conditions, the Istrian sheep gives between 100 and 150 kg of milk in lactation with 9% of fats and more than 6,4% of proteins. In Slovenia, there are from 400 to 500 Istrian sheep, which are included in Program of Conservation of Native Slovene Breeds of Domestic Animals. The content of dry matter was pretty higher in the milk of Istrka pramenka than in the milk of the other observed breeds.

Table 5

Average milk yield of recorded Istrian pramenka in the period between years 1995 and 1998

Year (1)	No. of ewes (2)	Total milk yield, kg (3)	Fat, % (4)	Protein, % (5)	Lactose, % (6)	Dry matter, % (7)	Milking days (8)
1995	45	150	7,2	5,8	4,1	16,7	229
1996	87	131	7,4	5,1	4,1	16,6	210
1997	99	138	7,4	5,5	4,1	17,0	185
1998	216	143	6,9	5,2	4,1	16,2	202

5. Tabelle: Durchschnittliche Milchleistung der Istrian-Pramenka-Schafe von 1995-1998

Jahr(1), Anzahl der Mutterschafe(2), Milchleistung kg(3), Fett %(4), Protein %(5), Laktose %(6), Trockensubstanz %(7), Laktationstage(8)

CONCLUSIONS

In the last decades around 300.000 ha of agricultural land in Slovenia has been overgrown. Conditions for production on most of mountain and alpine land are not useful for farming. In many places sheep breeding is the last alternative before overgrowing the farms.

Dairy sheep breeding in Slovenia is important at Karst and Primorska region due to specific climate.

Milk yield in Slovenian sheep breeds is recorded according to the regulations of ICAR and it is evaluated by the method A4.

During the observed period the number of all recorded ewes was increasing. The number of included sheep breeders is still increasing. The most prevailing dairy sheep in Slovenia is Bovška breed.

Between the years 1995-1998 the total milk yield in Slovenian sheep breeds has decreased. The milk yield by separate breeds also decreased in the observed period; by 17 kg in Bovška breed, by 6 kg in improved Bovška breed and by 7 kg in Istrian pramenka. The Istrian pramenka had the lowest milk yield in all observed years and the improved Bovška sheep had the highest milk yield.

The fat content in Slovenian sheep breeds has increased in the observed period. It has also increased in Bovška breed (by 0,7%) and in improved Bovška breed (by 0,3%), but it has decreased in Istrian pramenka (by 0,3%). The Istrian pramenka had the highest fat content and the lowest lactose content in the milk in all observed years.

The results of milk yield in Slovenian sheep breeds show that there is still quite a lot of possibilities to improve the milk yield. Nutrition, maintenance and state of health can contribute to improve the production and to influence on rearing success.

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SECTION 2

PIG AND RABBIT BREEDING SCIENCE



Gegenwart und Zukunft der ungarischen Schweinezucht

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ZUSAMMENFASSUNG

Die Autoren berichten über die Situation der Schweinezucht in Ungarn und zeigen die zu erwartenden Tendenzen auf. Ihre Analysen beziehen sich einerseits auf die Reproduktions-, Mast- und Schlachtwerteigenschaften, andererseits auf die Klassifizierung der Schlachtschweine. Weiterhin werden die wichtigsten genetischen Parameter der Schweine-Grundrassen mitgeteilt. Aufgrund der Analyse der statistischen Daten wurde festgestellt, dass in Ungarn in den 70-er Jahren bereits die Voraussetzungen für eine Schweinezucht auf hohem Niveau geschaffen wurden. Aufgrund der gesellschaftlich-wirtschaftlichen Umgestaltung verschlechterten sich in der ersten Hälfte der 90-er Jahre diese Bedingungen, und deshalb trat in den niedrigeren h^2 -wertigen Eigenschaften (Reproduktion, Mastfähigkeit) ein vorübergehender Rückfall ein. Gegenwärtig ist das Produktionsniveau in diesen Eigenschaften bereits wieder auf dem Niveau der mittleren 80-er Jahre. Die genetischen Bedingungen für einen Fortschritt sind vorhanden, da die Autoren feststellten, dass die genetische Struktur der ungarischen Stammpopulationen mit den Beständen in den entwickelten Schweinezuchtländern gleichzusetzen ist. Die Schlachtschweinproduktion im untersuchten Zeitraum hat eine glockenförmige Kurve, deren Höhepunkt auf die Mitte der 80-er Jahre fällt. Die Schlachtqualität verbesserte sich zwischen 1975 und 1985 ständig, fiel aber danach teilweise wegen fehlender Klassifizierung, teilweise wegen der politisch-wirtschaftlichen Umgestaltung zurück. Nach Einführung der EUROP-Handelsklassen im Jahre 1997 verbesserte sich die Schlachtqualität wieder., Gegenwärtig liegt der Gesamtanteil von Schlachtschweinen der Klassen O und P unter 10%. Die Autoren sind der Meinung, dass in Zukunft nicht mit einer steigenden Schweinebestandszahl zu rechnen ist. Die Zuchtarbeit wird jedoch fortgesetzt, und deshalb ist in den hohen h^2 -wertigen Eigenschaften ein ständiger Fortschritt zu erwarten. Bei den anderen Eigenschaften kann nur mit einer langsamen Wertverbesserung gerechnet werden. Bei der Erzeugung der Endprodukte wird eine Verbesserung der Schlachtqualität prognostiziert und ein Ankaufspreis, der auch die einzelnen Handelsklassen berücksichtigt.

(Schlüsselwörter: Schweinezucht, Bestandsgröße, Produktionsergebnisse, Genetische Parameter, EUROP-Verordnung)

ABSTRACT

The present and the future in Hungarian pig production

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In this paper the authors give an overview of the situation in pig production in Hungary, and outline the tendencies to be anticipated. The analyses performed are based partly on

the traits related to reproduction, fattening capacity and slaughter value in herd book pig populations, and partly on quality classification results for slaughter pigs. The major genetic parameters for the various basic pig breeds are also outlined. On the basis of analysis of the series of statistical data it was ascertained that in the 1970s the conditions necessary for pig production of a high standard in Hungary were established. In the first half of the 1990s, due to social and economic transformation, environmental conditions deteriorated; thus, a transitional decline in the traits of lower h^2 value (reproduction and fattening capacity) was observed in the nucleus populations. The standard of production with respect to these traits has now risen back to the levels characteristic of the mid-1980s. The genetic fundamentals for progress already exist, since, as the authors demonstrate, the genetic structure of the nucleus populations can now be considered the same as that of populations in the countries in which pig production is highly developed. Slaughter pig production in the period studied can be represented by a bell-shaped curve, its peak corresponding to the mid-80s. Between 1975 and 1985 there was continuous improvement in slaughter quality; however, this subsequently declined, partly due to the lack of a classification system and partly as a result of political and economic transformation. Following the introduction of the EUROP classification system in 1997 an improvement in slaughter quality was observed; the total proportion of slaughter pigs classified into categories O and P has now decreased to below 10%. With respect to the future, the authors express the opinion that no increase in pig population numbers should be anticipated. Breeding activity continues, and therefore steady progress with regard to the traits of high h^2 value can be expected. There is likely to be only slower improvement in results for the other traits. Regarding the production of end products, further improvement in slaughter quality can be predicted, as can the establishment of value-proportional purchases prices in relation to the respective quality categories.

(Keywords: pig production, population size, production results, genetic parameters, EUROP classification)

EINFÜHRUNG

In Ungarn hat die Schweinezucht eine lange Tradition. Zwar war bis zu Anfang des vergangenen Jahrhunderts das Schweinefleisch nicht sehr beliebt, aber durch die Industrialisierung und die Urbanisierung wuchs die Bedeutung von Schweinefleisch und -fett in der Ernährung der Bevölkerung. Damals dominierte noch die Mangalica-Rasse, die gegenwärtig noch in vier Farbtönen als Genreserve gehalten wird. Später wurden die direkt aus England importierten Fleischerassen in Ungarn heimisch.

In den 70-er und 80-er Jahren gelang es den ungarischen Schweinezüchtern, den günstigen Markt für lebende Schweine und Schweinehälften in der damaligen Sowjetunion auszunutzen, was einen ständigen Anstieg des Schweinebestandes zur Folge hatte. In der Mitte der 80-er Jahre wurde - wie das aus *Abbildung 1* hervorgeht - die Anzahl von 10 Millionen überschritten. Setzt man diese Zahl ins Verhältnis zur Einwohnerzahl, so kam auf jeden Einwohner 1 Mastschwein. Der Pro-Kopf-Verbrauch an Fleisch in Höhe von 74 kg bestand zu mehr als 50% aus Schweinefleisch (*Baltay, 1983*).

Die Ende der 80-er Jahre eingetretenen politischen und wirtschaftlichen Veränderungen hatten auch Auswirkungen auf die ungarische Schweinezucht. Der osteuropäische Markt verengte sich oder fiel teilweise völlig. Dazu kam noch ein Rückfall im Inlandsverbrauch an Schweinefleisch, der gegenwärtig bei 26-27 kg pro Kopf liegt. Ein neuer großer Absatzmarkt wurde für die sich in Ungarn anhäufenden

Fleischvorräte wurde inzwischen nicht gefunden. Das hatte zur Folge, dass die bedeutenden Produktionskapazitäten sowohl in den Großbetrieben als auch bei den Kleinproduzenten nicht ausgenutzt werden konnten. Der Rückgang der Schweinehaltung bei den Kleinproduzenten hat auch teilweise seine Ursachen im Generationswechsel und in der Änderung des Lebensstiles bei den jüngeren Jahrgängen.

MATERIAL UND METHODE

In unsere Untersuchungen wurden teilweise die Daten der ungarischer Herdbuchbestände einbezogen. Die vom Landesinstitut zur Qualitätssicherung bei landwirtschaftliche Produkten mitgeteilten offiziellen Daten wurden mit herkömmlichen statistischen Methoden bewertet. Die Ergebnisse wurden in Tabellen bzw. Abbildungen zusammengefasst.

Die Klassifizierungsdaten der ungarischen Schlachtschweine auf den Schlachthöfen wurden von uns fast zwei Jahre lang (22 Monate) verfolgt und untersucht. Unter Verwendung der Tabellen aus der Wochenfachzeitschrift „Durchschnittliche Markt- und Ankaufpreise für Schlachtschweine und -rinder“, herausgegeben vom Agrarordnungsamt, wurden vergleichende Analysen durchgeführt, in welche ab Mitte 1997 noch die Daten der EUROP-Klassifizierung dazukamen.

Vom Ergebnis aus jeweils 3 Wochen wurde der Durchschnitt errechnet. Darin sind alle Daten der im gegebenen Zeitraum auf den registrierten Schlachthöfen geschlachteten und klassifizierten Schweine enthalten, ausgenommen die untergewichtigen (<50 kg) und übergewichtigen (>120 kg) Tiere sowie die aussortierten Sauen und Eber. Die Daten wurden mit herkömmlichen mathematischen Methoden per Computer ausgewertet und die Ergebnisse mit dem Graphikprogramm dargestellt.

ERGEBNISSE UND DISKUSSION

Situation der ungarischen Schweinezucht

Bestandszahl

Zur Darstellung der jetzigen Situation in der ungarischen Schweinezucht halten wir es für notwendig, die Veränderungen in der Schweinebestandszahl in den vergangenen 25 Jahren (*Abbildung 1*) zu betrachten. Die Grafik zeigt, dass in der zweiten Hälfte der 70-er Jahre durchschnittlich jährlich 8 Mill. Schweine gehalten wurden, von denen 10-12 tausend als Zuchttiere unter Herdbuchkontrolle standen. Die größte Bestandszahl hatte das reinrassige Weiße Edelschwein, das 30% des Stammbestandes ausmachte. Zahlenmäßig folgte danach die Landrasse und die estländische Population. Die größten Hybridschweinpopulationen waren KAHYB, HUNGAHYB und TETRA.

In den 80-er Jahren stiegen die Bestandszahlen weiter an. Besonders 1983 und 1984 war das Produktionsniveau mit jährlich fast 10 Millionen Schweinen außergewöhnlich hoch. In diesen beiden Jahren erreichte die ungarische Schweinezucht das größtes Produktionsergebnis in ihrer Geschichte, sowohl was die Bestandszahl als auch das Produktionsvolumen betrifft.

In der zweiten Hälfte der 80-er Jahre wurde die Produktion auf hohem Niveau fortgesetzt - die Bestandszahl betrug 9 Millionen. Es ist ein wichtiges Ereignis, dass es in diesem Zeitraum die periodische Produktion fast völlig abgeschafft werden konnte. In diesem Zeitraum bewegte sich die Anzahl der herdbuchgeführten Zuchttiere zwischen 15-17.000. Die höchste Bestandszahl wurde 1988 erreicht, als die Sauenzahl unter Herdbuchkontrolle 20.661 betrug.

1. Abbildung

Entwicklung des Schweinebestandes von 1975 bis 1999

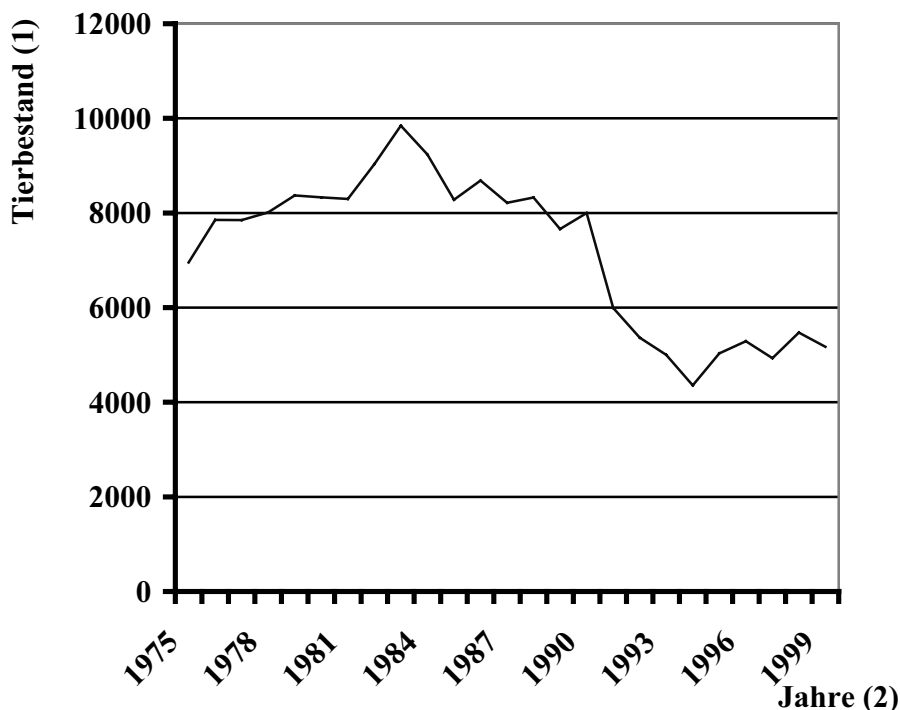


Figure 1: Changes in pig population in 1975-1999

Number(1), Years(2)

Wie in der Grafik zu sehen ist, brachte das Jahr 1992 eine drastische Veränderung, denn die Bestandszahl fiel von 9 auf 6,8 Millionen zurück. Ungünstige Tendenzen (Futterpreiserhöhung, Agrarschere, Rückgang der Nachfrage, sinkende Ankaufspreise usw.) führten dahin, dass der Bestand 1993 und 1994 um weitere 0,7-0,8 Millionen zurückging und 1995 nur noch 5,3 Millionen betrug. Im Jahre 1995 trat in Ungarn sogar ein Mangel an Schweinefleisch auf, der Importe notwendig machte.

In den letzten drei Jahren bildete sich im Schweinesektor zwischen Nachfrage und Angebot ein dynamisches Gleichgewicht aus. Laut Prognosen wird sich in den kommenden Jahren der Schweinebestand in Ungarn zwischen 5 und 6 Millionen stabilisieren (Csató et al., 1995).

Leistungsniveau der Zuchtschweine

Der Entwicklungsstand der Schweinezucht wird durch ein bestimmtes Leistungsniveau in den wichtigsten Produktionseigenschaften charakterisiert. Nachstehend wird auf die erreichten Ergebnisse bei den Reproduktions-, Mast- und Schlachtwerteigenschaften eingegangen. Zur besseren Übersicht wurden die Herdbuchdaten des Landes von 1985, 1990, 1995 und 1997 in Tabellen zusammengefasst.

1. Tabelle

Fruchtbarkeits- und Aufzuchtergebnisse der
Herdbuch-Schweinepopulationen in Ungarn

Lebendgeborene Ferkel je Wurf (Stück) (1)				
Rasse (2)	1985	1990	1995	1997
Ung.W.Edelschwein (3)	10,4	9,7	9,6	10,4
Ung.Landschwein (4)	10,2	9,7	9,4	10,1
DUROC	8,6	8,6	9,0	9,1
PIETRAIN	7,2	8,6	9,1	9,0
21 Tage alte Ferkel je Wurf / Wurfgewicht am 21. Lebenstag (kg) (5)				
Rasse (2)	1985	1990	1995	1997
Ung.W.Edelschwein (3)	9,4/50,1	8,9/53,0	8,6/49,6	9,3/53,6
Ung.Landschwein (4)	9,3/51,3	8,9/52,1	8,6/52,0	9,2/55,3
Duroc	7,0/39,9	7,3/41,6	7,5/44,5	8,0/44,8
PIETRAIN	6,8/44,7	7,6/44,3	7,8/47,2	8,0/48,9

Table 1: Reproduction and rearing results for herdbook-registered pig populations in Hungary

No. of live piglets born per litter(1), Breed(2), Hungarian Large White meat type pig(3), Hungarian Landrace pig(4), No. of 21-day-old live piglets per litter / litter weight at 21 days (kg)(5)

Wie allgemein bekannt, wird die Rentabilität der Schweinehaltung bedeutend von den Reproduktionsergebnissen beeinflusst. Besonders wichtig ist die Zahl der lebend geborenen Ferkel je Wurf, was in *Tabelle 1* vorgestellt wird. Die Daten zeigen, dass die Ferkelzahl bei den Mutterassen (Weißes Edelschwein und Landschwein) in der ersten Hälfte der 90-er Jahre rückläufig war (0,7-0,8 Ferkel/Wurf). Der Grund dafür lag in der wirtschaftlich-gesellschaftlichen Umgestaltung in Mitteleuropa, denn viele Großbetriebe wurden aufgelöst und neue, private Stammzuchten mit kleineren Beständen gegründet, bei denen die Inhaber weder über genügend Zuchterfahrungen noch Kapital verfügten. Nach diesem vorübergehenden Rückfall liegt jedoch gegenwärtig die Fruchtbarkeit der beiden grossen Rassen wiederum auf dem Niveau von 1985.

In der Vermehrung der Duroc- und Pietrain-Rasse war im vergangenen Jahrzehnt ein lineares Wachstum zu beobachten, was die Folge eines ständigen Imports von Vatertieren war.

Die Veränderung in der 21-Tage-Wurfzahl ist eindeutig von der Wurfzahl bei der Geburt abhängig. Bei den Mutterassen war im vergangenen Jahrzehnt ein ständiges Anwachsen des 21-Tage-Wurfgewichtes charakteristisch. Es scheint so, dass die Züchter bei diesen Rassen den vorübergehende Rückfall des Fruchtbarkeitsparameters mit besserer Sauenfütterung nach der Entwöhnung ausgleichen konnten.

Aufgrund dieser Vorkommnisse ist festzustellen, dass die Reproduktionsergebnisse in bedeutendem Maße von den jeweiligen Bedingungen abhängig sind und gegenwärtig wieder das für die 80er Jahre charakteristische Niveau erreicht haben. Das bestätigt auch der wieder stabil gewordene Stammzuchtbestand und die Wirtschaftslage. Auch in den nächsten Jahren können wir mit Fortschritten rechnen, und zwar durch den Einfluss der Konsolidation.

2. Tabelle

**Tageszunahmen von Jungebern und Jungsauen
bis zum Ende der betrieblichen Eigenleistungsprüfung**

Tageszunahmen von Jungebern (g) (1)				
Rasse (2)	1985	1990	1995	1997
Ung.W.Edelschwein (3)	516	534	541	565
Ung.Landschwein (4)	538	557	557	575
Duroc	502	528	528	548
Pietrain	418	505	524	555
Tageszunahmen von Jungsauen (g) (5)				
Rasse (2)	1985	1990	1995	1997
Ung.W.Edelschwein (3)	472	496	488	516
Ung.Landschwein (4)	503	523	518	532
Duroc	478	512	509	509
Pietrain	418	470	509	459

Table 2: Daily weight gain in the young boars and gilts up to the end of the individual performance test

Daily weight gain in the young boars(1), Breed(2), Hungarian Large White meat type pig(3), Hungarian Landrace pig(4), Daily weight gain in the gilts(5)

Das Masterergebnis wird bedeutend durch die Wachstumsintensität der Schweine beeinflusst und allgemein durch die tägliche Gewichtszunahme ausgedrückt. Die Tageszunahmen werden in der betrieblichen Eigenleistungsprüfung analysiert und sind in *Tabelle 2* zusammengefasst. Die Daten der Jungeber zeigen im vergangenen Jahrzehnt eine ständige Verbesserung der täglichen Zunahme, die gegenwärtig mit 40-100 g das Niveau von 1985 übersteigt. Bei den Jungsauen erhöhten sich in den 90-er Jahren die Tageszunahmen um 30-40 g gegenüber 1985. Berücksichtigt man, dass sich im vergangenen Jahrzehnt die Bedingungen in der Stammzucht nicht bedeutend verändert haben, muss man die Gründe für die Steigerung in einer besseren genetischen Fähigkeit der Schweinepopulation suchen.

3. Tabelle

**Prozentualer Anteil der wertvollen Fleischstücke
bei der zentralen Mast- und Schlachtwertprüfung**

Rasse (1)	1985	1990	1995	1997
Ung.W.Edelschwein (2)	44,2	45,9	47,7	48,6
Ung. Landschwein (3)	45,1	46,6	47,6	48,1
Duroc	44,8	45,5	48,8	47,8
Pietrain	54,2	54,4	55,9	56,3

Table 3: Proportion of valuable meat parts in the central fattening capacity and slaughter value test

Breed(1), Hungarian Large White meat type pig(2), Hungarian Landrace pig(3)

Um den Schlachtwert der Schweine auszudrücken, wurde in Ungarn in den vergangenen Jahrzehnten der Anteil an wertvollen Fleischteilen gemessen. Die diesbezüglichen Parameter sind in *Tabelle 3* zusammengefasst. Die Ergebnisse zeigen, dass sich die Schlachtwerte ständig verbesserten. Auch in Zukunft wird die Zuchtarbeit bei den höheren h^2 -wertigen Eigenschaften erwartungsgemäß erfolgreich sein. Damit werden dem genetischen Trend entsprechend weitere Fortschritte bei den wertvollen Fleischanteilen, und davon ausgehend auch beim Fleischanteil, erreicht.

Genetische Struktur der Zuchtbestände

Um die genetischen Struktur der Schweinerassen mit großer Bestandszahl in Ungarn mit internationalen Daten zu vergleichen, führten wir eine Varianzkomponentenschätzung durch mit dem von Groeneveld (1993) ausgearbeiteten VCE 3.2 Programm. Von den Varianten mit zufälliger Wirkung analysierten wir die h^2 - und c^2 -Werte, bzw. die Fehlervarianz - die Parameter in % ausgedrückt -. Die geschätzten h^2 -Werte der wichtigsten Mast- und Schlachteigenschaften wurden -aufgrund der Daten der zentralen Stationen - in *Tabelle 4* zusammengefasst.

4. Tabelle

Errechnete h^2 -Werte (und Schätzungsfehler im Prozent) für wirtschaftlich wichtige Eigenschaften bei in Prüfstationen untersuchten Schweinen

Rasse (1)	Anzahl Tiere (n) (2)	Anzahl Masttage (Tage) (3)	Futtermverbrauch während der Mast (kg) (4)	Wertvolle Fleischteile (kg) (5)	Fleischqualität (Punkte) (6)
Ung. Weißes Edelschwein (7)	6.194	0.41 (3.0)	0.42 (3.9)	0.67 (3.3)	0.09 (14.1)
Ungarisches Landschwein (8)	2.992	0.51 (8.4)	0.32 (11.0)	0.55 (6.3)	0.13 (17.8)
Duroc	1.150	0.27 (9.7)	0.32 (6.6)	0.61 (5.8)	0.21 (14.2)
Pietrain	709	0.44 (24.8)	0.55 (16.7)	0.39 (18.1)	0.17 (22.6)

Table 4: h^2 values (and estimation error, %) calculated for the economically important traits of the pigs examined at the central testing stations

Breed(1), No. of animals(2), No. of days of fattening period(3), Feed consumed during the trial period (kg)(4), Quantity of valuable meat parts (kg)(5), Points total for meat quality(6), Hungarian Large White meat type pig(7), Hungarian Landrace pig(8)

Aus der Tabelle ist festzustellen, dass bei den Masteigenschaften der Vererbungsfaktor in Abhängigkeit vom Genotyp zwischen 0,20 und 0,55 liegt. Der Schätzungsstandardfehler liegt zwischen 3-25% und wird meistens von der Rassenbestandszahl beeinflusst. Der Schlachtwert (Menge an wertvollen Fleischteilen) wird durch die höheren h^2 -Wert charakterisiert. In unseren Untersuchungen fanden wir Koeffizienten zwischen 0,55 und

0,67 bei dieser Eigenschaft, die auch denen in der Fachliteratur entsprechen. Die Punktzahl für die Vererbung der Fleischqualität liegt zwischen 0,09 und 0,21, was bedeutet, dass bei dieser Eigenschaft die Vererbungseinflüsse nur eine geringe Rolle spielen.

Zusammengefasst ist festzustellen, dass sich die in zentralen Stationen geprüften ungarischen Schweinestammpopulationen in den untersuchten wichtigsten h^2 -wertigen Eigenschaften nicht von denen in Westeuropa unterscheiden. Eine ähnliche Feststellung machten wir auch bei den Koeffizienten der Wurfumwelt (c^2) (siehe *Tabelle 5*).

5. Tabelle

**Wurfumwelt (und Schätzungsfehler im Prozent) bei Schweinerassen
aufgrund der Daten aus den zentralen Prüfstationen**

Rasse (1)	Tierzahl (n)	Anzahl Masttage (Tage)	Futtermittel- verbrauch während der Mast (kg)	Wertvolle Fleischteile (kg)	Fleisch- qualität (Punkte)
	(2)	(3)	(4)	(5)	(6)
Ung. Weißes Edelschwein (7)	6.194	0.24 (3.7)	0.18 (5.1)	0.05 (17.2)	0.08 (15.9)
Ungarisches. Landschwein (8)	2.992	0.22 (9.1)	0.23 (8.4)	0.03 (52.0)	0.08 (21.3)
Duroc	1.150	0.29 (7.5)	0.27 (7.7)	0.09 (16.9)	0.04 (25.5)
Pietrain	709	0.30 (17.4)	0.18 (25.1)	0.06 (51.8)	0.04 (58.6)

Table 5: Effect of litter environment (and its estimation error, %) for Hungarian pig breeds, on the basis of data from the central testing stations

Breed(1), No. of animals(2), No. of days of fattening period(3), Feed consumed during the trial period (kg)(4), Quantity of valuable meat parts (kg)(5), Points total for meat quality(6), Hungarian Large White meat type pig(7), Hungarian Landrace pig(8)

All das beweist, dass die genetische Struktur des ungarischen Schweinebestandes nicht von der in den entwickelten Schweinezüchtländern der Welt abweicht. Das wird auch in Zukunft so bleiben, da durch laufende Importe aus diesen Ländern ganz ausgezeichnete Zuchttiere erworben werden, die auch in die allgemeine Zucht einbezogen werden.

Klassifizierung der Schlachtschweine

In Ungarn sind mit Wirkung vom 1. Januar 1995 - nach Anordnung Nr. 9/1994 (10.III) des Landwirtschaftsministeriums (*MÉM Értésítő*, 1994) - alle Schlachthöfe, unabhängig von ihrer Kapazität her, verpflichtet, zur Einstufung die neuen EUROP-Handelsklassen für Schlachtschweine anzuwenden (*Rafai et al.*, 1995). Diese Klassifizierung wurde jedoch erst 1997 allgemein angewandt. Seitdem werden durchschnittlich wöchentlich 65-80.000 Schweine in den registrierten Schlachthöfen geschlachtet, und davon werden ca. 40-70.000 klassifiziert. Der Anteil an klassifizierten Schweinen in den Schlachthöfen wuchs von anfangs 50-55% auf gegenwärtig ca. 75-85% an.

2. Abbildung

Anteil der Schlachtschweine in den einzelnen Qualitätsklassen

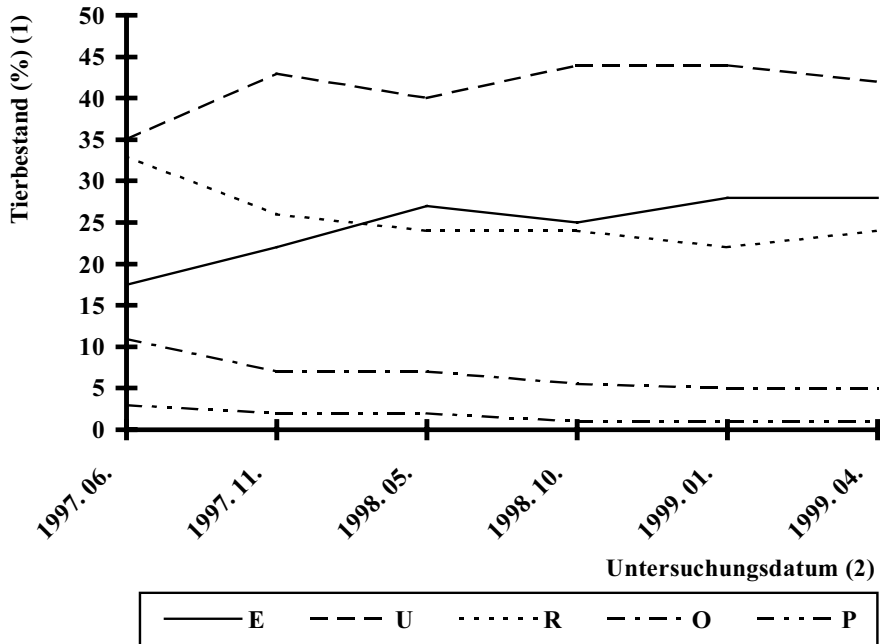


Figure 2: Changes in slaughter pig number ratios with regard to the respective quality grades

Number ratio(1), Data collection periods(2)

In *Abbildung 2* stellen wir die Entwicklung der Schlachtschweinklassifizierung in die einzelnen EUROP-Klassen dar. Daraus ist zu sehen, dass die Bestandszahl in den höheren Qualitätsklassen angestiegen ist. Damit parallel ist ein Absinken in den niedrigeren Klassen (O, P) zu beobachten. Betrachten wir den Trend in den einzelnen Zeitabschnitten, ist zu sehen, dass die Einstufungen in die beste Qualitätsklasse E von Beginn der Untersuchung an bis Mai 1998 ziemlich bedeutend (fast um 10%) angestiegen ist, und zwar auf Kosten der noch immer guten U- und R-Klassen. Danach war eine minimaler Rückgang im zweiten Halbjahr 1998 zu beobachten, der jedoch die ansteigende Tendenz nicht umkehrte. Parallel mit am Anstieg der in die E-Klasse gehörenden Schweine ist auch in der U-Klasse ein Anstieg zu verzeichnen, und zwar auf Kosten der niedrigsten Kategorien O und P.

Zusammengefasst ist festzustellen, dass in der untersuchten zwei Jahren die Schweinezahl mit schwacher Fleischqualität in den O- und P-Klassen ständig zurückging und bereits die 10-Prozent-Schwelle unterschritten hat.

3. Abbildung

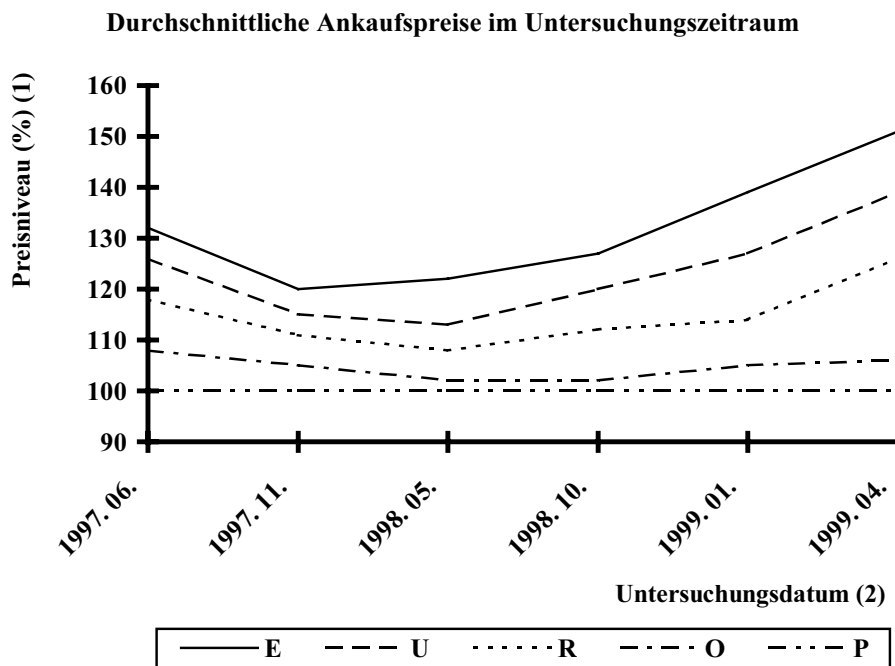


Figure 3: Changes in average purchase price ratios during the period examined

Average price ratio(1), Data collection periods(2)

In *Abbildung 3* stellen wir die zu den einzelnen Qualitätsklassen gehörenden Ankaufsdurchschnittspreise dar. Zum leichteren Verständnis nahmen wir die Ankaufspreise für die P-Klasse - also die niedrigste Qualität - als Vergleichsbasis mit 100% an und untersuchten die Verhältnisse zu den anderen Qualitätsklassen. Wir stellten fest, dass es anfangs zwischen den einzelnen Qualitätsstufen verhältnismäßig große Abweichungen gab (P=100%, E=133%), die sich bis Ende 1997 um 10% verringerten (P=100%, E=123%). Diese Tendenz - mit Ausnahme der Klasse E - verringerte sich zwar bis Mai 1998, bleibt aber weiterhin bestehen. Danach - bis zum Ende der Untersuchungen - war wiederum eine Verbesserung der Preisverhältnisse zu beobachten, was bedeutet, dass die zur Klasse E, U und R gehörenden Schweine durch Ankaufspreise qualitätsmäßig unterschieden wurden. Es kann also zusammenfassend gesagt werden, dass während der Untersuchungszeit die Ankaufspreise und deren Unterschiede zwischen den einzelnen Qualitätsklassen ein wellenförmiges Bild zeigen. So wurde z.B. die bessere Schlachtqualität am Jahreswechsel 1997/1998 von der Verarbeitungsindustrie weniger honoriert als bei Einführung der EUROP-Klassifizierung oder am Ende der Untersuchungszeit.

Die Ergebnisse unserer Untersuchungen verglichen wir mit den Daten in Deutschland, wo die EUROP-Qualifizierung bereits früher eingeführt wurde (*DGS Magazin*, 1998-1999). Dabei stellten wir fest, dass die Klassen O und P in den Tabellen

der deutschen Statistik nicht mehr vorhanden sind, da nur ein unbedeutend kleiner Anteil der Schlachtweine in diese Qualität eingestuft wird. Die Ankaufspreise in den Klassen E, U und R zeigen, dass es in den besten Schlachtqualitäten preismäßig sehr bedeutende, mitunter über 20% liegende Abweichungen gibt. Der kleinste Preisunterschied ist ca. 10%. Die Tabelle bestätigt, dass auch in Deutschland die Preisverhältnisse zwischen den Qualitätsklassen veränderlich sind und von der Marktlage abhängen. Insgesamt werden aber die Qualitätsunterschiede im Preis gut ausgedrückt.

SCHLUSSFOLGERUNGEN

In der gegenwärtige Lage der ungarischen Schweinezucht und für die zukünftige Entwicklung ergeben sich aufgrund der Analyse nachstehende Schlußfolgerungen:

- Die Größe des ungarischen Schweinebestandes wird grundlegend von äußeren Faktoren (Markt, Rentabilität usw.) bestimmt. Bei steigender Nachfrage wäre der Schweinesektor zu einem schnellen Wachstum fähig, z. B. von gegenwärtig 5-6 Millionen auf 7-8 Millionen. Die dazu notwendige Kapazität in der Fleischverarbeitung ist bereits früher ausgebaut worden und kann somit steigende Mengen verarbeiten, - wird aber gegenwärtig nicht genutzt.
- Durch die eineinhalb Jahrzehnte zurückreichende Analyse der Produktionsergebnisse wird bestätigt, dass die ungarische Schweinezucht zu Beginn der 80-er Jahre die Voraussetzungen (Fütterung, Haltung, Tierhygiene usw.) für eine Produktion auf hohem Niveau schuf. Daraufhin erfolgte kein wesentlicher Fortschritt, und deshalb zeigen die Produktionsparameter, die in hauptsächlich umweltabhängig sind (z.B. Reproduktion, Lebendgewichtszunahme) in den vergangenen Jahrzehnten eine stagnierende Tendenz.
- In den kommenden Jahren kann Ungarn in den äußeren Bedingungen nicht mit einer günstigen Entwicklung rechnen, die auch für die Schweinezucht und -haltung einen wesentlichen Fortschritt bringen würde. Infolge dessen ist bei den durchschnittlichen Reproduktions- und Mastparameter ein gleicher Produktionswert wie heute zu prognostizieren.
- Eine Verbesserung der höheren h^2 -wertigen Schlachtwerte ist weniger von der Umgebung abhängig. Die Zuchtarbeit auf diesem Gebiet war bereits in den vergangenen Jahren erfolgreich, und es ist zu erwarten, dass dieser genetische Trend auch in Zukunft entsprechende Fortschritte bringt.
- Die genetische Struktur des ungarischen Schweinebestandes ist dem in den entwickelten Schweinezuchtländern der Welt gleichwertig. Dieses Niveau wird wegen der regelmäßigen Zuchttierimporte auch in Zukunft erhalten bleiben.
- Seit Einführung der (S)EUROP-Handelsklassen (1997) stieg die Anzahl der klassifizierten Schlachtschweine ständig an.
- Die als ausgezeichneten Schlachtqualität eingestuften Schweine (Klassen E und U) zeigten auf Kosten der niedrigeren Klassen einen Anstieg.
- Die Ankaufspreise für bessere oder schlechtere Qualität zeigen im Untersuchungszeitraum wellenförmige Schwankungen. Die gute Schlachtqualität wurde von der Verarbeitungsindustrie zum Jahreswechsel 1997/1998 weniger gut honoriert als bei Einführung der Qualitätsklassen bzw. am Ende des Untersuchungszeitraumes.

- Im Vergleich zu den offiziellen Schlachtparametern bei Schlachtschweinen in Deutschland ist festzustellen, dass noch bedeutende Anstrengungen zur Verbesserung der Schlachtqualität notwendig sind, besonders im Interesse der Stabilisierung eines wertgemäßen Preissystems.

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Expression of growing and slaughtering qualities of Swedish Landrace pigs according to sex

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ABSTRACT

Better slaughtering and fattening results have induced more frequent fattening of young uncastrated boars. While fattening boars, the problem of unpleasant odour from the boar meat, which is caused by endosteron, scatol and other testicular hormones, often occurs. There are some differences between genetic bases of swine in extracting of these hormones. Therefore, the aim of this paper was to pay more attention on legitimacy of slaughtering Swedish Landrace uncastrated boars. The experiment was carried out on a group of uncastrated boars and a group of uncastrated gilts. The groups were composed of 15 accidentally chosen pigs per group from 15 different litters (one male and one female pig from each litter). The experimental fattening lasted for 95 days (from 30 to 90 kg of body weight) and the pigs were fed ad libitum. The boars had significantly higher daily growth rate (660g vs. 640g, $P<0.05$), thinner back fat, higher meatiness of pork sides (56.92% vs. 54.53%), lower share of back part (14.83% vs. 18.94%) and higher share of shoulders (15.02% vs. 13.29%) than the gilts. Furthermore, the differences in meat quality according to sex were also determined. The boar meat had more unpleasant odour, significantly lower rate of water (72.91% vs. 73.72%) and ashes (1.05% vs. 1.08%) and higher rate of crude proteins (23.49% vs. 22.55%) than the gilt meat. The rate of crude fat in the boar meat was lower than in the gilt meat, but without significant differences (1.85% vs. 2.14%). Concerning pH_1 and pH_2 values, water fixation ability and meat colour, there were no significant differences determined according to sex ($P>0.05$). The pork sides were dissected according to the method by Weniger et al. (1963).

(Keywords: sex, boars, gilts, growth rate, slaughtering quality)

ZUSAMMENFASSUNG

Bewertung der Wachstumsfaktoren und der Schlachtkörperqualität bei Schweinen der Schwedischen Landrasse nach dem Geschlecht

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Bessere Schlacht- und Mastleistung haben dazu geführt, daß immer häufiger nichtkastrierte Schweine männlichen Geschlechts (Eber) gemästet werden. In diesem Fall steht man vor einem Problem: dem unangenehmen Geruch, dessen Intensität durch Androteron, Skatol und andere testikuläre Hormone bedingt ist. Mit Bezug auf das oben

Genannte gibt es genetische Varianten zwischen den Schweinen. Mit dieser Arbeit soll gezeigt werden, dass das Schlachten von Nicht-Kastraten der Schwedischen Landrasse von männlichem Geschlecht seinen Grund hat. Die Untersuchung wurde in zwei Gruppen durchgeführt: die erste Gruppe bestand aus männlichen nichtkastrierten Schweinen (Ebern), die zweite aus weiblichen nichtkastrierten Schweinen. In jeder Gruppe gab es 15 zufällig ausgewählte Tiere, je ein Tier männlichen und weiblichen Geschlechts aus 15 verschiedenen Würfen. Die Versuchs-Mastzeit dauerte 95 Tage. Die Schweine wurden ad libitum gefüttert. Während der Mastdauer (von 30 kg bis 90 kg Körpergewicht) wuchsen die Jungeber signifikant schneller als die Jungsauen (660 g:640 g), ihr Rückenspeck war dünner, die Fleischfülle der Schlachtkörper war besser (56,92%:54, 53%), der Rückenanteil war geringer und der Schulteranteil stärker im Vergleich zu den Jungsauen (15,02%:13,29%). Es wurde festgestellt, daß die Fleischfülle einen engen Zusammenhang zum Geschlecht der Tiere hat. Im Vergleich zu den Jungsauen hatte das Eberfleisch folgende Merkmale: was den Geruch betrifft, war die Intensität schwach, die Wasseranteil (72,91%:73,72%) und Ascheanteil (1,05%:1,08%) waren statistisch signifikant geringer ($P < 0,01$), während der Anteil an Rohprotein (23,49%:22,55%) höher war als im Fleisch der Jungsauen. Der Anteil von Rohfett im Eberfleisch war geringer, aber nicht statistisch signifikant im Vergleich zum Jungsauenfleisch (1,85%:2,14%). Was die pH_1 und pH_2 Werte betrifft, stellte man keine statistisch signifikanten Unterschiede zwischen den Geschlechtern ($P > 0,05$) bezüglich des Wasserbindevermögens und der Fleischfarbe fest. Die Schlachtkörper wurden nach der Methode von WENIGER et al. (1963) zerlegt.

(Schlüsselwörter: Geschlecht, Eber, Jungsau, Schlachtqualität)

INTRODUCTION

Many investigations (Metz et al., 1980; Champbell et al., 1985; Zhang et al., 1993; Chaad et al., 1993; Koucky et al., 1994) point out more efficient production of the meat with higher share of muscle tissue than fatty tissue from uncastrated boars. High anabolic effect in uncastrated boars is caused by the interaction of growth hormones, sexual hormones and IGF (Insulin Growth Factor). Castrating boars causes increased gathering of fatty tissue in a carcass, which has a negative influence on the efficiency of food conversion and quality of a swine carcass.

The important problem while fattening uncastrated boars can be unpleasant odour and taste of meat caused by scatol, androsterone and other testicular hormones. Regarding high variability in concentration of andosterone between different breeds (Willeke et al., 1987; Landstrom et al., 1988), its high heritability (Willeke et al., 1987) and the fact that a level of scatol can be reduced by changing the way of holding and feeding before slaughtering (Ekklundh-Larsen et al., 1993), the presence of andosterone does not have to be an obstacle in fattening of uncastrated boars.

The aim of this paper was to pay more attention on legitimacy of slaughtering Swedish Landrace uncastrated boars with regard to daily growth rate and slaughtering quality of pork sides and meat.

MATERIALS AND METHODS

The experiment was carried out on a group of uncastrated boars and a group of uncastrated gilts. The groups were composed of 15 accidentally chosen pigs per group from 15 different litters (one male and one female pig from each litter). The

experimental fattening lasted for 95 days (from 30 to 90 kg of body weight). While fattening, the pigs were accommodated in-groups, but separated by sex. Housing conditions were the same and optimal for both groups.

From 30 to 60 kg of body weight the pigs were fattened ad libitum by a feed mixture with 17% of crude proteins and 13167 kJ of ME/kg, and from 60 kg to the end of fattening period with 15% of crude proteins and 13251 kJ of ME/kg.

Back fat thickness with belonged skin and MLD area were measured on live pigs on two positions (1 and 2), at the end of fattening period. The measuring was carried out by Scanner 480 VET with a linear sound with dual frequency between 3.5 and 5.0 MHz.

The position of the first measurement (position 1) was about 50 mm from the medial line of the last rib and the position of the second measurement was about 50 mm from the medial line between 11th and 10th rib.

Pork sides were dissected according to the method by *Weniger et al.* (1963). Muscle tissue from less valuable parts (head, knuckles and tail) was not taken into the account of total quantity of muscle tissue.

pH meat values were determined on the 45th minute and on the 24th hour of post mortem period on the sample of MLD taken between 13th and 14th rib (position 2), which was cooled on +4°C.

Five examiners estimated the smell of the boar meat after baking. The meat without boar smell was graded with mark 3, the meat with weak boar smell with mark 2 and the meat with expressive boar smell with mark 1.

The colour of the meat was estimated according to the American NPPC (National Pork Producers Council) method with marks from 1 to 6.

The water fixation ability was determined according to the compression method by Grauhamm.

The chemical analysis of the meat (MLD) was carried out by the following methods:

- the content of water was determined by pulling down to 105°C to a permanent mass;
- the content of proteins was determined according to the method by Kjeldahl;
- the content of fat was determined according to the method by Soxleth;
- the content of ash was determined by a direct burning on the temperature of 550°C.
- The results of the investigation were elaborated with the statistical program SPSS (*Nie et al.*, 1975).

RESULTS AND DISCUSSION

The boars were growing slightly faster than the gilts (*Table 1*), and because of that they had significantly higher daily growth rate ($P < 0.05$). However, there were no significant differences between the body weights at the end of fattening period, which was connected with expressed variability between the groups.

The boars had significantly thinner back fat at the position 2 than the gilts, while there were no significant differences regarding MLD area between the analysed groups ($P > 0.05$). *Chaad et al.* (1993) found out that boars fattened to 120 kg of body weight have significantly higher daily growth rate (974 g vs. 806 g) and smaller MLD area (43.3 cm² vs. 45.0 cm²) than gilts. Contrary to this, *Siegel et al.* (1990) point out larger MLD area and thinner back fat in gilts than in boars. Higher daily growing rate and thinner back fat in uncastrated boars were the results of investigations of *Metz et al.* (1980), *Campbell et al.* (1985), *Zhang et al.* (1993), *Koucky et al.* (1994) and others.

Table 1

Some indicators of growing parameters and slaughtering qualities of swine before slaughtering according to sex

Indicators (1)	BOARS (2)		GILTS (3)	
	$\bar{x}$	s	$\bar{x}$	S
Initial body weight, kg (4)	29.83	2.89	31.00	4.04
Final body weight, kg (5)	93.00	6.54	92.25	6.45
Daily growing rate, kg (6)	0.660*	0.05	0.640	0.05
Back fat thickness, cm:				
- position 1	1.10	0.25	1.20	0.29
- position 2 (7)	0.81*	0.18	0.99	0.19
MLD area, cm ² :				
- position 1	36.68	3.47	34.86	3.85
- position 2 (8)	39.67	4.29	40.62	3.51

*P<0.05

1. Tabelle: Wachstumsfaktoren und Schlachtqualitätsmerkmale der Schweine vor dem Schlachten (nach Geschlecht)

Merkmale(1), Eber(2), Jungsauen(3), Lebendgewicht zu Mastbeginn, kg(4), Lebendgewicht zu Mastende, kg(5), tägliche Zunahme(6), Speckdicke, cm: Stelle 1, Stelle 2(7), MLD-Fläche, cm²: Stelle 1, Stelle 2(8)

Table 2

Quality indicators of pork sides according to sex

Indicators (1)	BOARS (2)		GILTS (3)	
	$\bar{x}$	S	$\bar{x}$	S
Mass of right cooled pork sides, kg (4)	34.97	2.59	34.15	1.75
Meatiness ¹ , kg (5)	19.91**	1.74	18.65	1.75
Meatiness ¹ , % (6)	56.92*	2.00	54.53	3.00
Ham share, % (7)	29.63	1.45	29.09	0.89
Back part share, % (8)	14.83**	1.25	18.94	1.29
Shoulder share, % (9)	15.02**	0.95	13.29	0.96

*P<0.05

**P<0.01

¹Without muscle tissue of less valuable parts (*ohne Muskelfleischanteil weniger wertvoller Teile*)

2. Tabelle: Qualitätsmerkmale der Schlachthälften bei Schweinen (nach dem Geschlecht)

Merkmale(1), Eber(2), Jungsauen(3), Kaltgewicht des rechten Schlachtkörpers, kg(4), Fleischfülle¹, kg(5), relative Fleischfülle, %¹(6), Anteil der Keule, %(7), Anteil des Rückens, %(8), Anteil der Schulter, %(9)

The results in *Table 2* show that the boars had significantly higher absolute and relative meatiness ($P<0.05$) than gilts. However, there are some contradictory results in literature about that. For instance, *Chaad et al.* (1993), experimenting on Danish Landrace and Large White swine, once have found higher meatiness in boars and another time in gilts (58.7% vs. 57.2% and 59.8% vs. 60.4%, respectively).

The pork sides from the boars had significantly higher shares of shoulders ($P<0.01$) and lower shares of back part than those from the gilts. Despite of slightly more developed hams in the boars, there were no significant differences for ham share according to sex.

The quality indicators of the meat are shown in *Table 3*. pH_1 and pH_2 values were in normal ranges and there were no significant differences according to sex.

The water fixation ability was in optimal range and about equal in the both groups of swine.

The smell of the meat, which had been determined by a panel-group degustation after baking, was slightly worse in the meat from the boars. It was determined that the meat from three boars (20% of the group) had a strong boar smell, and the meat from one boar had a weak boar smell.

The colour of the meat, which had been estimated subjectively by marks from 1 to 5, was optimal in the both groups of swine and without variabilities.

The boar meat had significantly lower water and ash content ($P<0.01$) and higher content of crude proteins than the gilt meat. The content of crude fat in the boar meat was lower than in the gilt meat, but without significant differences.

Table 3

Quality indicators of pork according to sex

Indicators (1)	BOARS (2)		GILTS (3)	
	$\bar{x}$	s	$\bar{x}$	s
- pH_1 (4)	6.40	0.15	6.31	0.17
- pH_2 (5)	5.70	0.15	5.82	0.16
- water fixation ability, cm^2 (6)	4.00	0.38	4.50	0.37
- smell (1-3) ¹ (7)	2.25	0.96	3.00	0.00
- colour (1- 6) ² (8)	4.00	0.00	4.00	0.00
Chemical structure, %: (9)				
-water (10)	72.91**	0.43	73.72	0.55
- proteins (11)	23.49**	0.40	22.55	0.56
- fat (12)	1.85	0.40	2.14	0.75
- ash (13)	1.05**	0.03	1.08	0.04
- NFE ³ (14)	0.70	0.32	0.51	0.46

** $P<0.01$

¹Mark 1 – strong smell. (*Note 1 – starker Geruch.*), Mark 2 – weak smell. (*Note 2 – schwacher Geruch.*), Mark 3 – normal smell. (*Note 3 – normale Geruchsintensität.*)

²Mark 1 and 2 – bright color. (*Note 1 und 2 – helle Farbe.*), Mark 3 and 4 – normal color. (*Note 3 und 4 – normale Farbe.*) Mark 5 and 6 – dark color. (*Note 5 und 6 – dunkle Farbe.*)

³Nitrogen-free extract. (*N-freier Extrakt.*)

3. Tabelle: Schlachtkörperqualität (nach dem Geschlecht)

Merkmale(1), Eber(2), Jungsauen(3), pH_1 (4), pH_2 (5), Wasserbindevermögen, cm^3 (6), Geruch(7), Farbe(8), Chemische Zusammensetzung(9), Wasser(10), Proteine(11), Fette(12), Asche(13), Nitrogenfreier Extrakt(14)

CONCLUSIONS

In the experimental fattening of the pigs that lasted for 95 days (from 30 to 90 kg of body weight), the boars had significantly higher daily growth rate (660g vs. 640g, $P < 0.05$), thinner back fat, higher meatiness of pork sides (56.92% vs. 54.53%), lower share of back part (14.83% vs. 18.94%) and higher share of shoulders (15.02% vs. 13.29%) than the gilts.

Furthermore, the differences in meat quality according to sex were also determined. The boar meat had more unpleasant odour, significantly lower rate of water (72.91% vs. 73.72%) and ashes (1.05% vs. 1.08%) and higher rate of crude proteins (23.49% vs. 22.55%) than the gilt meat. The rate of crude fat in the boar meat was lower than in the gilt meat, but without significant differences (1.85% vs. 2.14%).

Concerning pH₁ and pH₂ values, the water fixation ability and the colour of the meat, there were no significant differences determined according to sex ($P > 0.05$).

Generally saying, boars fattened to 90 kg of body weight are superior in growing characteristics and pork sides qualities, but on the other side, they are inferior in smell of the meat. Because of high variability and heritability of boar smell in meat, this can be reduced by proper selection.

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Energiesparende Heizung und Temperaturbehaglichkeit für Schweine im Abferkelstall

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ZUSAMMENFASSUNG

In einem zweijährigen Versuch mit eigenem Prototyp an Ferkelkisten in Abferkelbuchten wurden 60 Würfe beobachtet. Säugezeit je Wurf war 28 Tage. Der durchschnittliche Energieverbrauch war 17,69 kWh in der 1. Woche; 12,49 kWh in der 2. Woche; 8,19 kWh in der 3. Woche und 4,01 kWh in der 4. Woche nach der Abferkelung. In der klassischen Abferkelbucht mit ständig betriebenen 250 W Infrarotstrahler (250 W IR) werden 42 kWh pro Woche verbraucht. Die Kosten pro Bucht und Jahr sind in den Buchten mit beheizbaren Ferkelkisten 40,22 EURO, und 137,92 EURO bei offenem Liegeplatz mit 250 W IR.

(Schlüsselwörter: Schwein, Sau, Ferkel, Temperatur, Energieverbrauch)

ABSTRACT

Economical heating and temperature comfort of pigs in the farrowing house

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In a two-year experiment with our own prototype hover 60 litters were observed in the farrowing pen. The lactation period for each litter was 28 days. Average electrical energy consumption was 17.69, 12.49, 8.19 and 4.01 kWh in the 1st, 2nd, 3rd and 4th weeks, respectively, after farrowing. In the classic farrowing pen with a 250 W infrared bulb permanently operational (250 W IR) energy consumption was 42 kWh per week. The heating cost per pen with the hover was 40.22 EURO and 137.92 EURO for 250 W IR per year.

(Keywords: pigs, sows, piglets, temperature, energy consumption)

EINFÜHRUNG

Ein globales Problem unserer Welt ist der verschwenderische Energieverbrauch. Die elektrische Energie scheint sauber zu sein, ist aber sehr umweltbelastend, wenn sie in Kohle- oder Kernkraftwerken produziert wird. Wenn wir in irgendeiner Produktion den Elektroenergieverbrauch pro Produkteinheit vermindern, kommt das im weiteren Sinne auch unserer Umwelt zugute. In der Schweinezucht ist der Energiebedarf im Abferkelstall besonders hoch. Die neugeborenen Ferkel brauchen eine ziemlich hohe Umgebungstemperatur für ihren Liegeplatz, um nicht zu unterkühlen. Wenn es den Ferkeln zu kalt ist, liegen sie ganz eng zusammen oder sogar in einem Haufen aufeinander. In Abferkelbuchten gibt es meistens elektrische Infrarotstrahler als Wärmequelle. Ein 250 W Infrarotstrahler kann in den 28 Tagen Säugezeit bei ununterbrochenem Betrieb sogar bis zu 168 kWh verbrauchen. Vorteil dieser Lösung ist ihre Einfachheit, aber die schlechten

Möglichkeit zur Regulierung der Temperatur (nur mit der Veränderung der Höhe des Infrarotstrahlers) und der häufige Wechsel der Glühbirnen sind ausgesprochen nachteilig. Ist der Liegeplatz offen, gibt es besonders hohe Wärmeverluste, da die warme Luft wegen der Konvektion aufsteigt. Wegen dieser Wärmeverluste aus den offenen Liegeplätzen steigt die Lufttemperatur im ganzen Abferkelstall. Damit besteht für die Sauen die Gefahr der Hitzebelastung. Bei höherer Lufttemperatur im Stall fressen die Sauen weniger und ihre Milchproduktion nimmt ab, was auch für die Ferkel nicht gut ist. *Jacobson* und *Johnston* (1998) stellten fest, daß die Sauen in einem 5°C kühleren Abferkelstall mit geschlossenen Ferkelkisten täglich 1 kg mehr Futter verzehren als Sauen in Ställen mit den klassischen offenen Liegeplätzen. Wenn die erwärmte Luft aufsteigt, dringt von den Seiten kalte Luft ein, was sehr ungünstig ist für die Ferkel am Rand der Gruppe. Diese Ferkel suchen nach einem besseren Platz, was ständig Unruhe in der Gruppe verursacht. Das ideale Temperaturverhältnis wäre 16 bis 18°C im ganzen Raum des Abferkelstalls und 30°C im Bereich der Ferkelliegeplätze. *Rist et al.* (1993) halten sogar eine Temperatur von 33 °C für die Ferkel als optimal. Mit fortschreitendem Lebensalter der Ferkel kann die Temperatur des Liegeplatzes - abhängig von anderen Umweltfaktoren (Tiefstreu, ohne Stroh) - unterschiedlich schnell verringert werden. Eine Lösung zur Schaffung unterschiedlicher Temperaturbehaglichkeitszonen für Sauen und Ferkel im gleichen Raum ist schwierig. Die beste Lösung ist ein kalter Raum als Abferkelstall, in dem sich Abferkelbuchten mit warmen, geschlossenen Ferkelkisten befinden (*Rist et al.* 1993). Damit es in den Ferkelkisten nicht zu heiß wird, sollte in den Thermoregulator auch ein Thermostat eingebaut werden. Diese Ausrüstung schaltet den Wärmestrahler ab, wenn die eingestellte Temperatur erreicht ist. Ist der Wärmestrahler nicht ständig eingeschaltet, kommt man mit weniger Energie aus. In vorliegender Arbeit wurde ein eigener Prototyp von Ferkelkiste entwickelt und längere Zeit hindurch getestet.

MATERIAL UND METHODE

Im Zeitraum vom Juli 1994 bis August 1996 wurden 60 Würfe beobachtet. Bis zum 28. Lebenstag der Ferkel wurde jeden Tag und für jeden Wurf gesondert der Elektroenergieverbrauch gemessen. Die Temperatur in jeder Ferkelkiste wurde je nach dem Verhalten der Ferkel reguliert: Lagen die Ferkel auf einem Haufen, wurde die Temperatur erhöht; Lagen die Ferkel außerhalb ihrer Kiste, wurde die Temperatur verringert.

Die Ferkelkiste wurde in einer Ecke der Abferkelbucht an zwei Holztrennwänden angebracht. Die Kiste war 60 cm hoch. Zwei der Kistenwände bestanden aus Plastikvorhängen, damit die Ferkel ungehinderten Ein- und Ausgang hatten. Die Ferkelkiste wurde mit Stroh eingestreut. An der Kistendecke wurde der Wärmerestahler angebracht. Dieser besteht aus einem 200 W Elektrorohrwärmer mit nach unten gerichtetem Strahlungsschirm und einem Wärmesensor sowie einem Temperaturregler an der Kistendecke. Innerhalb dieser Regulationsanlage befindet sich auch ein Thermostat, um den Wärmestrahler auszuschalten, wenn die eingestellte Temperatur erreicht war. Jede Abferkelbucht hatte einen eigenen Zähler für den Energieverbrauch. Das Verhalten der Ferkel wurde täglich fünfmal beobachtet, um eine optimale Einstellung des Thermostats zu erreichen.

ERGEBNISSE UND DISKUSSION

In der *Abb.1* sind Außen- und Stalltemperaturen dargestellt. Es ist ersichtlich, daß zwei Jahre lang die durchschnittliche tägliche Außentemperatur zwischen 32°C im Sommer und -2°C im Winter schwankte. Die Innen- bzw. Stalltemperatur zeigte wegen guter Isolationsfähigkeit des

Stallbaumaterials nur geringe Schwankungen. Nur im Hochsommer stieg auch auch die Stalltemperatur bis auf 22°C. Überwiegend lag die Temperatur zwischen 18 und 19°C.

Abbildung 1

Außen- und Stalltemperatur in verschiedenen Jahreszeiten

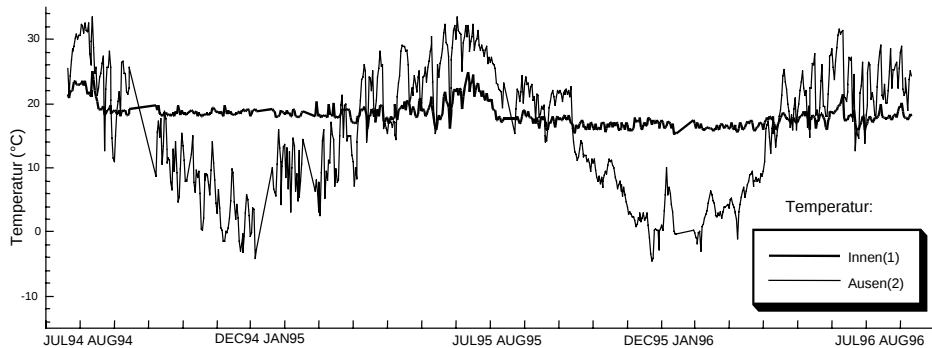


Figure 1: Outdoor and indoor temperature in the various seasons

Indoor(1), Outdoor(2)

Der durchschnittlicher Energieverbrauch war in der ersten Woche am größten und nahm mit fortschreitendem Alter der Ferkel ständig ab (Abb. 2). Dafür gibt es zwei Gründe: Erstens sind die älteren Ferkel weniger anspruchsvoll hinsichtlich einer warmen Umgebung; zweitens geben die älteren Ferkel im der Ferkelkiste Nest mehr Wärmeenergie ab und der Wärmestrahler schaltet seltener ein.

Abbildung 2

Durchschnittlicher Energieverbrauch von der 1. bis 4. Lebenswoche der Ferkel

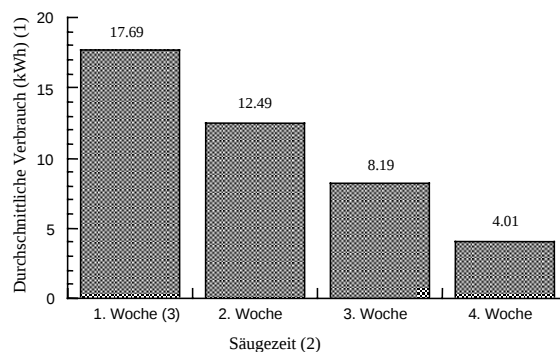


Figure 2: Average energy consumption from the 1st to the 4th week of life of the piglets

Average energy consumption(1), Lactation period(2), Week(3)

Wird der Energieverbrauch in der Ferkelkiste mit jenem der üblichem 250 W Infrarotstrahler in offenem Nest verglichen, erhöhen sich die Energieersparnisse mit zunehmendem Alter der Ferkel (Tab. 1).

Tab. 1

Vergleich des Energieverbrauchs bei Verwendung der Ferkelkiste und bei offenem Liegeplatz mit 250 W Infrarot-Glühbirne

Woche (1)	Energieverbrauch in der Ferkelkiste (kWh)(2)	Energieverbrauch bei offenem Liegeplatz (kWh)(3)	Unterschied (kWh)(4)
1.	17,69	42,00	24,31
2.	12,49	42,00	29,51
3.	8,19	42,00	33,81
4.	4,01	42,00	37,99
Σ	42,38	168,00	125,62

Table 1: Comparison of energy consumption in the hover and in the open farrowing pen with a 250 W infrared bulb

Week(1), Energy consumption in the hover(2), Energy consumption in the open farrowing pen(3), Difference(4)

Tab. 2

Kosten pro Bucht und Jahr für zwei Ferkelwärmesysteme bei vierwöchiger Sägezeit (in EURO)*

Lfd. Nr. (1)	Kostenart (2)	Bemerkung (3)	Ferkelkiste (4)	Offener Liegeplatz mit 250 W Infrarot- Strahler (5)
1	Investitionskosten (6)		105,47	21,30
2	Abschreibung(7)	10% von Z1	10,55	2,13
3	Betriebskosten(8)	Reparaturen	-	18,19
4	Kosten für Technik (9)	Z2+Z3	10,55	20,32
5	Energiebedarf (kWh pro Sägezeit)(10)		42,38	168
6	Durchgänge pro Jahr(11)		10	10
7	Preis je kWh (12)		0,07	0,07
8	Wirkungsgrad (13)		1	1
9	Energiekosten(14)	Z5.Z6.Z7/Z8	29,67	117,60
10	Kosten insgesamt(15)	Z4+Z9	40,22	137,92

Methode nach Baey-Ernsten et al. (1996)

*Table 2: Cost per pen per year for two farrowing pen heating systems, based on a four-week lactation period (in Euros)**

Article no.(1), Cost factor (2), Comments (3), Hover(4), Open farrowing pen with 250 W infrared lamp(5), Investment cost(6), Depreciation (7), Operational cost (8), Technology cost(9), Energy requirement (kWh per 4-week lactation period)(10), Stages per year(11), Energy price per kWh(12), Degree of efficiency(13), Energy cost(14), Total cost(15)

Die Energieersparnis mit 42.38 kWh pro Wurf bei Verwendung unseres Prototyps der Ferkelkiste ist bemerkenswert. Auch bei Elektrobodenheizung stellten mehrere Autoren einen etwas höheren Energieverbrauch fest. *Bay-Ernsten* et al. (1996) verbrauchten 56 kWh, *Fischer* und *Mellet* (1996) 61 kWh, *Rousseau* und *Mit.* (1994) 66,8 kWh pro Wurf. In der Ferkelkiste ohne Thermostat stellte *Weber* (1987) einen Verbrauch von 86 kWh pro Wurf fest.

Es stellt sich die Frage, ob die teure Ferkelkiste mit dem sparsamen Betrieb auch die höheren Investitionskosten deckt. Antwort auf diese Frage gibt *Tabelle 2*.

Bei Einsatz der Ferkelkisten betragen die Energiekosten 74% der Gesamtkosten, bei offenem Liegeplatz sogar 84%. Da die Energiekosten einen so hohen Anteil haben, ist die Verwendung von Ferkelkisten bedeutend günstiger als der offene Liegeplatz mit einer 250 W Infrarot-Glühbirne.

SCHLUSSFOLGERUNGEN

Die Ferkelkiste verhindert größere Wärmeverluste des Liegeplatzes. Wird der Wärmestrahler mit Thermostat und Thermoregulator ausgerüstet und die Anlage gut eingestellt, kann damit in kurzer Zeit eine Energieersparnis bis zu 75% erreicht werden. Das ist jedoch nicht der einzige Vorteil dieses Systems. Ein ziemlich kalter Abferkelstall (16–18°C) ist für die Sauen optimal. Die optimale Temperatur für die Ferkel wird durch den Einsatz der Ferkelkiste mit der Temperaturregulierung ermöglicht. Damit können zwei unterschiedliche Temperaturansprüche im gleichem Raum realisiert werden.

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Estimation of genetic parameters for litter size in pigs from different genetic groups

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ABSTRACT

Number of piglets born alive (NBA) and number of piglets born (NB) was analysed. A total of 46,960 litters of Swedish Landrace (SL) Large White (LW), and both F1 sows were included. Records were collected between 1993 and 1998. Animal model and REML procedures were used to estimate genetic and environmental parameters for the first six litters in univariate analyses. Random additive genetic effect and permanent environment effect of the sow were considered. The differences between genotypes were estimated by crossbreeding parameters: additive maternal and additive grand-maternal effect as well as maternal heterosis. Estimates were 0.14 and 0.12 for heritability and 0.20 and 0.18 for repeatability in NB and NBA respectively. The contribution of additive maternal effect to the breed differences (SL-LW) was estimated at 0.10 and 0.26 respectively. The estimated deviation of the F1 from the mid parental value (maternal heterosis effect) was 0.69 and 0.72 for NB and NBA respectively. The additive grand-maternal effect, which expresses the differences between crossbreeds, (SL x LW-LW x SL) was low (0.06 for NB and -0.03 for NBA).

(Keywords: pigs, litter size, variance components, heritability, crossbreeding parameters)

ZUSAMMENFASSUNG

Schätzung von genetischen Parametern für die Wurfgröße beim Schwein aus verschiedenen Zuchtgruppen

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In der vorliegenden Arbeit wurde die Anzahl der geborenen Ferkel (NB) und die Anzahl der lebend geborenen Ferkel (NBA) geschätzt. Insgesamt wurden 46.960 Würfe der Schwedischen Landrassee (SL), Large White (LW) und von beiden die F1 Kreuzungssauen (SL x LW, LW x SL) analysiert. Die Daten stammen aus den Jahren 1993-1998. Für die Schätzung der genetischen- und Umweltparameter für die ersten sechs Würfe in einer univariaten Analyse wurden Tiermodelle und die REML-Methode verwendet. Als zufälliger Effekt wurde additiv der genetischer Effekt und der permanente Umwelteffekt der Sau angenommen. Die Unterschiede zwischen den Genotypen wurden mit Kreuzungsparametern additiv maternalem, additiv grandmaternalem und maternalem Heterosiseffekt geschätzt. Die geschätzte Heritabilität betrug für NB 0.14, für NBA 0.12; und die Wiederholbarkeit 0.20 für NB beziehungsweise 0.18 für NBA. Der Beitrag von additiv maternalem Effekt zum Unterschied zwischen den Rassen (SL-LW)

wurde für NB auf 0.10 und für NBA auf 0.26 geschätzt. Die geschätzte Abweichung bei F1 Sauen vom Elterndurchschnittswert (maternaler Hettrrosiseffekt) betrug für NB 0.69 und für NBA 0.72. Der Beitrag von additiv grandmaternalem Effekt zum Unterschied zwischen den Kreuzungen (SL x LW-LW x SL) wurde auf 0.06 für NB und auf -0.03 für NBA geschätzt.

(Schlüsselwörter: Schwein, Wurfgröße, Varianzkomponenten, Heritabilität, Kreuzungsparameter)

INTRODUCTION

In pigs litter size is an important component of sow efficiency, and is therefore one of the objective traits in many selection programmes. *Haley et al.* (1988) suggested that litter size be used in successive parities as repeated measurements. In other words, the litters in different parities would be under the same genetic control, which implies a genetic correlation of one among parities. Many breeding programmes accept this assumption and use a repeatability model for litter size in pigs (*Schaeffer*, 1993; *Alfonso* and *Noguera*, 1995; *Alfonso et al.*, 1997; *Hofer*, 1998; *Andersen*, 1998; *Tölle et al.*, 1998). *Sadek-Pučnik* and *Kovač* (1996) obtained high correlations among litter size in the first six parities. The use of two different models to adjust the first litter for age at farrowing and later litters for lactation length was the main reason for not using a simple repeatability model. *Andersen* (1998) showed a way how to handle repeated records with different fixed effects.

The knowledge of genetic parameters for the various traits are the basis for genetic improvement in an advanced breeding programme and for successful selection. In crossbreeding schemes the expression of non-additive genes is even more important. This expression of genes could be evaluated in terms of crossbreeding parameters in the classic crossbreeding model (*Dickerson*, 1969). As has been shown by *Komender* and *Hoesehele* (1989), the accuracy of crossbreeding estimators can be improved by including genetic relationship between animals in the analysis, for example by an animal model.

The objectives of the research here were: 1) to estimate variance components for litter size in pigs from different genetic groups treating different parities as the same with respect to trait, and 2) to estimate differences between sow genotypes in terms of genetic parameters.

MATERIALS AND METHODS

Litter records from the Nemščak farm were provided by the Slovenian national pig breeding programme for the period between January 1993 and December 1998. Litters from the first to the sixth parity were analysed (*Table 1*). In gilts, age at farrowing (348 ± 31 days) was limited to between 290 and 430 days. The farrowing interval in sows was restricted to between 125 and 250 days. Average litter size was 10.38 for NB and 9.91 for NBA with standard deviation of 2.99 and 2.98 respectively. There were 18,629 Swedish Landrace (SL), 4948 Large White (LW), 21,456 SL x LW (matings of SL females and LW males) and 1927 LW x SL litters. Sows were mated to 312 service boars of five different breeds. The boars with less than ten litters were grouped. Season was created as a year-month-decade interaction and had 217 levels. A total of 17605 animals were included in the pedigree. Among these there were 14,961 sows with litters, 5391 dams and 265 sires, giving at least three generations of ancestors.

Table 1

Number of litters (n), piglets born (NB), and piglets born alive (NBA), previous lactation length and weaning to conception interval (WCI) by number of parities

Parity (1)	n	NB	SD	NBA	SD	Lactation (days) (2)	SD	WCI (days) (3)	SD
1	11882	9.18	2.74	8.76	2.83				
2	9281	10.10	2.81	9.79	2.79	25.42	5.43	24.52	25.63
3	8194	10.87	2.91	10.45	2.88	26.13	4.06	15.19	19.39
4	6936	11.15	2.97	10.62	2.96	26.17	3.78	15.03	19.15
5	5857	11.18	2.99	10.54	2.99	26.01	4.16	14.19	18.51
6	4810	11.02	3.00	10.28	3.00	25.98	4.28	13.86	18.36
Total (4)	46960	10.38	2.99	9.91	2.98	25.91	4.47	17.28	21.37

SD – phenotypic standard deviation (*Phänotypischen Standardabweichungen*)

1. Tabelle: Wurfzahl (n), geborene Ferkel (NB), lebend geborene Ferkel (NBA), Dauer der vorherigen Laktation und Zeitraum zwischen Abferkelung und Trächtigkeit (WCI)

Wurfnummer(1), Dauer der vorherigen Laktation(2) und Zeitraum zwischen Abferkelung und Trächtigkeit(3), Gesamt(4)

Covariance components were obtained by Restricted Maximum Likelihood (REML, Peterson and Thompson, 1971) using the Powell algorithm in PeRun (Kovač, 1992). The evaluation with the best set of covariance components was performed by means of PEST (Groeneveld and Kovač, 1990). The statistical model included crossbreeding parameters, age at first farrowing for gilts, lactation length and weaning to conception interval for sows, service boar (B_j), parity (P_i), and season of insemination (S_k) as fixed effects. The random part of the model consisted of permanent environment of the sow (p_i) and additive genetic effect (a_i). Age at first farrowing (x_{1kl}) was adjusted by quadratic regression, while lactation (x_{2ikl}) and weaning to conception interval (x_{3ikl}) was fitted as linear regression. The following repeatability model was used:

$$y_{ijkl} = P_i + B_j + S_k + b_1 x_{1kl} + b_2 x_{1kl}^2 + b_3 x_{2ikl} + b_4 x_{3ikl} + \alpha_m x_{4l} + \delta_m x_{5l} + \alpha_{gm} x_{6l} + p_i + a_i + e_{ijkl}$$

The crossbreeding parameters accommodated maternal additive effect (α_m), maternal heterosis effect (δ_m) and additive grand-maternal effect (α_{gm}). All of these were fitted as linear regression in order to obtain differences between genotypes straight from the model, as suggested by Dickerson (1969). The genotype class was replaced by the coefficients used as independent variables x_{4l} , x_{5l} and x_{6l} given in Table 2.

In order to describe covariance structure, the model was rewritten in matrix form:

$$y = X\beta + Za + Wp + e$$

where y stood for the observation vector, β for the vector of fixed effects, a for the vector of animal genetic effect, p for the vector of permanent environmental effects, and e for the vector of residuals. Matrices X , Z , W are corresponding incidence matrices.

Expectations and covariance matrices of random variables are described in the following equations:

$$E \begin{bmatrix} y \\ a \\ p \\ e \end{bmatrix} = \begin{bmatrix} X\beta \\ 0 \\ 0 \\ 0 \end{bmatrix} \quad \text{and} \quad V \begin{bmatrix} a \\ p \\ e \end{bmatrix} = \begin{bmatrix} A\sigma_a^2 & 0 & 0 \\ 0 & I\sigma_p^2 & 0 \\ 0 & 0 & I\sigma_e^2 \end{bmatrix}$$

where A is a genetic relationship matrix; I is an identity matrix; σ_a^2 , σ_p^2 , σ_e^2 additive genetic, permanent environment and residual variances, respectively; cov(a,e') and cov(a,p') are equal to zero.

Table 2

The coefficients for additive maternal (α_m), maternal heterosis (δ_m) and additive grand-maternal (α_{gm}) effects

Genotype (1)	Crossbreeding parameter(2)		
	Additive maternal (α_m)	Maternal heterosis (δ_m)	Additive grand-maternal (α_{gm})
Swedish Landrace	1	0	1
SL x LW	0.5	1	1
LW x SL	0.5	1	0
Large White	0	0	0

SL - Swedish Landrace, LW - Large White, F1 - SL x LW or LW x SL (breed of dam given first.) (*Erste Mutterrasse*.)

2. Tabelle: Koeffizienten für additiv maternale Effekte (α_m), maternale Heterosis (δ_m) und additive grandmaternale Effekte (α_{gm})

Genotyp(1), Kreuzungsparameter(2)

RESULTS AND DISCUSSION

Estimates of genetic, environmental and phenotypic parameters are presented in Table 3. Total phenotypic, permanent environmental and residual variances proved larger for NBA than for NB. The estimate of h^2 was 0.14 for NB and 0.12 for NBA. The estimates are close to the values reported by See et al. (1993), Crump et al. (1997) and Southwood and Kennedy (1990). In addition, Haley et al. (1988) reviewed heritabilities from many sources and concluded in summary that about 10% of variation in litter size was heritable. Heritability estimates were higher for NB than for NBA. The same conclusion was reached by Roehe and Kennedy (1995), Kisner et al. (1996), Mercer and Crump (1994) and Crump et al. (1997). Permanent environment effect explained 6% of phenotypic variation. The repeatability estimates (0.20 and 0.18) were close to the values reported by Mercer and Crump (1994) but larger than those reported by Kisner et al. (1996).

Table 3

Estimates of phenotypic
(σ^2), error (σ_e^2), permanent environment (σ_p^2), additive genetic (σ_a^2) variance,
repeatability, relative contribution of the permanent environment effect of sow (p^2)
and heritability (h^2) for the traits NB and NBA

Trait (4)	Variance components (1)				Repeatability (2)	Ratio (3)	
	σ^2	σ_e^2	σ_p^2	σ_a^2	r	p^2	h^2
NB	8.0114	6.4451	0.4573	1.1090	0.20	0.057	0.138
NBA	8.0877	6.5996	0.4994	0.9887	0.18	0.062	0.122

3. Tabelle: Phänotypische Varianz (σ^2), Restvarianz (σ_e^2), zufällige permanente Umweltvarianz (σ_p^2), Wiederholbarkeit, permanenter Umweltanteil (p^2) und Heritabilität (h^2) für geborene und lebend geborene Ferkel

Komponenten der Varianz(1), Wiederholbarkeit(2), Verhältnis(3), Eigenschaften (4)

In the crossbred sows litter size was about 0.7 piglets higher than in the pure-bred sows. SL gilts were on average 11 days younger than LW gilts at first farrowing. The difference between the two F1 genotypes was seven days, the SL gilts falling between the two extremes from this aspect (Table 4). The shortest weaning to conception interval was recorded in the LW. Previous lactation length did not differ greatly between the genotypes.

Table 4

Number of litters (n), number of piglets born (NB), number of piglets born alive
(NBA), previous lactation length, weaning to conception interval (WCI)
and first farrowing age

Genotype(3)	n	NB	NBA	Gilts(1)	Sows(2)	
				Age (days)(4)	Lactation (days)(5)	WCI (days)(6)
Swedish Landrace (SL)	18629	9.96	9.53	346	25.57	18.82
SL ¹ x LW	21456	10.84	10.33	349	26.20	16.33
LW x SL	1927	10.58	10.21	342	25.76	16.36
Large White (LW)	4948	9.92	9.39	357	25.88	16.21
Total (7)	46960	10.38	9.91	348	25.91	17.28

¹Breed of dam (Mutterrasse)

4. Tabelle: Wurfzahl (n), geborene Ferkel (NB), lebend geborene Ferkel (NBA), Alter beim 1. Wurf, Dauer der vorherigen Laktation und Zeitraum zwischen Abferkelung und Trächtigkeit (WCI)

Jungsauen(1), Sauen(2), Genotyp(3), Alter beim 1. Wurf in Tagen(4), Dauer der vorherigen Laktation(5), Zeitraum zwischen Abferkelung und Trächtigkeit(6), Gesamt(7)

For the interval observed litter size increased with age of gilts at first farrowing. The regression coefficients were similar for both traits. The results were comparable with Sadek (1994), from another nucleus herd in Slovenia. Furthermore, the effect of previous lactation length was smaller (0.026) than expected. Kovač et al. (1984) and Sadek (1994) excluded records with short lactation (under 18 days) and obtained regression coefficients more than twice as high (0.057 and 0.065). As records with short lactation were included in this study the regression line did not give the best fit to the records with longer lactation. With this in mind the authors suggested that litters in which lactation was short should not be included in genetic evaluation. The third independent variable, the weaning to conception interval, was found to have little effect on litter size (0.008 per day for NB or 0.007 for NBA).

The estimates of crossbreeding parameters included in the analyses are shown in Table 5. The additive maternal effect showed that Swedish Landrace sows had 0.091 more piglets per litter at birth than Large White sows. A larger difference (0.36) was observed with respect to piglets born alive. Contrary phenotypic differences between pure-breds were smaller for both traits. The main cause of this may lie in different age at first farrowing. SL gilts were younger at farrowing, and thus smaller litters were expected. In addition, LW sows produced more stillborn piglets, resulting in a sizeable difference between the sows of these two breeds.

As expected, litter size increased in crossbred sows. Maternal heterosis effect was estimated at 0.69 for NB and 0.72 for NBA (Table 5), which was twice as large as the difference between pure-breds. This was in agreement with values (from 0.6 to 0.7) summarised by Rothschild and Bidanel (1998).

In order to estimate the difference between the F1 crossbreeds, additive genetic effect of the grand-maternal breed was included in the analysis. The differences between the two crosses were negligible for NB (0.064) and for NBA (-0.025). Therefore, crosses may be used interchangeably with the expectation of almost the same litter size at birth in both crossbreeding schemes, the only difference expected being due to smaller litters in pure-bred LW. However, there was some evidence that LW and LW x SL sows might also lose more piglets during lactation. Due to cross-fostering this suspicion could not be proved from regular litter recording.

Table 5

Estimates of crossbreeding parameters

Crossbreeding parameter(1)	Piglets born(2)	Piglets born alive(3)
Additive maternal (α_m)	0.091	0.36
Maternal heterosis (δ_m)	0.69	0.72
Additive grand-maternal (α_{gm})	0.064	-0.025

5. Tabelle: Schätzung der Kreuzungsparameter

Kreuzungsparameter(1), Anzahl der geborenen Ferkel(2), Anzahl der lebend geborenen Ferkel(3)

Because of the high genetic correlation between NB and NBA (0.95) there are no reasons for using both traits for selection on litter size (Tölle et al., 1998). Even higher

correlation (0.97) was obtained in analysis of Logar (1998, unpublished results). The number of live-born piglets accounts for losses during farrowing. In addition, *Johnson et al.* (1999) justified lower NBA values with an undesirable genetic relationship between litter size during gestation and numbers of stillborn and mummified piglets. *Haley et al.* (1988) purposed that number of piglets weaned should be used even further. However, this would require that cross-fostering in the nucleus be stopped.

CONCLUSIONS

Litter size records were analysed using the REML method and a univariate repeatability model.

- Additive maternal crossbreeding parameter estimates were 0.091 and 0.36 piglets for NB and NBA, respectively.
- Estimated maternal heterosis was 0.7 piglets in both traits.
- Estimates for additive grand-maternal effect were negligible.
- The model used in this analysis could be used for genetic evaluation of litter size, with small corrections.
- The NBA could be more suitable in comparison with NB.

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Genetic correlations between test station and on-farm performance for backfat thickness and daily gain

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ABSTRACT

Performance test of boars (S-) and on-farm test of gilts (F-) for ultrasonic backfat thickness (BF) and daily live weight gain (LDG) were analyzed to estimate the magnitude of genotype-environment interaction (GxEI). GxEI was estimated as genetic correlation in multivariate animal model approach. The dataset consisted of 4583 records of boars and 12145 of gilts for three breeds: Swedish Landrace (SL), Large White (LW) and German Landrace (GL) in years 1990 - 1997 for the nucleus herd on farm Ptuj in Slovenia. Altogether, pedigree file contained 19076 animals. Separate analyses were performed for each breed using REML method in VCE 4. Estimated genetic correlations between corresponding traits in station and on-farm tests were high (above 0.9), except for LW (0.50 and 0.44 for BF and LDG, respectively). The heritability estimates were 0.11 - 0.35 for F-BF, 0.23 - 0.40 for S-BF, 0.14 - 0.23 for F-LDG and 0.13 - 0.31 for S-LDG. Common litter environment variance accounts for 6 - 23% of the phenotypic variance for BF and 7 - 25% for LDG.

(Keywords: pigs, genotype-environment interaction, backfat thickness, daily gain)

ZUSAMMENFASSUNG

Genetische Korrelationen zwischen Stations- und Feldtest für die Produktionsparameter Rückenspeckdicke und Tageszunahme

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Die Daten aus der Eigenleistungsprüfung der Eber und aus dem Feldtest der Jungsauen für Rückenspeckdicke (RS) und Tageszunahme (TZ) wurden analysiert, um die Größe der Genotyp-Umwelt-Interaktion (GxUI) zu schätzen. GxUI wurde als genetische Korrelation mit Hilfe eines multivariablen Tiermodells geschätzt. In die Analyse wurden 4583 Daten von Ebern und 12.145 von Jungsauen dreier Genotypen einbezogen (Schwedische Landrasse-SL, Large White-LW und Deutsche Landrasse-DL). Die Daten stammen aus einer Stammherde der Farm Ptuj in Slowenien von 1990 bis 1997. Die Herdbuchführung umfasst 19.076 Tiere. Für jeden Genotyp wurde eine gesonderte Analyse mit der REML-Methode in VCE 4 durchgeführt. Die geschätzten genetischen Korrelationen zwischen den untersuchten Merkmalen im Stations- und Feldtest waren hoch (über 0,9), außer für die LW Rasse (0.50 für RS und 0.44 für TZ). Die geschätzte Heritabilität für die RS lag im Stationstest zwischen 0.23 und 0.40, im Feldtest zwischen

0.11 und 0.35. Für die TZ lag die Heritabilität im Stationstest zwischen 0.13 und 0.31 und im Feldtest zwischen 0.14 und 0.23. Der Wurfeffekt trägt mit 6-23% bzw. 7-25% zur phänotypischen Variabilität der RS bzw. TZ bei.

(Schlüsselwörter: Schwein, Genotyp-Umwelt-Interaktion, Rückenspeckdicke, Tageszunahme)

INTRODUCTION

In pig breeding, performance testing on test stations is the base for selecting sire for next generation. Uniformity of environment, more accurate measurements, more traits measured are main reasons for station testing. Testing conditions often differ much from conditions for fatteners on the farm, so it may be expected some differences in genetic control of the same traits measured on the test station and in field. Because of that, breeding goal should be defined at commercial level (*Merks*, 1989), and selection at the nucleus level should include information from lower levels of breeding pyramid.

Differences in expression of the same genotype in different environments are defined as genotype-environment interactions (GxEI). The genotype involves breeds, lines, families, sires or simply individual animals, while environment includes effects such as location, housing, management, feeding. It is useful to know, if changes in a rank occur or if there is significant difference among expressions of the genotypes in different environments.

The method suggested by *Falconer* (1952) estimates the magnitude of GxEI as genetic correlation between observations of the same genotype in different environments. The same trait measured in two environments is considered as two correlated traits. A multivariate approach is the logical choice for estimation of genetic correlation between two traits. Where traits are measured on different individuals, information on relatives are used for estimation of genetic correlation. In early times, univariate approach was used, because no direct procedures were available for analysis of measurements taken on from different individuals (*Mathur and Schlote*, 1995). Studies from that time reported existence of GxEI interactions in pig breeding (reviewed by *Brascamp et al.*, 1985; *Merks*, 1986; *Webb and Curran*, 1989). In 1989, *Van Diepen and Kennedy* applied mixed model approach and produced very high estimates of genetic correlations. From this, *De Vries and Sorensen* (1990) raised possibility that low genetic correlations from earlier studies were an artefact of the method of estimation. *Merks and van Oijen* (1994) and *Crump et al.* (1997) also estimated high genetic correlation for fattening traits using multivariate approach. On contrary, the study of *Tholen et al.* (1998) showed poor genetic correlations between adequate fattening and carcass traits measured on test station and in fattening herds.

The aim of this paper was to find out the existence of genotype-environment interactions (GxEI) in Slovenian pig population through estimating of genetic correlations between boars and gilts for fattening traits measured under different performance test. Due to structure of data, it was impossible to distinguish between GxEI and genotype-sex interaction like in study of *Crump et al.* (1997).

MATERIALS AND METHODS

In analysis, performance test records from boars and gilts of three breeds were taken from a purebred nucleus breeding herd on farm Ptuj in Slovenia. The data set consisted of 4583 test records for boars and 12145 for gilts which were collected from July 1990

to December 1997 (Table 1). Complete pedigree over several generations was available. Pedigree file contained 14703, 1805 and 2568 animals for Swedish Landrace (SL), Large White (LW), and German Landrace (GL), respectively. Near 13% of animals from pedigree were without records and around 5% were base animals.

Table 1

Data structure of performance records

Breed(1)	SL	LW	GL
Boars(2)	3147	575	861
Gilts(3)	9656	986	1503
Animals in pedigree(4)	14703	1805	2568
% of animals without records(5)	12.9	13.5	7.9
% of base animals(6)	5.5	9.1	4.6
N° of progenies per sire(7)	85.4	13.7	19.4
N° of progenies per dam(8)	3.1	4.7	4.4
N° of progenies per litter(9)	1.9	2.0	1.9

1. Tabelle: Datenstruktur der Produktionsmerkmale

Genotyp(1), Eber(2), Jungsauen(3), Herdbuchtiere(4), Tiere ohne Abstammungsdaten(5), Tiere mit Abstammungsdaten(6), Geprüfte Nachkommen pro Vatertier(7), Geprüfte Nachkommen pro Muttertier(8), Geprüfte Ferkel pro Wurf(9)

Gilts were reared under commercial conditions, housed in groups and fed approximately to appetite. At around 100 kg, selection was based on daily live weight gain and ultrasonic backfat thickness. Before measuring, preselection based on subjective condition score was made. No individual food recording was carried out in gilts. Near 50% gilts were selected, the ratio depends a large extent on culling rate of sows and the number of gilts available. On the other hand, boars were penned individually and fed ad libitum. Same feed mixture with 14.6% of crude proteins was fed through entire test. Test was carried out in three stages: boars were first subjectively scored and selected before 30 kg. At 60 kg, between 40 and 60% of boars were culled on daily gain, feed conversion efficiency, and exterior abnormality. At the end of test at 100 kg, animals were selected according to index including duration of fattening, total feed consumption, and ultrasonic backfat thickness. Three to 15% of tested boars are selected annually as sires for the nucleus herd (Kovač *et al.*, 1999).

Boars have finished test between 95 and 107 kg live weight (Table 2), while weight at the test in gilts was one kilogram less and within wider range from 80 to 129 kg. Average backfat thickness in SL was 16.6 mm in boars and 16.7 mm in gilts. Gilts of other two breeds had 14.0 mm of backfat, while boars had 15.0 mm (LW) and 15.1 mm (GL), respectively. The standard deviations for backfat thickness ranged between 1.71 and 2.31 mm in boars, and between 1.87 and 2.36 in gilts. Averages for backfat thickness differed among breeds 1.5 mm in boars and 2.7 mm in gilts. All three breeds showed similar standard deviation in daily live weight gain (33 - 38 g). Daily live weight gain was close to 500 g in gilts and 600 g in boars with small differences among breeds. Average daily gain from 30 to 100 kg (TDG) on test station in boars was 870 g with standard deviation of 70 g.

Table 2

Basic statistics for analyzed traits in boars and gilts for three breeds

Breed(1)		SL			LW			GL		
Boars(2)	BF (mm)	16.6	±	2.31	15.0	±	2.15	15.1	±	1.71
	LDG (g)	609	±	33	594	±	38	585	±	34
	TDG (g)	874	±	69	884	±	76	856	±	69
	WT (kg)	99.8	±	3.00	100.2	±	3.21	99.5	±	2.87
Gilts(3)	BF (mm)	16.7	±	2.36	14.0	±	2.10	14.0	±	1.87
	LDG (g)	513	±	36	500	±	37	496	±	36
	WT (kg)	99.2	±	6.50	97.3	±	7.00	96.5	±	6.12

BF-Ultrasonic backfat thickness (*Ultraschall Rückenfettdicke*), LDG-Daily live weight gain (*Tägliche Zunahme*), TDG-Daily gain between 30 and 100 kg (*Tägliche Zunahme zwischen 30 und 100 kg*), WT–Weight on test. (*Körpergewicht*)

2. Tabelle: Mittelwerte und Standardabweichungen für Eber und Jungsauen von drei Genotypen)

Genotyp(1), Eber(2), Jungsauen(3)

Separate analyses were performed for each breed using REML method in VCE 4 (Neumaier and Groeneveld, 1998). For backfat thickness, the analysis was performed with two trait model, while model for daily gain contained daily live weight gain in gilts and boars as well as TDG. Daily gain from 30 to 100 kg in boars is one of traits on which boars are selected. Because of this, it was also included in analysis. The following linear model written in matrix notation was used in multiple trait analysis:

$$y = X\beta + Z_a a + Z_c c + e$$

where y is the vector of observations, β is the vector of fixed effects, a is the vector of additive genetic effects, c is the vector of common litter environment effects, and e is the vector of residuals. Known incidence matrices X , Z_a , Z_c relate observations to fixed and random effects. The vector of fixed effects β contained month of test as year-month interaction for daily gain and additionally, weight on test as covariate for backfat thickness. The expectations of all random effects as well as covariances between random effects were zero. The following variance structure was assumed in analysis:

$$\text{var}(a) = G = A \otimes G_o$$

$$\text{var}(c) = C = I_c \otimes C_o$$

$$\text{var}(e) = R = \sum_{i=1}^n \oplus R_{ko}$$

$$\text{var}(y) = V = R + Z_a G Z_a' + Z_c C Z_c'$$

where G is the matrix of additive genetic (co)variances, A is the numerator relationship matrix, C is the (co)variance matrix of the common litter environment, and complete residual covariance matrix R is direct sum of two types of R due to missing values. Covariance matrices G_o , C_o and R_{ko} for traits measured on the same individual for backfat thickness and daily gain are presented below.

BACKFAT THICKNESS

$$\mathbf{G}_o = \begin{bmatrix} \sigma_{a_1}^2 & \sigma_{a_1 a_2} \\ \sigma_{a_2 a_1} & \sigma_{a_2}^2 \end{bmatrix}$$

$$\mathbf{C}_o = \begin{bmatrix} \sigma_{c_1}^2 & \sigma_{c_1 c_2} \\ \sigma_{c_2 c_1} & \sigma_{c_2}^2 \end{bmatrix}$$

$$\mathbf{R}_{10} = \begin{bmatrix} \sigma_{e_1}^2 & 0 \\ 0 & 0 \end{bmatrix} \mathbf{R}_{20} = \begin{bmatrix} 0 & 0 \\ 0 & \sigma_{e_2}^2 \end{bmatrix}$$

DAILY GAIN

$$\mathbf{G}_o = \begin{bmatrix} \sigma_{a_1}^2 & \sigma_{a_1 a_2} & \sigma_{a_1 a_3} \\ \sigma_{a_2 a_1} & \sigma_{a_2}^2 & \sigma_{a_2 a_3} \\ \sigma_{a_3 a_1} & \sigma_{a_3 a_2} & \sigma_{a_3}^2 \end{bmatrix}$$

$$\mathbf{C}_o = \begin{bmatrix} \sigma_{c_1}^2 & \sigma_{c_1 c_2} & \sigma_{c_1 c_3} \\ \sigma_{c_2 c_1} & \sigma_{c_2}^2 & \sigma_{c_2 c_3} \\ \sigma_{c_3 c_1} & \sigma_{c_3 c_2} & \sigma_{c_3}^2 \end{bmatrix}$$

$$\mathbf{R}_{10} = \begin{bmatrix} \sigma_{e_1}^2 & \sigma_{e_1 e_2} & 0 \\ \sigma_{e_2 e_1} & \sigma_{e_2}^2 & 0 \\ 0 & 0 & 0 \end{bmatrix} \mathbf{R}_{20} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \sigma_{e_3}^2 \end{bmatrix}$$

RESULTS AND DISCUSSION

Variance component estimates for daily gain are summarized in *Table 3*. Estimated phenotypic variances for LDG were in range between 958.0 g² in GL boars and 1245.4 g² in LW gilts. Within breeds, there were small differences between sexes. TDG in boars is different trait with phenotypic variance estimated between 3818.1 g² in GL and 4457.7 g² in LW. Similar magnitude of variance components for residual and common litter environmental effect were estimated for LDG in both sexes in all three breeds. In his study on German and Australian data, *Brandt* (1994) estimated higher phenotypic variances for LDG (range 2400-3000 g²). Joint analysis for daily gain on different intervals in boars and LDG in gilts on data from another Slovenian nucleus farm by *Kovač* (1992) showed more comparable estimates (1486.1 g²). The LW population showed higher additive genetic variance (379.5 in boars and 279.2 in gilts) in comparison to the other two breeds (166.4 and 231.8 in SL and GL boars; around 130 in both Landrace gilts). Consequently, heritabilities (*Table 4*) in LW boars (0.31) and gilts (0.22) were higher. GL gilts also showed heritability of 0.23, while heritabilities for LDG were lower (0.13-0.14) in SL gilts and boars and GL boars. Heritability for LDG in gilts from *Kovač* (1992) was 0.24, while estimates from *Brandt* (1994) were in range 0.20 - 0.32. Common litter environment effect accounted for 7 to 25% of phenotypic variance in LW and GL boars, respectively.

The highest phenotypic variance for BF (*Table 5*) was estimated to 3.94 mm² for SL gilts. Similar result (3.74 mm²) was obtained for SL boars. In smaller breeds, phenotypic variance was smaller. Additive genetic variance varied among breeds: 1.50 and 1.37 mm² for SL, almost three times smaller in GL (0.50 and 0.49 mm²), while 1.20 and only 0.30 mm² in LW boars and gilts, respectively. LW gilts also showed highest residual variance component (2.31 mm²). Reason for smaller genetic variance may be in possible closer genetic relationship in small size populations, which must be confirmed in the future. Variance for common litter environment of 0.41-0.50 mm² in boars was comparable with estimates in both Landrace gilts, while LW gilts (0.16 mm²) differed a lot.

Table 3

Phenotypic variance and variance components from multivariate analysis for daily gain

Breed(3)	Boars(1)				Gilts(2)			
	LDG		TDG		LDG		TDG	
	σ_p^2	σ_a^2	σ_c^2	σ_e^2	σ_p^2	σ_a^2	σ_c^2	σ_e^2
SL	1044.7	131.9	180.3	732.5	4068.8	742.2	331.8	2994.7
LW	1205.2	379.5	78.7	747.0	4457.7	1461.0	203.8	2792.8
GL	958.0	134.2	240.4	583.4	3818.1	816.0	753.3	2248.8

LDG - Daily live weight gain (*Tageszunahme Lebendgewicht*), TDG - Daily gain between 30 and 100 kg (*Tageszunahme zwischen 30 und 100 kg*), σ_p^2 -Phenotypic variance, σ_a^2 -Additive genetic variance, σ_c^2 -Common litter environmental variance (*Umwelt-Wurf-Varianz*), σ_e^2 -Residual variance (*Residualvarianz*)

3. Tabelle: Phänotypische Varianz und Varianzkomponenten aus der multivariablen Analyse für Tageszunahmen

Eber(1), Jungsauen(2), Genotyp(3)

Table 4

Proportions of variance components from multivariate analysis for daily gain

Breed(1)	Boars(2)		Gilts(3)	
	LDG	TDG	LDG	TDG
	h^2	c^2	h^2	c^2
SL	0.13	0.17	0.14	0.17
LW	0.31	0.06	0.16	0.22
GL	0.14	0.25	0.23	0.09

LDG - Daily live weight gain (*Tageszunahme Lebendgewicht*), TDG- Daily gain between 30 and 100 kg (*Tageszunahme zwischen 30 und 100 kg*), h^2 -Heritability (*Heritabilität*), c^2 -Common litter environmental variance as proportion of phenotypic variance (*Umwelt-Wurf-Varianz als Teil der phänotypischen Varianz*)

4. Tabelle: Varianzanteile aus der multivariablen Analyse für Tageszunahmen

Genotyp(1), Eber(2), Jungsauen(3)

Table 5**Phenotypic variance and variance components from bivariate analysis for backfat thickness**

Breed(1)	Boars(2)				Gilts(3)			
	σ_p^2	σ_a^2	σ_c^2	σ_e^2	σ_p^2	σ_a^2	σ_c^2	σ_e^2
SL	3.74	1.50	0.46	1.79	3.94	1.37	0.59	1.98
LW	3.18	1.20	0.41	1.57	2.76	0.30	0.16	2.31
GL	2.21	0.50	0.50	1.21	2.19	0.49	0.32	1.39

σ_p^2 -Phenotypic variance (*Phänotypische Varianz*), σ_a^2 -Additive genetic variance (*Additive genetische Varianz*), σ_c^2 -Common litter environmental variance (*Umwelt-Wurf-Varianz*), σ_e^2 -Residual variance (*Residualvarianz*)

5. Tabelle: Phänotypische Varianz und Varianzkomponenten aus der bivariablen Analyse für Rückenspeckdicke

Genotyp(1), Eber(2), Jungsauen(3)

Heritabilities for BF in boars (0.23-0.40) were higher in comparison to 0.11-0.35 in gilts (Table 6), which was expected because of more uniform environment on test stations than on farms. Very low heritability in LW gilts was a consequence of small additive genetic variance component (0.30 mm²) comparing to rest of variance (Table 5). Crump *et al.* (1997) estimated comparable heritabilities for BF (0.28-0.36 and 0.25-0.46 in boars and gilts, respectively) with similar model. Additive genetic effect accounted for 23% of phenotypic variance in the study of Kovač (1992) and from 15 up to 52% of Brandt (1994).

Table 6**Proportions of variance components, phenotypic (r_p) and genetic correlation (r_a) for backfat thickness**

Breed(1)	Boars(2)				Gilts(3)	
	h^2	c^2	h^2	c^2	r_a	R_p
SL	0.40	0.12	0.35	0.15	0.91	0.38
LW	0.38	0.13	0.11	0.06	0.50	0.12
GL	0.23	0.23	0.22	0.14	0.92	0.26

h^2 -Heritability (*Heritabilität*), c^2 -Common litter environmental variance as proportion of phenotypic variance (*Umwelt-Wurf-Varianz als Teil der phänotypischen Varianz*)

6. Tabelle: Varianzanteile, phänotypische (r_p) und genetische Korrelationen (r_a) für Rückenspeckdicke

Genotyp(1), Eber(2), Jungsauen(3)

Between LDG in boars and gilts, low phenotypic correlations were estimated: 0.14, 0.19 and 0.22 in LW, GL, and SL, respectively (Table 7). Estimates were also low for phenotypic correlations between LDG in gilts and TDG in boars (from 0.10 to 0.17). Phenotypic correlations between LDG and TDG in boars were in range between 0.76 (LW) and 0.79 (SL). While genetic correlations for LDG between boars and gilts were high with 0.93 in SL and 1.00 in GL (Table 7). In LW population, genetic correlation was only 0.44. The explanation for low estimates, as reasoned Simianer (1991) in his simulation study, may be in small sample size and low heritabilities even if there is no GxE interactions. The two daily gains measured in boars were also highly correlated (from 0.82 in GL to 0.93 in LW). Lower genetic correlations were expected between LDG in gilts and TDG in boars. However, they all lie between 0.82 and 0.93. Merks and van Oijen (1994), as well as Crump et al. (1997) also estimated very high genetic correlations for backfat thickness (0.81-1.00).

Table 7

Phenotypic (r_p) and genetic correlations (r_a) from multivariate analysis for daily gain

Breed (1)	r_a^*	r_p^*	r_a^{**}	r_p^{**}	r_a^{***}	r_p^{***}
SL	0.93	0.22	0.90	0.79	0.72	0.17
LW	0.44	0.14	0.93	0.76	0.68	0.10
GL	1.00	0.19	0.82	0.76	0.77	0.12

*Between LDG in boars and LDG in gilts (*Tageszunahmen bei Ebern und Jungsauen*)

**Between LDG and TDG in boars (*Tageszunahmen und Tageszunahmen zwischen 30 kg und 100 kg Lebendgewicht bei Ebern*)

***Between LDG in gilts and TDG in boars (*Tageszunahmen bei Jungsauen und Tageszunahmen zwischen 30kg und 100 kg Lebendgewicht bei Ebern*)

7. Tabelle: Phänotypische (r_p) und genetische Korrelationen (r_a) aus der multivariablen Analyse für Tageszunahmen

Genotyp(1)

If genetic correlation is good measure for the magnitude of G x E interactions, was argued in Simianer (1991), Mathur and Horst (1994) and Mathur and Schdlote (1995). Nevertheless, with high estimated genetic correlations (above 0.9) might be concluded on non-existence of G x E interactions and/or genotype-sex interactions from this data. On the other hand, high genetic correlations have their own significance. Including information from full- and halfsibs from on-farm test in the procedure for predicting of breeding values of boars from the test station means more accurate estimation and consequently, more efficient selection.

CONCLUSIONS

Slovenian data for backfat thickness and daily gain were analyzed using REML method and multitrait approach. The intention was to determine the magnitude of genotype-environment The heritability estimates for backfat thickness were 0.11- 0.35 in gilts and

0.23-0.40 in interactions boars. For daily live weight gain estimates for heritabilities were lower (0.14-0.31 and 0.14-0.23 in boars and gilts, respectively).

Common litter variance accounted for six to 25% of phenotypic variance for daily live weight gain. Similar proportion for common litter effect (6-23%) was estimated in backfat thickness, too.

Estimated genetic correlations were high (above 0.90 for backfat thickness and daily live weight gain), except for Large White breed with very small data set (0.44 and 0.50 for LDG and BF, respectively). Phenotypic correlations were much lower in comparison to genetic correlations (0.10-0.22 for LDG and 0.12-0.38 for BF).

In the future, the study will be extended to other nucleus herds in Slovenia, especially interesting will be analysis in small populations like LW and terminal sire breeds.

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Comparison of once-daily, free and combined forms of suckling in rabbits

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ABSTRACT

These three experiments involved the investigation of various forms of suckling: free (F, n=71 litters, 576 young), once daily (O, n=68 litters, 543 young) and, in two experiments, combined suckling. In group F the does had free access to the litter throughout the entire day; in group O the does were allowed to suckle their young between 8.00 and 8.30 a.m. each day, but at all other times were separated from the litter; in group K, in the week following parturition free suckling was allowed for 7 days (expt. 2) or 4 days (expt. 3), subsequent to which the does were able to suckle their young only once daily until the 18th day. In experiments 1 and 2, in the week after kindling significantly lower mortality was observed in the young rabbits of group F (F=3.8 and 4.8%, O=6.0 and 9.2%, for expts. 1 and 2 respectively); between the 7th and the 21st day the young of group O showed more favourable mortality figures (F=3.6 and 5.4%, O=0.6 and 0.6%, for expts. 1 and 2 respectively). Mortality between days 0 and 21 proved lowest where the two forms of suckling were combined, in group K (expt. 2: F=10.2%, O=9.8%, K=5.3%). Experiment 3 produced no clear-cut result (F=7.5%, O=9.6%, K=7.5%). Contradictory results were obtained within the groups with respect to primiparous (P) and multiparous (M) does. The highest mortality with P does was observed in group F, that with M does in group O (P does: F=12.2%, O=6.4%, K=8.3%; M does: F=6.3%, O=11.4%, K=7.3%). Litter size at 21 days proved the highest in group K in experiment 2, but in the other experiments no difference attributable to form of suckling was ascertained. With respect to litter and individual weight at 21 days there emerged no difference of such a nature as to form the basis for the conclusion that the form of suckling used had influenced milk production in the does or the quantity of milk available per young rabbit. Although the majority of the results obtained confirm the advantages of combined suckling, due to divergent data in the literature and differences between younger and older does observed in experiments performed by the authors, it is not possible to offer a definitive recommendation with respect to the most favourable form of suckling.

(Keywords: suckling forms, rabbit)

ZUSAMMENFASSUNG

Vergleich von Säugemethoden - täglich einmal, frei, kombiniert - bei Kaninchen

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In drei Versuchen wurde das freie Säugen (F, n=72 Würfe, 576 Tiere), täglich einmal (O, n=68 Würfe, 543 Tiere) und in zwei Versuchen das kombinierte Säugen (K, n=50 Würfe,

424 Tiere) untersucht. In der F-Gruppe hatten die Mutterkaninchen den ganzen Tag freien Zugang zur Wurfbox, in der O-Gruppe nur morgens zwischen 8 und 8.30 Uhr und im 2. und 3. Versuch in der K-Gruppe in der ersten Woche nach dem Werfen konnte 7 bzw. 4 Tage frei, danach bis zum 18. Tag täglich einmal gesäugt werden. Im 1. und 2. Versuch war der Ausfall in der ersten Lebenswoche in der F-Gruppe signifikant niedriger ($F=3,8$ und $4,8\%$; $O=6,0$ und $9,2\%$), zwischen dem 7. und 21. Tag erreichte die O-Gruppe das bessere Ergebnis ($F=3,6$ und $5,4\%$, $O=0,6$ und $0,6\%$). Der Ausfall zwischen dem 0-21. Tag war in der kombiniert säugenden K-Gruppe am niedrigsten (2. Versuch: $F=10,2\%$, $O=9,8\%$, $K=5,3\%$). Der 3. Versuch brachte kein eindeutiges Ergebnis ($F=7,5\%$, $O=9,6\%$, $K=7,5\%$). Widersprüchlich war das Ergebnis bei den erstwerfenden (P) und den bereits mehrmals geworfenen (M) Muttertieren. Bei den P-Müttern trat in der F-Gruppe, bei den M-Müttern in der O-Gruppe die höchste Mortalität auf (P-Mütter: $F=12,1\%$, $O=6,4\%$, $K=8,3\%$; M-Mütter: $F=6,3\%$, $O=11,4\%$, $K=7,3\%$). Die 21-Tage-Wurfzahl war in der K-Gruppe im 2. Versuch am höchsten, in den anderen Versuchen erhielten wir keine auf die Säugemethode zurückzuführende Abweichung. Im 21-Tage-Wurfgewicht und im individuellen Gewicht gab es keine solche Abweichungen, die einen Zusammenhang die Säugemethode mit der Milchproduktion der Mütter oder mit der zur Verfügung stehenden Milchmenge pro Saugakt vermuten ließen. Obwohl die meisten unserer Ergebnisse das kombinierte Säugen bestätigen, können wir keinen eindeutigen Vorschlag für die beste Säugemethode machen, da die diesbezüglichen Daten in der Fachliteratur und in unseren eigenen Versuchen zwischen den jungen und älteren Mutterkaninchen zu differenziert sind. (Schlüsselwörter: Säugemethoden, Hase, Kaninchen)

INTRODUCTION

Suckling rabbits remain in very close relation with their mother until weaning. Their successful rearing is dependent almost solely on their mother, and rabbit breeders have only limited chance of reducing mortality. Newborn rabbits spend their first 15-18 days in the nest box and their survival and growth depend on the milk production and nursing ability of mother does.

Rabbits – similarly to wild rabbits – suckle only once a day (Lebas, 1969). However, after parturition some does go into the nest box two or three times a day and may patiently wait as long as ten minutes to feed their young. This can be explained by the finding that in the early stages neither the doe nor the young has established sufficient routine, and both have to learn how to suckle (Szendrő et al., 1991). The time required for suckling during the subsequent days decreases from 4-6 minutes to 2.5-3 minutes when milk production is increased. This indicates that kits are capable of suckling increasingly large of milk per minute (Mohamed et al., 1992).

During the first 12 days of their lives young rabbits only suckle and sleep. Does may disturb sleeping, resting kits when not suckling. A frightened doe jumping into the nest may scatter or even trample her offspring, causing considerable harm. For the purpose of avoiding this problem, many authors suggest that does should go to the nest box only once a day, in the morning hours, and should be excluded for the remainder of the day, in contrast to the traditional, free mode of suckling. However, so far experimental results have not unambiguously supported this method. Pizzi and Crimella (1985) showed no significant difference in mortality or in weight increment between traditional (free) methods of suckling and that in which does were allowed to spend only 15 minutes per day in nest boxes. There was a higher rate of kit mortality on the 2nd,

16th, 17th and 28th days when nursing was allowed only once a day than was recorded in the free suckling group in the experiments of *Constantini et al.* (1986). According to results reported by French authors, the method of once-a-day nursing is more favourable during the first days after parturition, while free suckling is of advantage later on (*Coureaud et al.*, 1998).

In the light of these divergent findings experiments were performed to compare once-a-day nursing, free suckling, and the combined methods of these for rabbits.

MATERIALS AND METHODS

The experiments were conducted at the Pannon University of Agricultural Science, Faculty of Animal Science in Kaposvár. Rabbits of the New Zealand White and Pannon White varieties were used in the first experiment, and in the second and third experiments, respectively.

The rabbits were kept in closed welded flat-decks heated in winter (to a minimum of 15°C) but not maintained at a moderate temperature in summer (maximum 26°C). Wood shavings were put in the plastic nest boxes hung outside the cages 2-3 days preceding parturition, the placing of these being estimated such that their entrances were at the same level as the floors of the cages.

In the traditional nursing groups the does were able to the nest boxes freely. In the once-a-day nursing groups the entrances to the nest boxes were open only between 8 and 8:30 in the morning and does were separated from the litter during the rest of the day. Both does and kits could leave the nest boxes freely from the time the kits were 18 days of age. In the combined nursing group in experiment 2 the does could nurse freely for 1 week after parturition, and in experiment 3 for 4 days, following once-a-day nursing as above.

The kits were weaned at 6, 4 and 5 weeks of age in experiments 1, 2 and 3, respectively. The numbers of individuals involved in the respective experiments are shown in *Table 1*.

The experimental data were analysed using analyses of variance and the Chi² test.

Table 1

Number of litters and kits in the experimental groups

Experiment (5)	n	<i>EXPERIMENTAL GROUP (1)</i>		
		Free (2)	Once a day (3)	Combined (4)
1	Number of litters (6)	21	21	-
	Number of kits (7)	167	168	-
2	Number of litters	19	19	19
	Number of kits	166	160	171
3	Number of litters	31	28	31
	Number of kits	254	215	253

1. Tabelle: Für die einzelnen Versuchsgruppen charakteristische Daten

Versuchsgruppen(1), Freies Säugen(2), Täglich einmaliges Säugen(3), Kombiniertes Säugen(4), Versuch(5), Anzahl der Würfe(6), Anzahl der Jungkaninchen(7)

RESULTS AND DISCUSSION

Litter size

No significant difference was found between experiments 1 and 2 in the litter size of the experimental groups at birth, whereas in experiment 3 there were significantly fewer kits recorded even at parturition in the once-a-day nursing group (Table 2). Therefore, comparisons of litter number recorded at different dates after parturition may not be completely realistic. More reliable results can be achieved by determining decrease in litter number, but no definite difference was observed in this respect either. Changes in litter number could be explained by the mortality data.

Table 2**Effect of suckling method on litter size**

Age (5) (weeks)	EXPERIMENTAL GROUP (1)								
	FREE (2)			ONCE A DAY (3)			COMBINED (4)		
	n	mean	SD	n	mean	SD	N	mean	SD
<i>1st experiment (6)</i>									
Kindling (7)	21	7.95	0.84	21	8.00	0.81			
1	21	7.71	1.08	21	7.52	0.85			
2	21	7.43	1.14	21	7.48	0.85			
3	21	7.29	1.20	21	7.48	0.85			
4	21	7.24	1.19	21	7.48	0.85			
5	21	7.19	1.22	21	7.48	0.85			
6	21	7.05	1.29	21	7.48	0.85			
Difference between 0 and 3 weeks (8)		0.66			0.52				
<i>2nd experiment</i>									
Kindling	19	8.74		19	8.58		19	9.00	
1	19	8.32		19	7.79		19	8.79	
2	19	7.95		19	7.74		19	8.53	
3	19	7.84		19	7.74		19	8.53	
4	19	7.84		19	7.74		19	8.53	
Difference between 0 and 3 weeks		0.90			0.84			0.47	
<i>3rd experiment</i>									
Kindling	31	8.19 ^a	1.01	28	7.82 ^b	1.02	31	8.16 ^a	0.97
1	31	7.84 ^a	1.19	28	7.25 ^b	1.00	31	7.77 ^a	1.15
2	31	7.65 ^a	1.43	28	7.11 ^b	1.07	31	7.65 ^a	1.14
3	31	7.61 ^a	1.45	28	7.04 ^b	1.17	31	7.55 ^a	1.18
4	31	7.42 ^a	1.61	28	6.96 ^b	1.14	31	7.42 ^a	1.09
5	31	7.29 ^a	1.60	28	6.93 ^b	1.18	31	7.32 ^a	1.25
Difference between 0 and 3 weeks		0.58			0.78			0.61	

Means with different letters are significantly different ($P < 0.05$). (Innerhalb der Spalten bezeichnen die verschiedenen Buchstaben eine Signifikanz von $P < 0,05$.)

2. Tabelle: Herausbildung der Wurfgrösse in Abhängigkeit von der Säugungsart

Versuchsgruppen(1), Freies Säugen(2), Täglich einmaliges Säugen(3), Kombiniertes Säugen(4), Alt(5), Erste Versuch(6), Werfen(7), Differenz zwischen den Wochen 0-3.(8)

Table 3

Effect of suckling method on mortality (%)

		<i>EXPERIMENTAL GROUP (1)</i>		
Weeks (5)		<i>FREE (2)</i>	<i>ONCE A DAY (3)</i>	<i>COMBINED (4)</i>
<i>1st experiment (6)</i>				
n		167	168	
1		3.0 ^a	6.0 ^b	
2		3.6 ^a	0.6 ^b	
3		1.8	-	
4		0.6	-	
5		0.6	-	
6		1.8	-	
0-3		6.6	6.6	
<i>2nd experiment</i>				
n		166	163	171
1		4.8 ^a	9.2 ^b	2.3 ^a
2		4.2 ^a	0.6 ^b	2.9 ^{ab}
3		1.2	-	-
4		-	-	-
0-3		10.2 ^a	9.8 ^a	5.3 ^b
<i>3rd experiment</i>				
n		254	219	253
1		4.7	6.9	4.7
2		2.4	1.8	1.6
3		0.4	0.9	1.2
4		1.9	1.0	0.8
5		2.0	0.4	2.0
0-3		7.5	9.6	7.5
1	Primiparous (7)	6.1	3.9	4.2
	Multiparous (8)	4.4	8.6	4.9
2	Primiparous	6.1	2.1	2.1
	Multiparous	1.4	2.1	1.4
3	Primiparous	0.0	1.3	2.0
	Multiparous	0.5	0.7	1.0
4	Primiparous	2.1	2.6	0.0
	Multiparous	1.4	0.6	1.0
5	Primiparous	4.1	0.6	6.3
	Multiparous	1.0	0.7	0.0
0-3	Primiparous	12.2	6.4	8.3
	Multiparous	6.3	11.4	7.3

Means with different letters are significantly different ($P < 0.05$). (Innerhalb der Spalten bezeichnen die verschiedenen Buchstaben eine Signifikanz von $P < 0.05$.)

3. Tabelle: Wöchentlicher Abgang (%) der Nachkommenschaft in Abhängigkeit von der Säugungsart

Versuchsgruppen(1), Freies Säugen(2), Täglich einmaliges Säugen(3), Kombiniertes Säugen(4), Woche(5), Erster Versuch(6), Erstmals geworfen(7), Mehrmals geworfen(8)

Mortality

As is summarised in *Table 3*, significantly fewer kits were lost during the week after parturition in the group where kits suckled freely in experiments 1 and 2. However, just the opposite trend was observed in the following week, does of the once-a-day nursing group having better results. Combined nursing (free nursing in the first week and once-a-day nursing afterwards) combined the advantage of both methods (experiment 2). Mortality in this group (5.3%) was just half that recorded in the other two groups (10.2 and 9.8% respectively).

There was no definite difference in the once-a-day nursing group in the first week. Combined nursing proved to be a little (but not significantly) superior to the once-a-day nursing group during the first 3 weeks, having lower mortality (at 7.5%) than the other two groups (9.6 and 7.5%, respectively). Considerable differences for this parameter were revealed between the groups of different ages when does were divided into two distinct groups of primiparous individuals. Free nursing among young does resulted in high mortality in the first and second week, in the first 3 weeks reaching 12.2 per cent for this group compared with 6.4 and 8.3 per cent for the once-a-day nursing group and for the combined nursing group respectively. Exactly the opposite result was observed in the group of older does: those in the once-a-day nursing group showed higher mortality (at 8.65%), particularly in the first week. Mortality rates of 6.3, 7.3 and 11.4 per cent among the kits of older does were determined for the free, combined and once-a-day nursing groups respectively.

Based on the above results the following conclusions can be drawn: free nursing may be more favourable in the first days after parturition while once-a-day nursing is of greater advantage until pelleted feed is introduced. This finding holds true for non-primiparous does. Contradictory results of previous experiments reported by other authors make conclusions more difficult to draw. *Constantini et al.* (1986) found free nursing to be more favourable for multiparous does, whereas *Pizzi and Crimella* (1984) considered once-a-day nursing more beneficial. They determined nearly a twofold mortality rate (11.4%) for kits in a once-a-day nursing group of older does compared to those in a free nursing group (6.3%). According to *Coureaud et al.* (1998), in the case of primiparous does once-a-day nursing in the 3-5 days after parturition following free nursing proved to give much better results than traditional (free) nursing. Once-a-day nursing seems to have been advantageous for young does during the 4 days after parturition in the experiments reported here, while this method or combined nursing resulted in lower mortality rates for kits compared to free nursing. Therefore, definite conclusions for practical application are rather difficult to make.

Individual and litter weight

In the group nursed freely individual and litter weight, characterising the milk production of does and also the milk consumption of kits, surpassed slightly but not significantly that measured in the group nursed once a day on the 21st day in experiment 1. In experiment 2, however, kits suckled by the combined method showed the highest litter weights while those suckled once a day achieved the greatest individual weights. In experiment 3 the highest litter weights was recorded in the case of combined nursing by young does and free nursing by older ones. Individual weights were the highest in the once-a-day nursing group at both ages (*Tables 4 and 5*). However, differences among the groups were not significant and the rankings were influenced by litter number; thus, it can be concluded that neither the milk production of does nor the milk consumption of

kits was determined by the nursing methods applied. No significant difference was found between the weights of kits nursing freely or once a day on the 28th day after parturition, as was also observed by *Constantini et al.* (1986).

Table 4**Effect of suckling method on litter weight (g)**

	METHOD OF SUCKLING (1)									
AGE (5)	FREE (2)				ONCE A DAY (3)			COMBINED (4)		
	n	mean	SD	n	mean	SD	n	mean	SD	
1 st experiment (6)										
At birth (7)	21	452	99	21	478	74	-			
1 week	21	1116	160	21	1078	171	-			
2 weeks	21	1871	293	21	1882	242	-			
3 weeks	21	2530	379	21	2519	287	-			
4 weeks	21	4174	596	21	3893	497	-			
2 nd experiment										
4 weeks	19	4767	1369	19	5053	1130	19	5127	1114	
3 rd experiment										
1 week	31	1162	214	28	1087	263	31	1174	264	
2 weeks	31	1972	448	28	1922	450	31	2104	418	
3 weeks	31	2857	577	28	2626	609	31	2841	575	
4 weeks	31	4775	1103	28	4394	988	31	4705	939	
1 week	Primiparous (8)	6	1047	242	10	1002	176	6	987	186
	Multiparous (9)	25	1189	203	18	1134	294	25	1219	263
2 weeks	Primiparous	6	1640	614	10	1808	266	6	1795	225
	Multiparous	25	2052	372	18	1986	522	25	2178	423
3 weeks	Primiparous	6	2370	779	10	2428	347	6	2445	160
	Multiparous	25	2973	465	18	2736	700	25	2936	600
4 weeks	Primiparous	6	4153	1113	10	4053	781	6	4273	260
	Multiparous	25	4924	1069	18	4584	1057	25	4809	1015

4. Tabelle: Herausbildung (g) des Wurfgewichts in Abhängigkeit von der Säugungsart

Abhängigkeit von der Säugungsart(1), Freies Säugen(2), Täglich einmaliges Säugen(3), Kombiniertes Säugen(4), Alter(5), Erster Versuch(6), Zur Geburt(7), Erstmals geworfen(8), Mehrmals geworfen(9)

Table 5**Effect of suckling method on individual weight (g)**

	METHOD OF SUCKLING (1)						
AGE (5)	FREE (2)		ONCE A DAY (3)		COMBINED (4)		
	n	mean*	n	mean*	N	mean*	
1 st experiment (6)							
At birth (7)	167	60.2	168	59.8			
1 week	162	146	158	144			
2 weeks	156	256	157	253			
3 weeks	153	354	157	340			
4 weeks	152	587	157	530			
2 nd experiment							
4 weeks	149	571	147	600	162	581	
3 rd experiment							
1 week	243	149	203	150	241	151	
2 weeks	237	259	199	271	237	275	
3 weeks	236	381	197	376	234	376	
4 weeks	231	644	195	631	232	628	
1 week	Primiparous (8)	45	135	75	134	46	128
	Multiparous (9)	197	153	128	159	195	156
2 weeks	Primiparous	43	223	74	247	45	239
	Multiparous	194	268	125	284	195	284
3 weeks	Primiparous	43	327	73	339	44	334
	Multiparous	193	394	124	396	190	386
4 weeks	Primiparous	42	590	73	574	44	584
	Multiparous	188	660	124	663	190	645

*Litter weight/litter size (*Wurfgewichts/ Wurfgrösse*)

5. Tabelle: Herausbildung (g) Des individuellen Gewichtes in Abhängigkeit von der Säugungsart

Abhängigkeit von der Säugungsart(1), Freies Säugen(2), Täglich einmaliges Säugen(3), Kombiniertes Säugen(4), Alter(5), Erster Versuch(6), Zur Geburt(7), Erstmals geworfen(8), Mehrmals geworfen(9)

CONCLUSIONS

The results of the above experiments show that free nursing proved better in the first week after parturition but once-a-day nursing gave better results subsequently until the kits were weaned onto pelleted feed. Mortality in the group fed according to this combination was lower in most cases compared to that in the groups nursing freely or once a day throughout the experimental period. Reared litter number was affected favourably by the differences observed in mortality, but it seems that neither the milk

production of the does nor the quantity of milk available per kit was affected by the nursing methods applied, based on individual and litter weights.

Although the majority of the results obtained confirm the advantages of combined suckling, due to divergent data in the literature and differences between younger and older does observed in experiments performed by the authors, it is not possible to offer a definitive recommendation with respect to the most favourable form of suckling.

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Effect of some probiotics on intestinal viscosity in rabbits

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ABSTRACT

The effects of three different probiotics (Toyocerin 10¹⁰ (spores of Bacillus toyoi), Paciflor (spores of Bacillus CIP 5832) and Yea-sacc (yeast Saccharomyces cerevisiae)) on the viscosity of small intestine and caecum content of 96 young New Zealand rabbits were studied. The experiment started at the 44th day of life (1363±107.9 g). The first half of the trial rabbits were slaughtered after 2 weeks of the trial, on the 57th day of life, and the second half after 4 weeks, on the 71st day of life. The intestinal viscosity analysis was carried out according to Bedford and Classen (1992) in the same way as in poultry. Values for viscosity were much higher in the caecum (7.07 to 7.73 mPa) than in the small intestine content (2.94 to 3.26 mPa). The addition of selected probiotics had no significant influence on viscosity in the small intestine or in the caecum content. The sex of the experimental rabbits influenced only viscosity of the small intestine content, females having higher viscosity than males (females 3.53, males 2.75 mPa, $p \leq 0.05$). The age of the experimental rabbits had no influence on intestinal viscosity.

(Keywords: animal nutrition, rabbits, probiotics, viscosity)

ZUSAMMENFASSUNG

Einfluss einer Probiotika auf die Viskosität des Darmes

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Untersucht wurde der Einfluß einiger Probiotika (Toyocerin 10¹⁰ (Sporen von Bacillus toyoi), Paciflor (Sporen von Bacillus CIP 5832) und Yea-sacc (Hefe Saccharomices cerevisiae)) auf die Viskosität des Dünndarm- und des Blinddarm Inhaltes bei 96 Jungkaninchen der Rasse Weiße Neuseeländer. Mit dem Versuch wurde am 44. Lebenstag (Tiergew. 1363±107,9 g) begonnen. Die erste Hälfte der Kaninchen wurde nach 14 Tagen des Versuches (Alter 57 Tage) nach dem Zufallsprinzip aussortiert und geschlachtet. Das Gleiche geschah mit der zweiten Hälfte der Tiere nach weiteren 4 Wochen (Alter 71 Tage). Die Viskosität des Verdauungstraktinhaltes wurde nach Bedford und Classen (1992), wie bei Geflügel, durchgeführt. Die Viskositätswerte waren im Blinddarm (7,07 bis 7,73 mPa) gegenüber dem Dünndarm (2,94 bis 3,26 mPa) viel höher. Der Zusatz der Probiotika bewirkte sowohl im Dünndarm als auch im Blinddarm keine signifikante Veränderung der Viskosität. Das Geschlecht der Tiere beeinflusste die Viskosität nur im Dünndarm, wo die Viskositätswerte bei weiblichen Tieren signifikant höher waren (weibl Tiere: 3,53, männl. Tiere: 2,75 mPa, $p \leq 0,05$). Das Alter der Versuchskaninchen zeigte keinen Einfluß auf die Viskosität des Inhaltes im Verdauungstrakt.

(Schlüsselwörter: Tierernährung, Kaninchen, Probiotika, Viskosität)

INTRODUCTION

The role of different probiotic additives is to sustain digestion processes, to enable better digestibility and food conversion and to improve the health of the animal. The addition of probiotics to food for rabbits has a particularly favourable effect on microbial balance in the caecum. A stable microbial metabolism in the caecum is extremely important to prevent digestion disturbances as well as to ensure favourable production parameters and low mortality rate in intensive breedings of rabbits. Probiotics can influence gastrointestinal weight, proportions between the digestive organs (Kermauner and Štruklec, 1996) and also the microbial fermentation pattern in the caecum (Kermauner *et al.*, 1996).

Probiotics can influence the digestibility of nutrients as well. Results reported by El-Hindawy *et al.* (1993) indicate improvement in the digestibility of all nutrients when probiotic Lacto-Sacc was added. Kamra *et al.* (1996) established improved digestibility of crude proteins after the addition of the same probiotic and Yamani *et al.* (1992) found improved digestibility of crude fibre. On the contrary, Holister *et al.* (1989) and Chaudhary *et al.* (1995) found no influence of probiotic, acids or yeast cultures on the digestibility of tested nutrients. Aderibigbe *et al.* (1992) found no effect of probiotic Yea-Sacc or Lacto-Sacc on *in vitro* caecal digestibility of different substrates.

Another indicator of digestibility and absorption of nutrients is intestinal viscosity, primarily of all in the small intestine, where the majority of absorption takes place. Effects of viscosity are related to the age of animals: the viscosity of the small intestine content of adult poultry is lower than that of broiler chicks. Also, for this reason, in older animals digestibility is higher (Almirall *et al.*, 1995; Salobir *et al.*, 1995a).

Viscosity also has an important effect on intestinal motility (McDougall *et al.*, 1996). Increased viscosity of intestinal content weakens the effect of peristaltic mixing of digesta, retards the diffusion of nutrients through the intestinal wall and reduces the speed of digestion and the absorption of organic nutrients (Hesselman and Aman, 1986, cit. after Van der Klis *et al.*, 1993a).

The influence of probiotics on the digestive process is part of an extended study, conducted and partly presented by Kermauner and Štruklec (1997, 1998). The aim of this part of the study was to introduce a method of viscosity measurement in rabbits and to establish the influence of different probiotics on the viscosity of the small intestine and caecum content. Three different probiotics were used: Toyocerin 10¹⁰ (spores of *Bacillus toyoi*), Paciflor (spores of *Bacillus* CIP 5832) and Yea-sacc (yeast *Saccharomyces cerevisiae*). Their influence on intestinal viscosity in two age groups of young rabbits was observed, in comparison with a control group.

MATERIALS AND METHODS

Animals and parameters measured

A total of 96 New Zealand White rabbits, both female and male, were allotted into 4 trial groups (24 rabbits per group). The rabbits were housed in wire cages: during the first part of the experiment two animals were housed together in each cage. During the second part of the trial the animals were housed individually. Temperature was between 17 and 18°C, humidity between 50 and 60 %, and the light period 16 hours long. The rabbits were given both feed and water *ad libitum*.

The rabbits were weaned at the age of 31 days, and individually marked (with ear tattoos) at the age of 37 days (1175±115.8 g). After an adjustment period of 1 week, the

experiment started at the 44th day of life (1363 ± 107.9 g). The first half of the trial rabbits (selected randomly) were slaughtered after 2 weeks of the trial, on the 57th day of life, and the second half after 4 weeks, on the 71st day of life. Before the trial began the rabbits were fed standard feed.

Feed

The feed was prepared according to recommendations for growing rabbits (Maertens, 1995) (Table 1).

Table 1

Composition of trial feed

Component(1)	%	Component(2)	%
Alfalfa meal(3)	23.6	Sunflower meal(9)	10.0
Barley(4)	11.0	Brewer's yeast(10)	2.0
Oats(5)	5.0	Sawdust(11)	3.0
Wheatfeed meal(6)	6.0	Molasses(12)	3.0
Sugar beet pulp(7)	18.0	Binder(13)	2.0
Soya meal(8)	11.0	Mineral-vitamin mix(14)	8.4

1. Tabelle: Zusammensetzung des Versuchsfutters

Komponente(1),(2), Luzernameh(3), Gerste(4), Hafer(5), Futterweizenschrot(6), Zuckerrübenschnitzel(7), Sojamehl(8), Mehl aus Sonnenblumenkernen(9), Bierhefe(10), Sägemehl(11), Melasse(12), Bindemittel(13), Mineral-Vitamin-Präparat(14)

The trial feeds were based on a control feed with the addition of the following probiotics:

- 0.01% Toyocerin 10¹⁰ (spores of *Bacillus toyoi*)
- 0.01% Paciflor (spores of *Bacillus CIP 5832*)
- 0.1% Yea-sacc (yeast culture *Saccharomyces cerevisiae*)

The basic feed mixture (recipe given in table 1) was divided into 4 parts. The three probiotics were added to 3 parts of feed, each to one part. All mixtures were prepared and pelleted in the experimental blend unit (Biotechnical Faculty, Zootechnical Dept.) in Homec. The chemical composition of the experimental feed mixtures is shown in Table 2.

Viscosity measurements

The intestinal viscosity analysis was carried out according to Bedford and Classen (1992) in the same way as in poultry. The total contents of the small intestine and the caecum were collected, immediately homogenised and placed in microcentrifuge tubes, and then centrifuged at 9500 g for 10 minutes. The supernatant was withdrawn and the viscosity determined by a rotational cone and plate viscometer (model LVDVMPA-II+, cone MPA-40; Brookfield Engineering Laboratories Inc., Stoughton, MA), maintained at 25°C and at a shear rate of 10 s⁻¹. The viscometer was labelled by means of Brookfield standard (viscosity 9.3 mPa at 25°C).

Table 2

Chemical composition of trial feeds (g/kg DM)

Component (g/kg DM)(1)	Control	Toyocerin(2)	Paciflor(3)	Yea-sacc(4)
Crude protein(5)	199.26	208.66	205.87	206.40
Crude fat(6)	25.23	21.61	20.82	20.71
Crude fibre(7)	153.14	175.50	176.60	174.36
NDF	331.87	339.76	346.97	350.04
ADF	184.51	217.51	219.66	220.41
ADL	33.15	41.39	40.57	38.96
Crude ash(8)	79.84	74.26	73.91	73.87
N-free extract(9)	542.53	519.97	522.80	524.65
Phosphorus	7.26	5.79	5.72	5.76
Calcium	13.81	11.01	10.68	10.84
Potassium	11.47	14.54	14.17	14.43
Sodium	2.61	2.30	2.24	2.30
Zinc (mg/kg DM)	183.92	264.76	251.28	273.33
Manganese (mg/kg DM)	237.05	315.73	295.64	309.81
Total sugars(10)	60.09	66.92	64.48	56.15
Dry matter (DM)(11)	862.83	909.61	893.44	897.18
Gross energy (MJ/kg DM)(12)	17.88	17.86	17.88	17.78
Digestible energy (MJ/kg)(13)*	10.0	10.0	10.0	10.0

* Calculated from tables (*Errechnet nach den Tabellen von*) (Schlölaut, 1982; Maertens et al., 1990)

2. Tabelle: Chemische Zusammensetzung des Versuchsfutters

Komponente(1), Futter mit Toyocerin(2), Futter mit Paciflor(3), Futter mit Hefekultur(4), Rohprotein(5), Rohfett(6), Rohfaser(7), Rohasche(8), Nitrogenfreier Extrakt(9), Gesamte Kohlenhydrate(10), Trockensubstanz(11), Bruttogennergie(12), Verdauliche Energie(13)

Statistics

The data were subjected to statistical analysis using the GLM procedure in the SAS statistical program (SAS/STAT, 1990). The model was as follows:

$$Y_{ijk} = \mu + P_i + S_j + A_k + P.S_{ij} + P.A_{ik} + S.A_{jk} + e_{ijk}$$

Y_{ijk}	- measured value
μ	- population mean
P_i	- effect of probiotic (i=1,2,3,4)
S_j	- effect of sex (j=1,2)
A_k	- effect of age (k=1,2)
$P.S_{ij}, P.A_{ik}, S.A_{jk}$	- interactions between main effects
e_{ijk}	- error

RESULTS

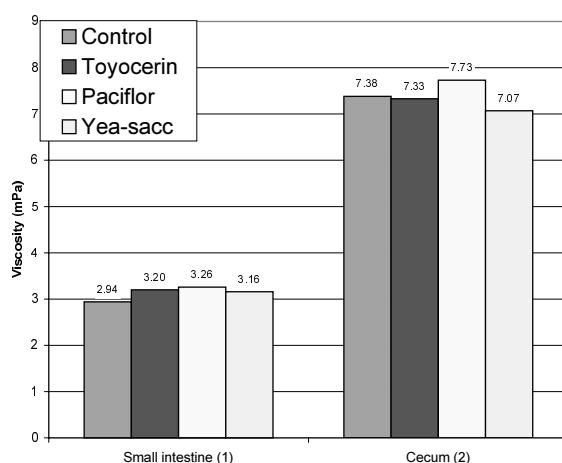
The viscosity of the small intestine content was highly influenced by the sex of the trial animals, while the viscosity of the caecum content was found to be independent of probiotic, sex or age of trial rabbits. Interactions were not expressed anywhere.

Influence of probiotics

Values for viscosity were much higher in the caecum than in the small intestine (Figure 1). In rabbits a special separation mechanism takes place in the colon and caecum. Due to this separation of large particles in the colon only small particles and solubles remain in the caecum. This part of the digesta probably has higher viscosity.

Figure 1

The effect of probiotic on viscosity of small intestine and caecum content in rabbits



1. Abbildung: Einfluss der Probiotika auf die Viskosität des Inhalts von Dünndarm und Blinddarm bei Kaninchen

Dünndarm(1), Blinddarm(2)

These results cannot be compared with others, since no data on viscosity measurements in rabbits are to be found in the literature available. Only data for viscosity in the small intestine of poultry exist: in experiments performed by *Salobir et al.* (1995a, 1995b) viscosity values in the small intestine content in broiler chickens were similar, but *Liebert* (1995) and *Salobir et al.* (1997) reported slightly higher values (from 3.30 to 8.14 mPa) than in the small intestine content of rabbits in the present experiment.

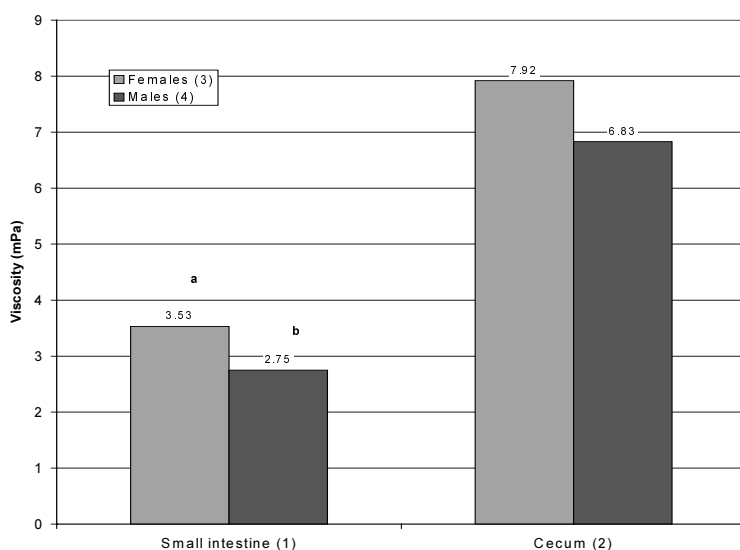
With respect to the influence of probiotics on the viscosity of the small intestine content no data are available, even relating to poultry. Only the effect of enzymes in poultry has been investigated: *Salobir et al.* (1995b) established lower viscosity in the small intestine of chickens when different enzymes were used (xylanase and β -glucanase).

Influence of sex

Analysis of variance (Table 3) showed that the sex of the trial animals influenced only the viscosity of the small intestine content. This influence is shown in Figure 2.

Figure 2

The effect of sex on viscosity of small intestine and caecum content in rabbits



2. Abbildung: Einfluss des Geschlechts auf die Viskosität des Inhaltes von Dünndarm und Blinddarm bei Kaninchen

Dünndarm(1), Blinddarm(2), Weiblich(3), Männlich(4)

Females had higher viscosity in the small intestine and caecum content, but only in the small intestine were the differences significant. In the literature all the experimental animals (in poultry) were of male sex, so no data on the influence of sex on viscosity in digesta are available.

Differences between sexes in rabbits have been established only by some authors and for some parameters: in growth, in weights of digestive organs and in some parameters of microbial fermentation in the caecum. Kermauner and Štruklec (1993, 1994) established decreased daily weight gain in females in the last trial week. Štruklec et al. (1994) found differences between sexes in stomach and caecum weight (with its content) and in percentage of acetic acid in the caecum content. Kermauner and Štruklec (1996) reported higher weight and proportion of the caecum and lower proportion of the small intestine in females than in males. Kermauner et al. (1996) found an interaction between sex and age of trial rabbits. At 67 days mol% of acetic acid in the caecum content was lower and mol% of propionic acid was higher in females than in males. Lopez et al. (1988) found faster growth of the digestive organs (particularly the caecum) in females than in males.

Influence of age

Age of rabbits had no effect on viscosity in the small intestine (57th d.: 3.02, 71st d. 3.26 mPa) or the caecum (57th d.: 7.56, 71st d. 7.19 mPa) content. This is not in accordance with *Almirall et al.* (1995) or *Salobir et al.* (1995a), who reported decreased viscosity in the small intestine of older chickens. This decrease can be expected, due to the more developed digestive tract in older animals. In the rabbits the small intestine reached its final weight in the 7th week (at 49 days), while growth of the caecum stopped after 9 weeks (at 63 days) (*Laplace and Lebas*, 1972; *Vicente et al.*, 1989).

If younger rabbits (before the 7th week of age) were compared with rabbits of 71 days of age (used in this experiment) differences in viscosity would probably be expressed more clearly.

CONCLUSIONS

Values for viscosity were much higher in the caecum than in the small intestine content.

The addition of the selected probiotics Toyocerin 10¹⁰, Paciflor and Yea-sacc had no significant influence on viscosity in the small intestine or the caecum content.

The sex of the experimental rabbits influenced only the viscosity of the small intestine content, females having higher viscosity.

The age of the experimental rabbits had no influence on intestinal viscosity.

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SECTION 6

ANIMAL NUTRITION AND OTHER TOPICS



Production results of free range broiler chickens

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ABSTRACT

The aim of this study was to compare growth performance and carcass characteristics from broilers raised in a free range system with those of broilers raised in a deep litter house. In the experiment 100 chickens of two commercial provenances were used. All the birds were raised in a deep litter house for the first four weeks. From then on they were divided into two groups, of which the free range group had free access to pasture ground. The chickens raised on pasture and the chickens raised in the deep litter house were slaughtered on the 56th day of age, after which certain carcass measurements were taken. The results obtained showed that the effects of genotype and sex on growth performance and carcass characteristics are much more important than the effects of the keeping system itself.

(Keywords: broilers, free range, fattening, carcass characteristics)

ZUSAMMENFASSUNG

Produktionsleistung von Broilern in Freilandhaltung

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In der vorliegenden Untersuchung wurden Wachstum und Schlachtkörperqualität von Broilern in Freilandhaltung und Bodenhaltung verglichen. In den Versuch wurden 100 Broiler von zwei Genotypen einbezogen. Alle Broilerküken wurden bis zum 28. Tag im Hühnerstall aufgezogen und dann in zwei Gruppen aufgeteilt. Die Broiler aus der Bodenhaltung blieben weiterhin im Hühnerstall, während diejenigen für Freilandhaltung einen freien Zugang zur Weide hatten. Alle Broiler wurden am 56. Tag geschlachtet und einige Schlachtkörpermerkmale verglichen. Die Ergebnisse der Untersuchung zeigen, daß Genotyp und Geschlecht einen größeren Einfluß auf Wachstum und Schlachtkörperqualität hatten als die Haltungsart.

(Schlüsselwörter: Broiler, Freilandhaltung, Mast, Schlachtkörperqualität)

INTRODUCTION

Free range chickens are thought to have a better taste and texture, mostly because they use their muscles (Remignon and Culioli, 1995). Standards and state regulations for free range chicken keeping are becoming very important as a guarantee for consumers. The *European Union (EU) Commission Regulation No 1538/91 of 5 June 1991* regulates stocking density for 'free range', 'traditional free range' and 'free range – total freedom' meat birds. In the United States loose federal guidelines do exist. Birds raised in the United States for meat – mainly chickens and turkeys – may be sold as 'free range' if they have USDA certified access to the outdoors and do not consume antibiotics or growth enhancers. No other criteria, such as vegetation, size of area, number of birds, or space per bird, are included in this term as defined by the Food Labelling Division of the Food Safety and Inspection Service (FSIS) of the US Department of Agriculture, which reviews and approves labels for federally inspected meat products (Morgan, 1999). In this study the effect of keeping system on the production results of broiler chickens was studied.

MATERIALS AND METHODS

Fifty broiler chickens of Ross commercial provenance and fifty broiler chickens of Prelux-bro commercial provenance were included in this research. The chickens of each provenance were divided in two groups according to sex (25 birds each) and housed from the time of hatching until 28 days of age in a deep litter house. At 28 days of age the chickens were allocated into two groups. The first group, which consisted of 12 Ross females, 13 Ross males, 12 Prelux-bro females and 13 Prelux-bro males, was reared indoors without access to pasture. The second group, which consisted of 13 Ross females, 12 Ross males, 12 Prelux-bro females and 12 Prelux-bro males, had free access to pasture all day. The ground to which the chickens had access was mainly covered with various types of grasses. The stocking density indoors was 0.17 birds per square metre up to 28 days of age and 0.34 birds per square metre from 28 days of age onward. Pasture available amounted to 2 m² per chicken. For the first 28 days the broilers were fed a starter diet which contained 3100 kcal/kg and 23.44% crude protein. From the 28th day until the end of the fattening period the broilers were given a feed mixture with 2700 kcal/kg and 14.5% crude protein. The latter feed mixture was composed of 70% grain (barley and maize). The chickens were fed ad libitum. Body weight and feed consumption were recorded in all groups and sub-groups once a week throughout the experiment. All the birds included in the experiment were slaughtered at 8 weeks of age. The chickens were dressed traditionally; that is, into the eviscerated carcass with the head and feet were inserted the gizzard, heart, spleen, liver and abdominal fat. An hour after slaughter the warm carcasses together with the innards (i.e. heart, liver, gizzard, spleen and abdominal fat) and the feet and head were weighed. During the night the carcasses were chilled in a cold store thermostatically maintained at +4°C. The next day the chilled carcasses together with the innards, abdominal fat, feet and head were weighed again. The edible innards (i.e. heart, liver and gizzard), abdominal fat, head, neck and feet belonging to each particular carcass were weighed separately. The data collected were used for statistical analysis. Statistical analysis was performed by means of the GLM procedure of the SAS/STAT programme package (*SAS/STAT User's Guide*, 1990). The statistical model used was as follows:

$$y_{ijk} = \mu + P_i + R_j + S_k + PR_{ij} + PS_{ik} + RS_{jk} + PRS_{ijk} + e_{ijk}$$

y_{ijk} = observed value of the trait studied

μ = mean value

P_i = effect of provenance i

R_j = effect of keeping system j

S_k = effect of sex k

PR_{ij} = interaction effect of provenance i and keeping system j

PS_{ik} = interaction effect of provenance i and sex k

RS_{jk} = interaction effect of keeping system j and sex k

PRS_{ijk} = interaction effect of provenance i, keeping system j and sex k

e_{ijk} = random error

RESULTS AND DISCUSSION

Basic statistical parameters for the growth performance and the carcass characteristics of the experimental groups are summarised in *Table 1*.

Free range chickens had lower weights at the time of slaughter, but the average weights showed no significant difference; the same was true of the eviscerated carcasses with innards after slaughter and chilling. These results are not in agreement with the work of *Muriel and Pascual* (1995) in which higher weights were recorded in free range chickens. More movement on the pasture in comparison with deep litter housing might explain these results. The free range chickens had less abdominal fat than the chickens raised indoors, but all the other carcass characteristics were modified only slightly. This result is consistent with the findings of *Ricard et al.* (1986) cited by *Muriel and Pascual* (1995), who wrote that intensive management techniques led to fatter birds. Comparison of feet weight showed that the chickens raised indoors had slightly heavier feet than the chickens raised on pasture. This result does not support the findings of *Garcia et al.* (1995), who asserted that a free range system assures higher development of shanks. The innards were heavier in the chickens reared on pasture, but no statistical differences were detected. These findings could be related to the well known effect of rearing on pasture, which promotes the development of the gizzard.

Although the differences were not statistically significant the males had more abdominal fat, in absolute terms, than the females. These results could be attributed to the fact that at the time of slaughter the males were significantly ($P \leq 0.001$) heavier than the females, since in terms of % of live weight at eight weeks of age the males had less abdominal fat than the females. Number of animals and feed conversion are shown in *Table 2*.

As expected, feed conversion for weight gain was higher in the chickens reared in the free range keeping system, although no great differences were observed between the two rearing systems. Overall mortality was 12%. This high mortality rate could be related to high ambient temperatures, which at the peak of mortality exceeded 30°C. The effects of provenance, keeping system and sex and their interactions on growth performance are shown in *Table 3*.

Table 4 reveals the effects of provenance, keeping system and sex and their interactions on carcass characteristics.

Table 1

Production results of broiler chickens included in the experiment (basic statistics)

Characteristics (1)	A	Provenance (3)		Keeping system (4)		Sex (5)	
Live weight in grammes at the age of: (6)		Ross (7)	Prelux (8)	Free range (9)	Indoors (10)	Females (11)	Males (12)
1 day (13)	<i>X</i> (22)	45.32	43.56	44.89	44.01	44.72	44.16
	<i>SD</i> (23)	3.87	4.23	4.20	4.06	4.15	4.13
1 week (14)	<i>X</i>	161.36	129.02	149.08	141.21	142.12	148.00
	<i>SD</i>	18.48	17.30	24.38	23.44	26.94	20.68
2 weeks	<i>X</i>	381.00	311.76	351.77	340.62	335.04	357.24
	<i>SD</i>	46.60	41.76	56.92	55.31	63.01	46.00
3 weeks	<i>X</i>	706.93	582.30	652.50	635.98	615.70	672.85
	<i>SD</i>	86.79	79.26	106.20	101.69	115.48	81.59
4 weeks	<i>X</i>	1094.08	891.12	997.44	988.13	924.40	1063.64
	<i>SD</i>	146.96	131.88	176.62	169.92	178.10	134.61
5 weeks	<i>X</i>	1483.97	1173.22	1317.23	1342.40	1233.70	1432.87
	<i>SD</i>	215.46	180.84	253.27	253.18	252.98	209.03
6 weeks	<i>X</i>	1910.20	1522.55	1703.40	1733.12	1573.22	1866.70
	<i>SD</i>	296.63	214.85	326.83	322.65	295.41	282.87
7 weeks	<i>X</i>	2435.72	1911.59	2142.02	2210.10	1974.16	2382.97
	<i>SD</i>	402.95	304.86	431.61	455.49	396.77	391.83
8 weeks	<i>X</i>	2889.09	2304.31	2560.46	2631.33	2384.65	2808.75
	<i>SD</i>	418.77	367.88	481.14	501.13	386.53	494.20
Eviscerated carcass with innards an hour after slaughter (g) (15)	<i>X</i>	2404.31	1940.90	2136.62	2207.00	1982.84	2362.38
	<i>SD</i>	369.52	307.04	384.89	434.82	309.28	413.93
Eviscerated carcass with intestines after chilling (g) (16)	<i>X</i>	2361.81	1909.20	2104.76	2164.88	1947.04	2323.97
	<i>SD</i>	360.61	304.32	381.57	423.35	304.74	402.37
Intestines weight (g) (17)	<i>X</i>	113.70	97.38	105.88	105.22	99.45	111.63
	(<i>SD</i>)	(15.43)	(12.76)	(15.49)	(17.19)	(13.97)	(16.31)
	<i>B</i>	3.93	4.22	4.13	3.99	4.17	3.97
Weight of abdominal fat (g) (18)	<i>X</i>	91.06	69.63	76.39	84.13	78.47	82.22
	(<i>SD</i>)	(24.59)	(16.89)	(21.25)	(25.27)	(22.70)	(24.54)
	<i>B</i>	3.15	3.02	2.98	3.19	3.29	2.92
Neck weight (g) (19)	<i>X</i>	103.13	92.65	94.16	101.46	78.93	116.86
	(<i>SD</i>)	(29.39)	(31.60)	(28.19)	(33.01)	(20.40)	(27.68)
	<i>B</i>	3.56	4.02	3.67	3.85	3.30	4.16
Feet weight (g) (20)	<i>X</i>	102.75	88.79	95.46	96.06	79.95	111.59
	(<i>SD</i>)	(21.14)	(19.56)	(21.75)	(21.36)	(11.89)	(16.61)
	<i>B</i>	3.55	3.85	3.72	3.65	3.35	3.97
Head weight (g) (21)	<i>X</i>	60.46	55.70	56.93	59.15	48.27	67.61
	(<i>SD</i>)	(14.57)	(19.00)	(19.23)	(14.71)	(15.43)	(12.59)
		2.09	2.41	2.22	2.24	2.02	2.40

A: Statistical parameter (2), X: mean (22), SD: standard deviation (23), B: weight at 8 weeks (24)

1. Tabelle: Die Produktionsergebnisse von Broilern im Versuch

Bezeichnung(1), Statistische Parameter(2), Genotyp(3), Haltungsmethode(4), Geschlecht(5), Lebendgewicht in Gramm im Alter von(6), Genotyp Ross (7) Genotyp Prelux(8), Freilandhaltung(9), Stallhaltung(10), weiblich(11), männlich(12), 1 Tag(13), 1 Woche(14), Schlachtkörper mit Innereien eine Stunde nach dem Schlachten(15), Schlachtkörper mit Innereien nach der Kühlung(16, Gewicht der Innereien(17) Gewicht des Bauchhöhlenfettes(18), Gewicht des Halses(19), Gewicht der Füße(20), Gewicht des Kopfes(21), Mittelwert(22), Standardabweichung(23), prozentuales Lebendgewicht im Alter von 8 Wochen(24)

Table 2**Effect of keeping system on feed conversion**

Weeks (1)	1 st	2 nd	3 rd	4 th	5 th	6 th		7 th		8 th	
						Free range(4)	Indoors(5)	Free range	Indoors	Free range	Indoors
Number of animals (2)	99	99	99	98	97	47	48	47	48	43	45
Feed conversion (3)	1.188	1.442	1.708	2.561	2.793	2.793	2.731	2.823	2.636	3.325	3.030

2. Tabelle: Einfluss der Haltungsmethode auf die Futterverwertung

Wochen(1), Bestandszahl(2), Futterverwertung(3), Freilandhaltung(4), Stallhaltung(5)

Table 3

**Influence of provenance, keeping system and sex
and their interactions on chicken growth performance**

CHARACTERISTICS(1)	EFFECT(2)						
Live weight at the age of: (3)	P _i	R _j	S _k	PR _{ij}	PS _{ik}	RS _{jk}	PRS _{ijk}
1 day (4)	0.0166	n.s.	n.s.	n.s.	n.s.	n.s.	0.0236
1 week (5)	0.0001	0.0257	n.s.	n.s.	n.s.	n.s.	0.0312
2 weeks	0.0001	n.s.	0.0088	n.s.	n.s.	n.s.	n.s.
3 weeks	0.0001	n.s.	0.0003	n.s.	n.s.	n.s.	n.s.
4 weeks	0.0001	n.s.	0.0001	n.s.	n.s.	n.s.	n.s.
5 weeks	0.0001	n.s.	0.0001	n.s.	n.s.	n.s.	n.s.
6 weeks	0.0001	n.s.	0.0001	n.s.	n.s.	n.s.	n.s.
7 weeks	0.0001	n.s.	0.0001	n.s.	n.s.	n.s.	n.s.
9 weeks	0.0001	n.s.	0.0001	n.s.	n.s.	n.s.	n.s.

P≤0.05 = Statistically significant (*Statistisch signifikant*), P_i = Effect of provenance i (*Einfluss des Genotyps*), PS_{ik} = Interaction effect of provenance i and sex k (*Interaktion zwischen Genotyp und Geschlecht*), P≤0.01 = Statistically significant (*Statistisch signifikant*), R_j = Effect of keeping system j (*Einfluss der Haltungsmethode*), RS_{jk} = Interaction effect of keeping system j and sex k (*Interaktion zwischen Haltungssystem und Geschlecht*), P≤0.001 = Highly statistically significant (*Hoch statistisch signifikant*) S_k = Effect of sex k (*Einfluss des Geschlechts*), n.s. = Non significant (P≥0.05) (*Nicht signifikant*), PR_{ij} = Interaction effect of provenance i and keeping system j (*Interaktion zwischen Genotyp und Haltungsmethode*), PRS_{ijk} = Interaction effect of provenance i, keeping system j and sex k (*Interaktion zwischen Genotyp, Haltungsmethode und Geschlecht*)

3. Tabelle: Einfluss des Genotyps, der Haltungsmethode, des Geschlechts und deren Interaktionen auf das Wachstum von Broilern

Bezeichnung(1), Einfluss(2), Lebendgewicht im Alter von (3), Tag(4), Wochen(5)

Table 4

**Influence of provenance, keeping system and sex
and their interactions on chicken carcass characteristics**

CHARACTERISTIC (1)	EFFECT (2)						
	P _i	R _j	S _k	PR _{ij}	PS _{ik}	RS _{jk}	PRS _{ijk}
Eviscerated carcass with intestines (gizzard, heart, liver, spleen, abdominal fat) an hour after slaughter (3)	0.0001	n.s.	0.0001	n.s.	n.s.	n.s.	n.s.
Eviscerated carcass with intestines (gizzard, heart, liver, spleen, abdominal fat) after chilling (4)	0.0001	n.s.	0.0001	n.s.	n.s.	n.s.	n.s.
Weight of innards (5)	0.0001	n.s.	0.0001	n.s.	n.s.	n.s.	n.s.
Weight of abdominal fat (6)	0.0001	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Neck weight (7)	0.0187	n.s.	0.0001	n.s.	n.s.	n.s.	n.s.
Feet weight (8)	0.0001	n.s.	0.0001	n.s.	n.s.	n.s.	n.s.
Head weight (9)	n.s.	n.s.	0.0001	n.s.	n.s.	n.s.	n.s.

P≤0.05 = Statistically significant (*Statistisch signifikant*), P_i = Effect of provenance i (*Einfluss des Genotyps*), PS_{ik} = Interaction effect of provenance i and sex k (*Interaktion zwischen Genotyp und Geschlecht*), P≤0.01 = Statistically significant (*Statistisch signifikant*), R_j = Effect of keeping system j (*Einfluss der Haltungsmethode*), RS_{jk} = Interaction effect of keeping system j and sex k (*Interaktion zwischen Haltungssystem und Geschlecht*), P≤0.001 = Highly statistically significant (*Stark statistisch signifikant*) S_k = Effect of sex k (*Einfluss des Geschlechts*), n.s. = Non significant (P≥0.05) (*Nicht signifikant*), PR_{ij} = Interaction effect of provenance i and keeping system j (*Interaktion zwischen Genotyp und Haltungsmethode*), PRS_{ijk} = Interaction effect of provenance i, keeping system j and sex k (*Interaktion zwischen Genotyp, Haltungsmethode und Geschlecht*)

4. Tabelle: Einfluss des Genotyps, der Haltungsmethode, des Geschlechts und deren Interaktionen auf den Schlachtkörper von Broilern

Bezeichnung(1), Einfluss (2), Ausgenommener Schlachtkörper mit Innereien (Magen, Herz, Leber, Milz, Bauchhöhlenfett) eine Stunde nach dem Schlachten(3), Ausgenommener Schlachtkörper mit Innereien (Magen, Herz, Leber, Milz, Bauchhöhlenfett) nach der Kühlung(4), Gewicht der Innereien(5), Gewicht des Bauchhöhlenfettes(6), Gewicht des Halses(7), Gewicht der Füße(8), Gewicht des Kopfes(9)

For live weight at the same age no significant differences were detected according to keeping system for eviscerated carcass weight and cut weight. These results are in agreement with the study performed by Garcia et al. (1995). The differences in the above characteristics were, with the exception of head weight, very significant between provenance and, as expected, between sexes.

CONCLUSIONS

The study of the influence of keeping system (indoor versus free range) on chicken growth performance and carcass characteristics was the subject of this study. The results of the experiment show no statistically significant differences between the chickens from the deep litter house and the free range chickens. Regarding growth and carcass characteristics, the effects of provenance and sex were much more important than the effect of keeping system.

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Quality parameters of thermally treated chickens of two provenances and free range keeping

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ABSTRACT

The aim of the research was to study the influence of two rearing methods (free range and indoors) for chickens of two provenances on some quality parameters of thermally treated chickens. The trial involved 48 chickens (24 Ross and 24 Prelux-bro). All the birds were raised in deep litter house for the first 4 weeks. Then they were divided into 2 groups, the free range chicken group having free access to pasture ground. Both the pasture-raised and the indoor-raised groups were slaughtered at the age of 56 days. After slaughter and chilling the chickens were thermally treated at 190°C, reaching the central temperature in the breast, $T_s=85^\circ\text{C}$. Thawing weight loss and thermal treatment weight loss were calculated, basic chemical composition was analysed and after thermal treatment instrument-based analysis of texture and sensory parameters was performed. The results showed that the method of raising affected the instrument-measured traits of texture and the chemical composition of thermally treated muscles. Sensory quality (overall acceptance) of chicken meat was not influenced significantly by method of raising or provenance, but an influence of the part of chicken (thigh versus breast) on the most of the sensory traits was established.

(Keywords: broilers, free range, meat, thermal treatment, quality parameters)

ZUSAMMENFASSUNG

Qualitätsparameter thermisch behandelter Broiler zweier Genotypen aus der Freilandhaltung

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Das Ziel der vorliegenden Untersuchung war festzustellen, welchen Einfluß die Zuchtbedingungen (Freilandhaltung und Zuchtort) und die zwei Genotypen (Ross und Prelux-bro) auf einige Qualitätsparameter der thermisch behandelten Broiler haben. Im Versuch wurden 48 Broiler der zwei Genotypen (24 Ross und 24 Prelux-bro) untersucht. Alle Broiler wurden bis zum 28. Lebenstag im Hühnerstall aufgezogen und dann in zwei

Gruppen geteilt. Die Broiler aus der Bodenhaltung blieben weiterhin im Hühnerstall, während diejenigen mit Freilandhaltung einen offenen Zugang zur Weide hatten. Alle Broiler wurden am 56. Tag geschlachtet. Nach dem Schlachten und Gefrieren wurden die Broiler bei 190 °C bis $T_c=85^\circ\text{C}$ im Zentrum des Filets thermisch (durch Braten) behandelt. Die Gewichtsverluste beim Auftauen und bei der thermischen Behandlung wurden gemessen. Anschließend erfolgte die Analyse der chemischen Zusammensetzung und nach der thermischen Behandlung die technische Untersuchung des Gewebes sowie die sensorische Analyse. Die Resultate beweisen, daß die Zuchtbedingungen Einfluss auf die instrumental gemessenen Textureigenschaften und die chemische Zusammensetzung des thermisch behandelten Muskelfleisches haben. Ein signifikanter Einfluss auf die sensorische Qualität (Gesamteindruck) konnte weder durch Zuchtbedingungen noch durch Genotypen festgestellt werden. Es war lediglich bei den meisten sensorischen Eigenschaften ein Unterschied zwischen Filet und Schenkel wahrnehmbar.

(Schlüsselwörter: Broiler, Freilandhaltung, Fleisch, Thermische Behandlung, Qualitätsparameter)

INTRODUCTION

The method of raising broilers can significantly influence the sensory quality of chicken meat alongside genotype, age, sex and certain other technological parameters before and after slaughter. Chickens raised according to various methods of less intensive free range, as set out in the regulations issued in 1991 (EEC, No. 1538/91) are preferred by some consumers due to their better sensory quality, overall acceptance, smell, flavour and texture. Less intensive methods of raising of chickens branded under particular trade marks such as *Label Rouge* and *Label Fermier* in France (Farmer et al., 1997) are strictly supervised in all phases of production, with regard to chicken genotype (i.e., slow-growing animals), food (to contain wheat), population density (free range) and age at slaughter (not less than 84 days). Such methods of raising bear a significant effect on texture, tenderness and juiciness, which deteriorate, while the smell and flavour of the meat do not, and may even improve. Better or changed sensory traits of chicken meat from less intensive raising are different in white meat (breast) compared with dark meat (thigh) (Farmer et al., 1997), and also depending on sex (Ristić, 1990). Free range keeping changes the chemical composition of meat: the lipid and protein content increase while water content decreases. The pH value and WHC increase, as does shear force (Mahapatra et al., 1989). The aim of this research was to study the influence of two methods of raising (free range and indoor) and two provenances (Ross and Prelux-bro) on the chemical composition and sensory quality parameters of broilers after thermal treatment.

MATERIALS AND METHODS

24 broilers (12 females and 12 males) from the commercial provenance Ross and 24 others (12 females and 12 males) from the commercial provenance Prelux-bro were included in this research. All chickens were housed from the time of hatching until 28 days of age in a deep litter house. At the age of 28 days the chickens were divided into two groups. The first group (12 Ross chickens and 12 Prelux-bro chickens) was raised indoors without access to pasture. The second group (12 Ross chickens and 12 Prelux-

bro chickens) had free access to pasture all day. The ground to which the chickens had access was mainly covered with various types of grasses. For the first 28 days the broilers were fed a starter diet which contained 3100 kcal/kg and 23.44% crude protein. From the 28th day until the end of fattening the broilers were given a feed mixture with 2700 kcal/kg and 14.5% crude protein. The chickens were fed ad libitum. All birds were slaughtered at the age of 8 weeks. The chicken carcasses were dressed traditionally (carcass with head, neck, lower parts of legs, giblets and abdominal fat) and ready for grilling (without the above parts). The chicken carcasses were frozen at -20°C. Before the analyses began the frozen chickens were thawed for 24 hours at T=0 to +4°C and thawing weight loss was calculated. The thawed carcasses were thermally treated by roasting in a steam convection oven at 190°C, adding steam until the central temperature in the breast at the breastbone reached T_s=85°C. Thermal treatment weight loss was then calculated. With the use of basic chemical analyses for thermally treated breast muscle the water content was determined by a method of drying to constant mass at 105°C, fat content by Soxhlet's method, and ash content by dry burning of the samples at 550°C. Instrument-based analysis of texture (cutting values across and along the direction of muscular fibres with a 1 cm long blade) was performed on *m. pectoralis superficialis* and on *m. biceps femoris* using INSTRON universal test apparatus, desk type 1111. The sensory parameters were determined by a three-member committee according to the system of non-structured score scale from the group of descriptive analytical tests (SEG, 1980). The shape and overall acceptance of the whole thermally treated chicken was assessed. Colour, texture, fatness and flavour were assessed for the skin, while colour, smell, flavour, juiciness, fatness, tenderness and mouth feeling were evaluated for the breast and thigh muscle. Tenderness was assessed using the 1-4-7 score system, where the mean value denotes optimal tenderness, a lower score that the muscle is too firm and a higher score that it is too soft. All other sensory traits were assessed using the 1-7 score system, where the highest score denotes a more expressed trait. Statistical analysis of the data was performed by means of the GLM procedure of the SAS/STAT programme package (SAS/STAT User's Guide, 1990).

RESULTS AND DISCUSSION

Table 1 shows the basic statistical parameters for all the chicken traits analysed.

Table 2 shows the parameters (method of raising, provenance, part of chicken and parallel/assessor) which cause the variability of values for some traits. The calculated P value shows the strength of influence of single parameter on each trait.

Technological parameters, chemical composition and instrument-based values of texture of parallel did not have any influence while assessor significantly and highly significantly affected most of the sensory traits analysed. The other three effects (method of raising, provenance and part of chicken) are described in detail in Table 3.

Table 1**Statistical parameters for chicken quality traits**

Parameter	N	Mean	Min.	Max.	SD	CV (%)
Technological: (1)						
Thawing weight loss (%) (2)	48	0.58	0.001	3.59	0.67	116.06
Thermal treatment weight loss (%) (3)	48	35.42	24.42	44.66	4.11	11.61
Thermally treated chicken: (4)						
Chemical – breast with skin (%): (5)						
Water (6)	64	60.47	55.38	64.71	1.93	3.19
Fat (7)	64	10.43	6.13	14.43	2.01	19.24
Ash (8)	64	1.13	0.93	1.42	0.12	10.35
Instrument-based (N): (9)						
Shear strength – across (10)	384	31.62	2.5	84	15.62	49.39
Shear strength – along (11)	384	15.14	3	43	5.75	37.97
Sensory (points): (12)						
Whole chicken: (13)						
Shape (1-7) (14)	144	5.76	5.0	6.5	0.34	5.89
Overall acceptance (1-7) (15)	144	5.63	5.0	6.0	0.27	4.87
Skin: (16)						
Colour (1-7) (17)	144	5.97	5.0	7.0	0.48	7.97
Texture (1-7) (18)	144	4.24	3.5	5.5	0.41	9.77
Fatness (1-7) (19)	144	2.11	1.0	5.5	0.63	29.83
Flavour (1-7) (20)	144	5.80	5.0	6.5	0.30	5.14
Breast and thigh – mean value: (21)						
Colour (1-7) (22)	288	5.83	4.5	6.5	0.43	7.42
Smell (1-7) (23)	288	5.85	5.0	6.5	0.25	4.21
Flavour (1-7) (24)	288	5.88	5.0	6.5	0.31	5.30
Juiciness (1-7) (25)	288	5.47	4.0	6.5	0.54	9.85
Fatness (1-7) (26)	288	1.49	1.0	3.0	0.57	38.54
Tenderness (1-4-7) (27)	288	3.84	2.5	5.5	0.32	8.47
Mouth feeling (1-7) (28)	288	5.51	4.5	6.5	0.38	6.92

CV - coefficient of variability (*Variationskoeffizient*)*1. Tabelle: Statistische Parameter für Qualitätsmerkmale bei Broilern*

Technologie(1), Gewichtsverlust beim Auftauen(2), Gewichtsverlust durch Erhitzen(3), Hitzebehandelte Broiler(4), Zusammensetzung von Brust mit Haut, %(5), Wasser(6), Fett(7), Asche(8), technische Analyse(9), Scherfestigkeit quer(10), Scherfestigkeit längs(11), Sensorische Analyse nach Punkten(12), Ganzer Broiler(13), Äußere Form(14), Gesamteindruck(15), Haut(16), Farbe(17), Gewebestruktur(18), Fettigkeit(19), Geschmack(20) Durchschnittswerte für Brust und Schenkel(21), Farbe(22), Geruch(23), Geschmack(24), Saftigkeit(25), Fettigkeit(26), Mürbheitsgrad(27), Mundgefühl(28)

Table 2

**Sources of variability and statistical significance (p) of their effect
on some quality parameters of chickens**

Parameter / DF	Source of variability (p value) (29)			
	Breeding (30)	Proven. (31)	Part (32)	Parallel or Assessor
	1	1	1	2
Technological: (1)				
Thawing weight loss (%) (2)	0.0078	0.0474		1.0000
Thermal treatment weight loss (%) (3)	0.0001	0.0172		1.0000
Thermally treated chicken: (4)				
Chemical - breast with skin (%): (5)				
Water (6)	0.4585	0.7915		0.0243
Fat (7)	0.0118	0.3941		0.6227
Ash (8)	0.0018	0.4922		0.5751
Instrument-based (N): (9)				
Shear strength – across (10)	0.0001	0.8114	0.0001	0.6003
Shear strength – along (11)	0.0001	0.0683	0.0001	0.4051
Sensory (points): (12)				
Whole chicken: (13)				
Shape (1-7) (14)	0.0001	0.02899		0.4237
Overall acceptance (1-7) (15)	0.3510	0.7556		0.0059
Skin: (16)				
Colour (1-7) (17)	0.0001	0.0900		0.0397
Texture (1-7) (18)	0.0004	0.6718		0.0402
Fatness (1-7) (19)	0.0768	0.8911		0.0042
Flavour (1-7) (20)	0.6660	0.1966		0.0044
Breast and thigh – mean value: (21)				
Colour (1-7) (22)	0.2713	0.3377	0.0001	0.0177
Smell (1-7) (23)	0.1502	0.6823	0.8796	0.0001
Flavour (1-7) (24)	0.5026	0.7266	0.0001	0.0001
Juiciness (1-7) (25)	0.0013	0.9826	0.0001	0.0029
Fatness (1-7) (26)	0.0340	0.2128	0.0001	0.0172
Tenderness (1-4-7) (27)	0.7286	0.0036	0.0064	0.4084
Mouth feeling (1-7) (28)	0.0218	0.1377	0.0001	0.0145

DF - degree of freedom (*Freiheitsgrad*)

2. Tabelle: Einfluss der Variabilitätsbasis und der statistischen Signifikanz auf einige Qualitätsmerkmale der Broiler

Technologie(1), Gewichtsverlust beim Auftauen(2), Gewichtsverlust durch Erhitzen(3), Hitzebehandelte Broiler(4), Zusammensetzung von Brust mit Haut, %(5), Wasser(6), Fett(7), Asche(8), technische Analyse(9), Scherfestigkeit quer(10), Scherfestigkeit längs(11), Sensorische Analyse nach Punkten(12), Ganzer Broiler(13), Äußere Form(14), Gesamteindruck(15), Haut(16), Farbe(17), Gewebestruktur(18), Fettigkeit(19), Geschmack(20) Durchschnittswerte für Brust und Schenkel(21), Farbe(22), Geruch(23), Geschmack(24), Saftigkeit(25), Fettigkeit(26), Mürbheitsgrad(27), Mundgefühl(28), Variabilitätsbasis(29), Haltungsmethode(30), Genotyp(31), Körperteil(32)

Table 3**The influence of keeping method on some quality parameters of chickens**

Parameter	Keeping method (29)				Difference between free range & indoors (32)
	Free range (30)		Indoors (31)		
	LSM	SEM	LSM	SEM	
Technological: (1)					
Thawing weight loss (%) (2)	0.45	0.07	0.71	0.07	-0.26*
Thermal treatment weight loss (%) (3)	37.87	0.35	32.96	0.35	4.91***
Thermally treated chicken: (4)					
Chemical – breast with skin (%) (5)					
Water (6)	60.67	0.26	60.92	0.26	-0.25
Fat (7)	9.91	0.28	10.94	0.28	-1.03*
Ash (8)	1.17	0.02	1.10	0.02	0.07*
Instrument-based (N): (9)					
Shear strength – across (10)	33.8	0.7	29.39	0.7	4.5***
Shear strength – along (11)	16.2	0.4	14.1	0.4	2.1***
Sensory (points): (12)					
Whole chicken: (13)					
Shape (1-7) (14)	5.90	0.03	5.63	0.03	0.26***
Overall acceptance (1-7) (15)	5.60	0.03	5.65	0.03	-0.04
Skin: (16)					
Colour (1-7) (17)	6.13	0.05	5.81	0.05	0.32***
Texture (1-7) (18)	4.12	0.05	4.35	0.05	-0.23***
Fatness (1-7) (19)	2.02	0.07	2.20	0.07	-0.18
Flavour (1-7) (20)	5.78	0.03	5.81	0.03	-0.02
Breast and thigh – mean value: (21)					
Colour (1-7) (22)	5.80	0.03	5.85	0.03	-0.05
Smell (1-7) (23)	5.83	0.02	5.86	0.02	-0.04
Flavour (1-7) (24)	5.87	0.02	5.90	0.02	-0.02
Juiciness (1-7) (25)	5.39	0.04	5.56	0.03	-0.17*
Fatness (1-7) (26)	1.45	0.02	1.53	0.02	-0.07*
Tenderness (1-4-7 (27))	3.85	0.03	3.83	0.03	0.01
Mouth feeling (1-7) (28)	5.47	0.03	5.56	0.03	-0.09

P≤0.001 *** highly stat. significant; P≤0.01 **, P≤0.05 * stat. significant;

LSM - least square mean; SEM - standard error mean

3. Tabelle: Einfluss der Haltungsmethode auf einige Qualitätsparameter der Broiler

Technologie(1), Gewichtsverlust beim Auftauen(2), Gewichtsverlust durch Erhitzen(3), Hitzebehandelte Broiler(4), Zusammensetzung von Brust mit Haut, %(5), Wasser(6), Fett(7), Asche(8), technische Analyse(9), Scherfestigkeit quer(10), Scherfestigkeit längs(11), Sensorische Analyse nach Punkten(12), Ganzer Broiler(13), Äußere Form(14), Gesamteindruck(15), Haut(16), Farbe(17), Gewebestruktur(18), Fettigkeit(19), Geschmack(20) Durchschnittswerte für Brust und Schenkel(21), Farbe(22), Geruch(23), Geschmack(24), Saftigkeit(25), Fettigkeit(26), Mürbheitsgrad(27), Mundgefühl(28), Haltungsmethode(29), Freiland(30), Stallhaltung(31), Differenz(32)

Table 4

The influence of provenance on some quality parameters of chickens

Parameter	Provenance (29)				Difference between Ross & Prelux (30)
	Ross		Prelux		
	LSM	SEM	LSM	SEM	
Technological: (1)					
Thawing weight loss (%) (2)	0.48	0.07	0.68	0.07	-0.19*
Thermal treatment weight loss (%) (3)	34.82	0.35	36.01	0.35	-0.19*
Thermally treated chicken: (4)					
Chemical - breast with skin (%) (5):					
Water (6)	60.84	0.26	60.75	0.26	0.09
Fat (7)	10.60	0.28	10.26	0.28	0.34
Ash (8)	1.12	0.02	1.14	0.02	-0.02
Instrument-based (N): (9)					
Shear strength – across (10)	31.5	0.7	31.7	0.7	-0.2
Shear strength – along (11)	14.7	0.4	15.6	0.4	-0.9
Sensory (points): (12)					
Whole chicken: (13)					
Shape (1-7) (14)	5.79	0.03	5.74	0.03	0.05
Overall acceptance (1-7) (15)	5.63	0.03	5.62	0.03	0.01
Skin: (16)					
Colour (1-7) (17)	6.03	0.05	5.90	0.05	0.13
Texture (1-7) (18)	4.25	0.05	4.22	0.05	0.03
Fatness (1-7) (19)	2.12	0.07	2.10	0.07	0.01
Flavour (1-7) (20)	5.76	0.03	5.83	0.03	-0.06
Breast and thigh – mean value: (21)					
Colour (1-7) (22)	5.85	0.03	5.80	0.03	0.05
Smell (1-7) (23)	5.85	0.02	5.84	0.02	0.01
Flavour (1-7) (24)	5.88	0.02	5.89	0.02	-0.01
Juiciness (1-7) (25)	5.47	0.04	5.47	0.04	-0.00
Fatness (1-7) (26)	1.47	0.02	1.51	0.02	-0.04
Tenderness (1-4-7 (27))	3.78	0.03	3.90	0.03	-0.11*
Mouth feeling (1-7) (28)	5.49	0.03	5.54	0.03	-0.06

P≤0.001 *** highly stat. significant; P≤0.01 **, P≤0.05 * stat. significant;

LSM - least square mean; SEM - standard error mean

4. Tabelle: Einfluss des Genotyps auf einige Qualitätsmerkmale der Broiler

Technologie(1), Gewichtsverlust beim Auftauen(2), Gewichtsverlust durch Erhitzen(3), Hitzebehandelte Broiler(4), Zusammensetzung von Brust mit Haut, %(5), Wasser(6), Fett(7), Asche(8), Technische Analyse(9), Scherfestigkeit quer(10), Scherfestigkeit längs(11), Sensorische Analyse nach Punkten(12), Ganzer Broiler(13), Äußere Form(14), Gesamteindruck(15), Haut(16), Farbe(17), Gewebestruktur(18), Fettigkeit(19), Geschmack(20) Durchschnittswerte für Brust und Schenkel(21), Farbe(22), Geruch(23), Geschmack(24), Saftigkeit(25), Fettigkeit(26), Mürbheitsgrad(27), Mundgefühl(28), Genotyp(29), Differenz(30)

Table 5

The influence of part (thigh or breast) on instrument-based and sensory parameters of thermally treated chickens

Parameter	Part of meat (12)				Difference between thigh & breast (15)
	Thigh (13)		Breast (14)		
	LSM	SEM	LSM	SEM	
Instrument-based (N): (1)					
Cutting value – across (2)	19.8	0.7	43.4	0.7	-23.6***
Cutting value – along (3)	12.6	0.4	17.7	0.4	-5.2***
Sensory (points): (4)					
Colour (1-7) (5)	5.71	0.03	5.94	0.03	-0.23***
Smell (1-7) (6)	5.84	0.02	5.85	0.02	-0.00
Flavour (1-7) (7)	5.96	0.02	5.81	0.02	0.16***
Juiciness (1-7) (8)	5.78	0.04	5.17	0.04	0.61***
Fatness (1-7) (9)	1.98	0.02	1.00	0.02	0.97***
Tenderness (1-4-7) (10)	3.89	0.03	3.79	0.03	0.10*
Mouth feeling (1-7) (11)	5.70	0.03	5.33	0.03	0.38***

P≤0.001 *** highly stat. significant; P≤0.01 **, P≤0.05 * stat. significant;

LSM - least square mean; SEM - standard error mean

5. Tabelle: Einfluss der Körperteile (Brust, Schenkel) auf die technische und sensorische Untersuchung der hitzebehandelten Broiler

Technische Analyse(1), Scherfestigkeit quer(2), Scherfestigkeit längs(3), Sensorische Analyse nach Punkten(4), Farbe(5), Geruch(6), Geschmack(7), Saftigkeit(8), Fettigkeit(9), Mürbekeitsgrad(10), Mundgefühl(11), Fleischteile(12), Schenkel(13), Brust(14), Differenz(15)

Thawing weight loss proved significantly lower in the free range chickens than in the chickens raised indoors. Thermal treatment weigh loss showed the opposite tendency, with a highly significant difference. Samples from the free range chickens contained significantly less fat and more minerals than samples from indoor-raised chickens. The instrument-measured cutting values were significantly higher in the free range chickens, which was in accordance with the findings of Mahapatra et al. (1989). The free range chickens maintained significantly better shape (i.e., with less damage) than the indoor-raised chickens, and had highly significantly mreo favourably assessed skin colour and significantly less fat in the muscles. Most of the other sensory traits of the free range chickens were assessed to be slightly less favourable than those of the indoor-raised chickens; this was also confirmed by slightly lower assessment (difference not statistically significant) of overall acceptance. Scores for flavour and tenderness of muscles for the free range chickens and the indoor-raised chickens did not differ significantly, which is not in agreement with the general belief that free range chickens have better flavour and texture (Remignon and Culioli, 1995). Absolute comparison of these findings with those in the literature is not possible, since the animals used in this

study were relatively young at slaughter (56 days), while the literature data refer to older free range chickens (80 to 90 days).

Thawing weight loss and thermal treatment weight loss were significantly lower in the chickens of Ross provenance than in those of Prelux-bro provenance. Instrument-measured cutting values proved slightly lower in the muscles of the chickens of Ross provenance than in those of Prelux-bro provenance, which is not in agreement with the fact that the tenderness of the muscles of the chickens of Ross provenance was assessed at significantly low values. Differences between the Ross and Prelux-bro provenances in the traits of overall acceptance assessed were insignificant, which shows very equal sensory quality of chickens of both provenances.

Instrument-measured cutting values for thigh muscles proved significantly lower than for breast muscles, which was in agreement with the significantly higher sensory assessment of the tenderness of thighs. The sensory trait smell was found not to vary substantially in different meat parts. The thighs were assessed at significantly lower values than the breasts with respect to colour, and at very significantly higher values for fatness, as an undesirable trait. All the other sensory traits analysed were assessed at significantly more favourable values for thigh muscle than for breast muscle. The reason for this better assessment of most sensory traits for thigh muscles is evidently the higher fat content of the thigh than of the breast.

Table 6

Coefficients of correlation between instrument-based and some sensory parameters of thermally treated chickens

	Shear strength – across (5)	Shear strength - along (6)
Juiciness (1)	-0.51***	-0.27***
Fatness (2)	-0.65***	-0.340***
Tenderness (3)	-0.17**	-0.09
Mouth feeling (4)	-0.42***	-0.21***

P≤0.001 *** highly stat. Significant, P≤0.01 ** stat. significant

6. Tabelle: Korrelationskoeffizient zwischen den technisch und sensorisch festgestellten Merkmalen der hitzebehandelten Broiler

Saftigkeit(1), Fettigkeit(2), Mürbheitsgrad(3), Mundgefühl(4), Scherfestigkeit quer(5), Scherfestigkeit längs(6)

Highly significant negative correlations between the instrument-measured cutting value across the direction of the muscle fibres and the sensory traits juiciness, fatness and mouth-feeling were established, but these were not high enough ($r < 0.7$) to be substantial.

CONCLUSIONS

Free range influences:

- chemical composition of thermally treated meat (less fat, more minerals);
- instrument-measured texture (higher cutting values).

Sensory quality (i.e., flavour and tenderness) was not affected by free range keeping.

The influence of provenance is significant only for thawing weight loss, thermal treatment weight loss and tenderness (lower weight losses and worse tenderness in chickens of Ross provenance).

All the sensory traits, except smell, colour and fatness, were assessed to be better in the thigh than in the breast muscle.

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The colour and texture of broiler breast meat related to different conditions of rearing and chilling

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ABSTRACT

The aim of the study was to establish the effects of chicken rearing conditions (the amount of ammonia in the air) and rate of chilling after slaughter on the variability of raw broiler breast colour and texture after thermal treatment. The dynamics of the post mortem decrease in pH value in the breast muscles (pectoralis superficialis) of chickens was also investigated. 160 chickens of Ross provenance were used in the experiment. The birds were divided into four groups subjected to different conditions of rearing and chilling. The results show that the effect of chilling on colour parameters of chicken breast meat, evaluated by means of technical instruments, was more substantial than the effect of rearing conditions. Chilling rate influenced the equipment-measured texture of chicken breast meat after thermal treatment. Glycolysis had not reached completion even six hours post mortem.
(Keywords: broiler, colour, texture, rearing, chilling)

ZUSAMMENFASSUNG

Einfluß verschiedener Zucht- und Kühlbedingungen auf Farbe und Textur von Broiler-Brustfleisch

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Ziel der vorliegenden Untersuchung war es festzustellen, welchen Einfluß die Zuchtbedingungen (die Konzentration des Ammoniaks in der Luft) sowie die Kühlbedingungen bei Broilern nach dem Schlachten auf die Farbe des rohen Brustfilets und seine Textur nach der thermischen Behandlung haben. Es wurde die Dynamik der post mortem pH-Wertverringerung im Masthähnchenfilet (pectoralis superficialis) gemessen. Objekt der Untersuchung waren hundertsechzig Broiler des Genotyps Ross. Die Tiere wurden hinsichtlich der Zucht- und Kühlbedingungen in vier Gruppen eingeteilt. Die Resultate beweisen, daß die Kühlbedingungen größeren Einfluss auf die Farbparameter (instrumental gemessen) haben als die Zuchtbedingungen. Die Kühlbedingungen haben auch einen signifikanten Einfluss auf die instrumental gemessene Textur nach der thermischen Behandlung. Die Glykolyse war sogar 6 Stunden nach dem post mortem noch nicht beendet.
(Schlüsselwörter: Masthähnchen, Farbe, Textur, Zucht, Kühlung)

INTRODUCTION

Colour and texture, primarily tenderness, are two of the main properties determining the quality and market acceptability of fresh thermally treated or processed poultry meat. Breast and fillet are the most preferred parts of the chicken for consumers as well as for producers, due to their pleasantly bright colour and good degree of tenderness and their low fat content. Unusually bright or dark colour of breast meat (fillet) and changed texture are the consequence of various pre-slaughter and post-slaughter factors (Froning, 1995). Dark colour of breast meat and firm texture occur in birds subjected to stress through struggling prior to slaughter and glycogen accumulation in muscles (Ngoka and Froning, 1982). Pre-slaughter handling causes PSE in muscles (Babji et al., 1982), apparent in a bright colour and soft water-like texture of breast meat that becomes firm and dry after thermal treatment (Allen et al., 1997). Regardless of genotype or nutrition, the colour of poultry meat, especially dark colours, can be affected by the concentration of gases such as ammonia, carbon dioxide and carbon monoxide in cages or during transport to the slaughter house by unsuitable means of transport (Sackett et al., 1986). Among the post mortem conditions, stunning (by means of electricity or CO₂), steaming before plucking and chilling of carcasses significantly affect the colour and texture of poultry meat (Froning, 1995). Chilling too rapidly can cause the firmness of muscles and dark colour that are also related to cold shortening of meat (Locker and Hagyard, 1963) but in contrast with red meat this does not deteriorate the colour or texture of poultry meat to such an extent.

The purpose of this study was to establish the effects of chicken rearing conditions (i.e., the amount of ammonia in the air) and rate of chilling after slaughter on the variability of raw broiler breast colour and texture after thermal treatment. The dynamics of the *post mortem* pH value decrease in the breast muscles of chickens was also investigated.

MATERIALS AND METHODS

Ross provenance broilers were included in this experiment. Non-sexed chickens were reared until 44 days of age. 160 chickens were divided into four groups: (i) reared in well aired cages and fast-chilled after slaughter; (ii) reared in well aired cages and slow-chilled after slaughter; (iii) reared in badly aired cages and fast-chilled after slaughter; (iv) reared in badly aired cages and slow-chilled after slaughter. The presence of ammonia was 5 ppm in the well aired cages and 31 ppm in the badly aired ones. This was measured by means of the Dräger model ACCURO with glass ampoules of AMMONIA 5/b, the measurement interval being ammonia quantity from 5 ppm to 100 ppm. The rate of air chilling was 2 hours at -2°C for fast chilling and 6 hours at 1°C for slow chilling. After slaughter pH_{45min} and temperature_{45min} were measured in the *pectoralis superficialis* muscle (PS), after which the carcasses were chilled. The chilled carcasses (at approximately 5°C) were weighed and the weight of the breast muscles estimated. The raw breasts were assessed both by sensory techniques (for colour hue, colour uniformity and damage) and by instrument-based procedures (for L*, a* and b* values); pH_{3h}, pH_{6-8h}, temperature_{45min} and temperature_{6-8h} were measured and samples of breast were taken. The samples taken (24 hours after slaughter) were heated in an MK AQUATERM 192095 heat-controlled water bath and after chilling assessed by an equipment-based method (for analysis of tenderness). Statistical analyses were performed using the *Statistical Analysis System* (SAS, 1990). The data obtained were analysed by the least squares method using the GLM procedure.

The sensory panel evaluated the colour hue of the samples with an analytical descriptive test using a scale of 1-3-5. Yellow hue was assessed at a score of 1, bright yellow at 2, suitably bright pink at 3, dark pink at 4 and dark hue on the surface of the fillet at 5. Colour uniformity and damage (to the breast, wings and thighs) were assessed. A system of scores of 1-7 or 1-3 was used, 1 signifying a trait not expressed, and 7 or 3 a significantly expressed trait. At the same time breast colour was analysed by means of a *Minolta CR b* chromometer (for L*, a* and b* values). L* value indicates the brightness of the sample (the higher the value the brighter the sample), a* shows the presence of red (the higher the value the redder the sample), and b* indicates yellow hue (the higher the value the yellower the sample). Each sample was measured at four places (two on the left and two on the right side of the breast). In PS muscle pH value was measured in two parallels. In each bird the temperature of the carcass after chilling was taken at the breastbone. Since pH values were determined in fast-chilled groups 2-3 hours *post mortem* (pH_{3h}) and in slow-chilled groups after 6-7 hours the pH values were measured again in the fast-chilled groups 7-8 hours *post mortem*. In all four groups the pH value measured was designated pH_{6-8h}.

The following day the breasts were thermally treated up to T_i=85°C and subjected to transverse cutting with INSTRON (desk model 1111) universal test apparatus. Measurements of the PS muscle were taken in three parallels.

RESULTS AND DISCUSSION

Table 1 shows basic statistical parameters for all measurements in the chickens.

Table 1

Statistical parameters for physical, sensory and equipment-measured parameters of poultry meat

Parameter	N	Mean(1)	Min.	Max.	CV (%)
pH _{45min}	318	6.53	5.95	7.00	3.35
pH _{3h}	154	6.19	5.77	6.78	3.67
pH _{6-8h}	314	5.98	5.54	6.67	2.52
Temperature _{45min} (°C)	159	29.14	22.40	35.90	10.17
Temperature _{6-8h} (°C)	157	4.10	1.70	6.60	21.28
Mass (g)(2)	157	1609	1010	2130	12
Colour hue (1-3-5)(3)	157	3.95	0.50	6.00	20.23
Colour uniformity (1-7)(4)	157	5.56	5.00	6.00	6.63
Damage (1-3)(5)	470	1.27	1.00	5.00	32.78
L*	471	53.79	47.40	64.00	5.07
a*	471	0.36	-1.40	2.10	169.34
b*	471	3.01	-0.50	7.50	50.92
Cutting value (N)(6)	474	30.04	11.00	98.00	39.25

CV - coefficient of variability

*Explanation below in text (*Erklärung im folgenden Text*)

1. Tabelle Statistische Merkmale für physisch, sinnlich und technisch gemessene Parameter bei Geflügelfleisch

Mittelwert(1), Masse(2), Farbschattierung(3), Gleichfarbigkeit(4), Verlust(5), Schlachtwert(6)

Table 2 shows three sources of variability (chilling rate, rearing conditions and interaction between chilling and rearing conditions) for some traits. The P value calculated shows the strength of some sources of variability or effects on some parameters. The effects on the chicken samples of the repeated taking of measurements are not significant, and are not shown in the table.

Table 2

Sources of variability and statistical significance (P) of their effect on physical sensory and equipment-measured parameters of poultry meat

Parameter / DF	Source of variability (P value) (1)		
	Chilling (2)	Conditions of rearing (3)	Chilling* conditions of rearing (4)
	1	1	1
pH _{45min}	0.5940	0.2131	0.0008
pH _{3h}		0.0001	
pH _{6-8h}	0.0009	0.6882	0.1838
Temperature _{45min} (°C)	0.0007	0.0202	0.0001
Temperature _{6-8h} (°C)	0.0011	0.8228	0.0004
Mass (g)(5)	0.1256	0.1630	0.8255
Colour hue (1-3-5)(6)	0.3871	0.0578	0.0009
Colour uniformity (1-7)(7)	0.4763	0.1444	0.4487
Damage (1-3)(8)	0.0001	0.2623	0.7345
L*	0.0068	0.0048	0.1434
a*	0.0022	0.6341	0.3722
b*	0.0014	0.5386	0.0001
Cutting value (N)(9)	0.0043	0.0034	0.2882

P≤0.001 highly stat. Significant (*stark statistisch signifikant*); P≤0.01, P≤0.05 stat. Significant (*statistisch signifikant*); DF: degree of freedom (*Freiheitsgrad*)

* Explanation in text (*Erklärung im Text*)

2. Tabelle: Einfluss der verschiedenen und statistisch signifikanten (P) Quellen auf die physische, sinnlich und technisch gemessenen Parameter bei Geflügelfleisch

Variabilitätsquelle (P-Wert)(1), Kühlung(2), Zuchtbedingungen(3), Kühlimstände(4), Gewicht(5), Farbschattierung(6), Gleichfarbigkeit(7), Verlust(8), Schlachtwert(9)

Chilling rate significantly affects all equipment-measured parameters of colour, pH_{6-8h} and cutting value after thermal treatment. Also, conditions of rearing (i.e., airing) affect some parameters such as L* value and cutting value. The effects of airing and chilling interact and significantly affect the colour hue of breasts (assessed by a sensory technique) and the initial pH value.

The next two tables show the above effects in detail. The differences in temperature are technical and did not influence the experiment. Damage proved more frequent in the case of the fast-chilled chickens, but this was not derived from chilling speed, and was random. The very low Pearson's coefficients of correlation between damage and colour (colour hue 0.031; L* -0.020; a* 0.024; b* 0.080) show that no relations existed among them.

The slow-chilled breasts were darker, and more red or yellow, as was established by *Froning* (1995). Sensory assessment of the hue of these breasts showed almost optimal pink colour. The slow-chilled breasts were slightly brighter in colour (although care should be taken in drawing conclusions, as this was not true in the case of both breeders).

The cutting value of the fast-chilled thermally treated breasts was significantly higher than that of the more slowly chilled ones.

Table 3

The influence of chilling on physical, sensory and equipment-measured parameters of poultry meat (Tukey test)

Parameter(1)	Group (2)	LSM	SEM	Difference between chilling(3) fast - slow	P value
pH _{45min}	fast	6.54	0.02	0.02	0.594
	slow	6.52	0.02		
pH _{3h}	fast	6.19	0.01		
pH _{6-8h}	fast	5.95	0.01	-0.06	0.0009
	slow	6.01	0.01		
Temperature _{45min} (°C)	fast	29.88	0.30	1.46	0.001
	slow	28.42	0.30		
Temperature _{6-8h} (°C)	fast	3.87	0.09	-0.44	0.001
	slow	4.31	0.09		
Mass (g)(4)	fast	1633	22	49	0.126
	slow	1584	22		
Colour hue (1-3-5)(5)	fast	4.00	0.09	0.11	0.387
	slow	3.89	0.09		
Colour uniformity (1-7)(6)	fast	5.54	0.04	-0.04	0.476
	slow	5.58	0.04		
Damage (1-3)(7)	fast	1.37	0.02	0.21	0.0001
	slow	1.16	0.02		
L *	fast	53.45	0.17	-0.67	0.007
	slow	54.12	0.17		
a *	fast	0.44	0.04	0.17	0.002
	slow	0.27	0.04		
b *	fast	3.24	0.09	0.45	0.001
	slow	2.79	0.09		
Cutting value (N)(8)	fast	31.64	0.75	3.07	0.004
	slow	28.57	0.75		

LSM - least square mean (*Kleinstes quadratische Mittel*), SEM - standard error mean (*Standart Fehlerwert*)

*Explanation in text (*Erklärung im Text*)

3. Tabelle: Einfluss der Kühlung auf die physische, sinnlich und technisch gemessenen Parameter bei Geflügelfleisch (Tukeytest)

Parameter(1), Gruppe(2), Kühl Differenz(3), Gewicht(4), Farbschattierung(5), Gleichfarbigkeit(6), Verlust (7), Schlachtwert(8)

Table 4

The influence of rearing conditions on physical, sensory and equipment-measured parameters of poultry meat

Parameter	Group	LSM	SEM	(1)Difference between conditions of rearing, 1–2	P value
pH _{45min}	1	6.54	0.02	0.03	0.213
	2	6.51	0.02		
pH _{3h}	1	6.29	0.02	0.20	0.000
	2	6.09	0.02		1
pH _{6-8h}	1	5.97	0.01	-0.01	0.688
	2	5.98	0.01		2
Temperature _{45min} (°C)	1	29.65	0.30	0.99	0.020
	2	28.66	0.30		
Temperature _{6-8h} (°C)	1	4.10	0.09	0.02	0.823
	2	4.08	0.09		
Mass (g)	1	1587	22	-44	0.163
	2	1631	22		
Colour hue (1-3-5)	1	4.07	0.09	0.24	0.058
	2	3.83	0.09		
Colour uniformity (1-7)	1	5.60	0.04	0.08	0.144
	2	5.52	0.04		
Damage (1-3)	1	1.29	0.03	0.04	0.262
	2	1.25	0.03		
L *	1	53.43	0.17	-0.70	0.005
	2	54.13	0.17		
a *	1	0.37	0.04	0.03	0.634
	2	0.34	0.04		
b *	1	3.06	0.10	0.09	0.539
	2	2.97	0.10		
Cutting value (N)	1	31.68	0.76	3.15	0.003
	2	28.53	0.74		

1 - Low amount of ammonia in air (*Weniger Ammonium in der Luft*), 2 - High amount of ammonia in air (*Viel Ammonium in der Luft*)

*Explanation in text (*Erklärung im Text*)

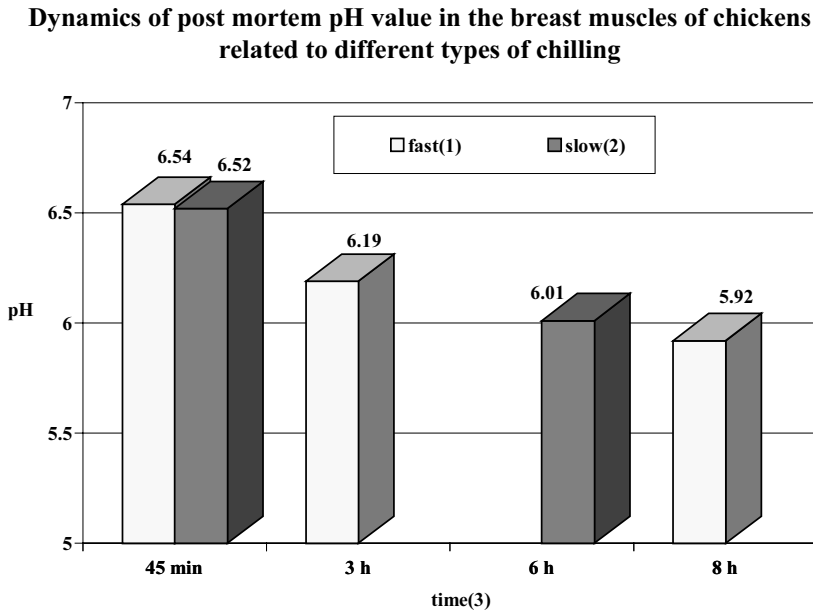
4. Tabelle: Einfluss der Zuchtbedingungen auf die physische, sinnlich und technisch gemessenen Parameter bei Geflügelfleisch

Unterschiede in den Zuchtbedingungen(1), Weitere Bezeichnungen wie in Tabelle 3.

The effect of rearing conditions was evident in two important traits: chickens from better aired cages had darker colour after slaughter (L* value P=0.005: colour hue differed greatly from that for the chickens from less well aired cages, but this difference was not statistically significant). These results are in accordance with the findings of Sackett et al.

(1986). The difference in cutting value after thermal treatment was significant. The breasts of the groups of birds reared in cages with lower presence of ammonia were firmer.

Figure 1



1. Abbildung: Der pH-Wert im Brustmuskel von Broilern bei verschiedenen Kühlmethoden

Schnell(1), Langsam (2), Zeitdauer(3)

Figure 1 shows whether glycolysis was completed 4 hours *post mortem*. Clearly, the pH value continued to decrease even 6 hours *post mortem*. The difference between pH 6.01 and pH 5.92 is statistically significant ($P=0.0009$). This observation is surprising. Generally, in normal conditions glycolysis is completed by 4 hours *post mortem* (Addis, 1986).

CONCLUSIONS

In comparison to the fast-chilled chickens, the slow-chilled carcasses

- displayed brighter and less intensive colour of the breast (measured by equipment, but not by sensory techniques);
- had significantly more tender texture after thermal treatment.

Better aired cages resulted in

- slightly darker breast colour (low L^* value);
- optimal sensory-determined colour.

Variability in breast colour with respect to hue: the fast-chilled breasts from the first breeder (chickens reared in well aired cages) were significantly pinker than the slow-

chilled breasts and also than the fast-chilled breasts from the second breeder (chickens reared in badly aired cages). Glycolysis was not completed even 6 hours *post mortem*.

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In vivo measurement of breast muscle in broiler chickens by means of CT

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ABSTRACT

*In this investigation 72 Arbor Acres genotype broiler chickens were subjected to CT examination at the ages of 2, 3, 4, 5, 6, 7 and 8 weeks. Trial slaughter was then performed and the weight of the filleted breast muscle was recorded. In the evaluation of the CT images produced (6-11 images per broiler) the volume of the breast muscle was determined. The largest muscle area was measured in the plane intersecting the second or the third rib (2nd and 8th week, 6.3 and 34 cm² respectively). The values obtained for the volume of the breast muscle increased from 21.9 cm³ at 2 weeks to 194 cm³ by the 8th week of life. When the weight of the filleted breast muscle was estimated on the basis of the CT images *r* values ranging between 0.46 and 0.88 were calculated. The results obtained indicate that the spatial configuration of the breast muscle changes with age. In the first weeks of life muscle growth in the plane intersecting the second and third rib, taken with birds examined lying in a prone position, is characteristic; with advancing age this growth shifts along the longitudinal axis of the animal in the caudal direction.*
(Keywords: broiler, breast muscle, CT)

ZUSAMMENFASSUNG

Messung des Brustmuskelvolumens bei Broilern mit Computer Tomograph

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*Während des Versuches wurden von 72 Broilern des Genotyps Arbo Accres im Alter von 2,3,4,5,6,7 und 8 Lebenswochen CT-Aufnahmen gemacht. Danach wurden die Versuchstiere probegeschlachtet und das Volumen des filetiert Brustmuskels gemessen. Bei der Auswertung der CT-Aufnahmen (pro Individuum 6-11 Aufnahmen) wurde das Brustmuskelevolumen bestimmt. Die größte Muskeloberfläche konnte auf der Schnittebene der zweiten bzw. dritten Rippe gemessen werden (2. und 8. Woche, 6,3 und 34 cm²). Die Werte Brustmuskelvolumens erhöhten sich von 21,9 cm³ im Alter von 2 Wochen auf 194 cm³ in der 8. Lebenswoche. Aufgrund der CT-Aufnahmen wurde die Masse des Brustmuskels geschätzt, die „*r*“-Werte lagen zwischen 0,46 und 0,48. Unseren Ergebnissen nach ist die räumliche Ausdehnung des Brustmuskels vom Lebensalter abhängig. In den ersten Wochen ist der Muskeleinbau in Höhe der zweiten und dritten Rippe (in Bauchlage untersucht) charakteristisch, mit fortschreitendem Alter verschiebt sich dieser an der Längsachse des Tieres in Richtung caudalis.*
(Schlüsselwörter: Broiler, Brustmuskel, CT)

INTRODUCTION

In the field of experimental animal research there is an increasing need for the development of non-invasive methods which enable the number of animals required to be reduced without any detriment to the accuracy or authority of the conclusions reached. Therefore the further development of non-invasive *in vivo* methods for practical application is necessary. In experiments in nutrition, physiology and genetics body composition is usually determined by means of comparative slaughter followed by chemical analysis. However, this cannot be used to follow age-related changes in the same animal. *Fekete* (1992) reviewed the methods for estimating body composition in live animals.

One of these methods is X-ray computer tomography (CT), first applied in animal research by *Skjervold et al.* (1981). The Digital Imaging Centre at the Pannon University of Agriculture was put into operation in 1990 (*Horn*, 1991), and has since that time accommodated a number of experiments.

Using broilers, *Bentsen et al.* (1986; 1989), and also *Bentsen and Sehested* (1989) measured abdominal fat and breast muscle quantity by means of CT. *Svihus and Katle* (1993) examined five-week-old broilers in three consecutive years, using the method of *Bentsen* cited above. In testing the estimation of abdominal fat and breast muscle with a stock originating from the same year, independent correlations in the range of $r=0.63-0.70$ and $0.54-0.76$ respectively between the estimated and the measured values were ascertained.

By means of the correlation between variables formulated from pixel density values and the results of whole body analysis an estimation equation has been developed for the determination of body fat content. Equations constructed by MGLH and main component analysis enable a relation of r^2 value $0.71-0.93$ between calculated and measured fat content to be determined *Romvári et al.* (1994). CT has been applied in the field of broiler nutrition to determine relative tissue composition in two body segments (two treatments, at the ages of 28 and 49 days). By means of the HU index calculated, independent of body weight, groups subjected to different nutritional conditions proved, on the basis of their fat content, clearly distinguishable from each other *Romvári*, (1996).

Within the framework of the EU-financed Copernicus programme, between 1994 and 1996 long-term experiments on broilers were in progress at this faculty in the form of a Danish-Hungarian cooperation project. In addition to standard broilers specialised lines produced by the partner establishment were also subjected to comparison. CT examinations constituted a part of these comparative studies; serial images were prepared at regular intervals, at the ages of 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14 and 16 weeks. For each bird (from a total of almost 1000 broilers, with two replicates) the cross-section of the breast muscle was determined.

The objectives set for this study were the *in vivo* estimation of the weight of the breast muscle of broiler chickens and the examination of muscle tissue development between the ages of two and eight weeks.

MATERIALS AND METHODS

The examinations were performed on Arbor Acres (AA) broilers of standard genotype (36 of each sex), within a weight range of 300 to 2000 g. The birds forming the experimental group originated from the stock used in comparative performance studies performed at the university Department of Poultry Breeding Science, and, as such, were housed in a livestock building operating under closed, intensive conditions, with deep

litter and a cubicle system, at the Experimental Livestock Production Site of the university faculty. The broilers were fed in accordance with the standard two-phase programme specified by the distributor.

At the ages of 2, 3, 4, 5, 6, 7 and 8 weeks 6 experimental birds of each sex were subjected to CT examination after being fasted for ten hours. These examinations were performed by means of the Siemens Somatom DRG equipment of the Diagnostics Centre, the slice thickness used being 8 mm and the step 8 mm; 15-25 CT images per bird were taken. The birds were examined lying in a prone position, without the use of anaesthetic.

In the evaluation of the cross-sectional images the surface area of the breast muscle was determined (involving between 6 and 11 images); pixel density data were also collected from each of the scans by means of an appropriately designed computer programme (Pannon University of Agriculture, Digital Imaging Centre, Kaposvár). Hounsfield variables were then calculated for the formulation of prediction equations, as described by *Romvári et al.* (1996). In the present work the extreme density values (corresponding to bone and air) were excluded, only those corresponding to muscle and fat being retained, i.e. the range from +200 to -200 on the Hounsfield scale (water=0). Each set of 10 consecutive HU values was taken collectively, resulting in 40 Hounsfield variables (HUv). These variables were used for the construction of three dimensional histograms (3D) from the frequency data, with negative exponential interpolation.

Subsequent to the CT examination trial slaughter was performed by cervical dislocation and the weight of the filleted breast muscle was recorded. In the evaluation of the data obtained the effect of sex was analysed by means of one-way ANOVA, and linear regression models were formulated for the purpose of defining the relations of the weight of muscle to its surface area and to its volume.

RESULTS AND DISCUSSION

Table 1 gives the mean body weight values determined for the mixed-sex groups at each examination, and also the weight of the breast muscle, filleted in the process of trial slaughter.

Table 1

Values for body weight and breast weight in the experimental stock examined, according to age group

Age (weeks) (1)	Live weight (g) (2)		Breast weight (g) (3)	
	average (4)	SD	average	SD
2	317	5.0	30	2.6
3	573	27	64	6.0
4	875	36	103	9.6
5	1303	121	172	15
6	1605	157	204	23
7	1908	135	285	16
8	2415	317	353	43

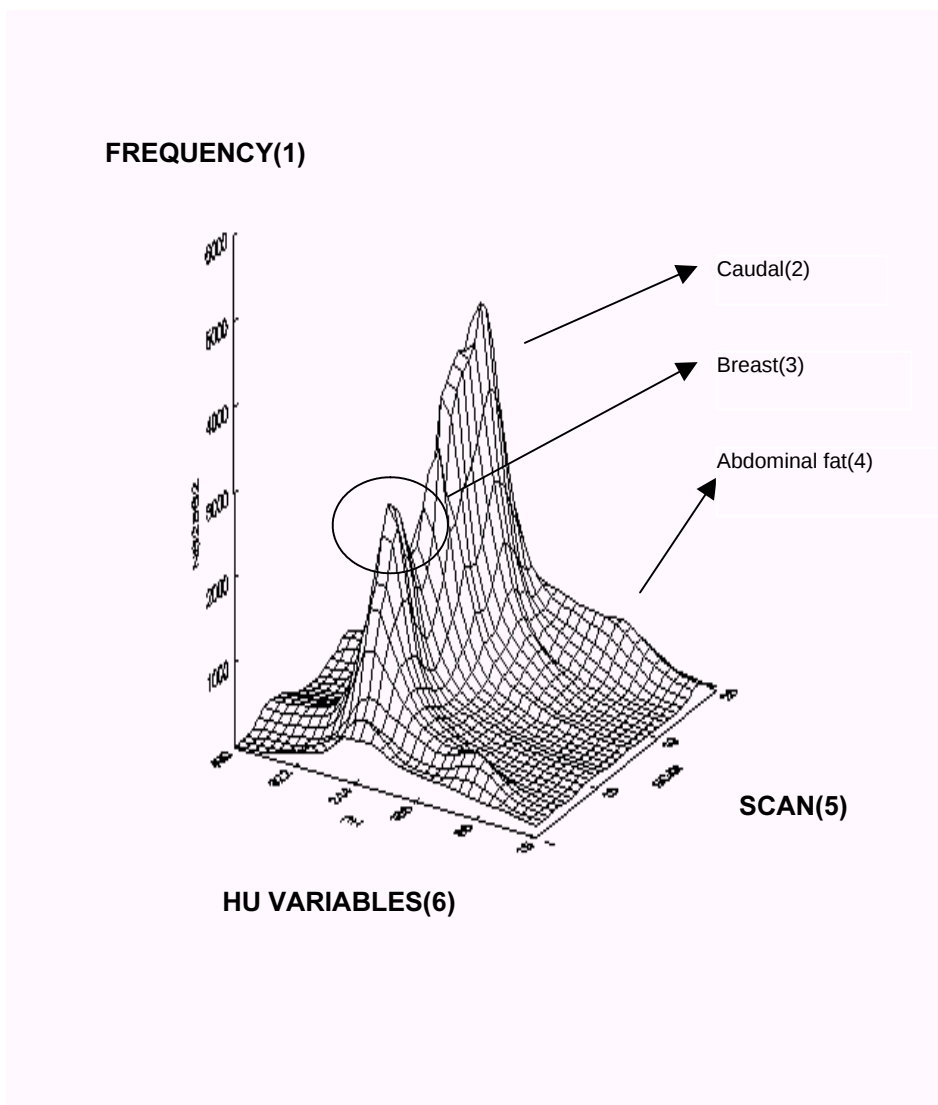
1. Tabelle: Körpergewicht und Brustgewicht im untersuchten Bestand nach Altersgruppen

Alter(1), Lebendgewicht(2), Brustgewicht(3), Durchschnitt(4)

The 3D histogram shown in *Figure 1* was produced on the basis of 24 images.

Figure 1

3D histogram for six-week-old broilers



1. Abbildung: 3D Histogram von einem Broiler im Alter von 6 Wochen

Frequenz(1), Caudales Ende(2), Brustmuskel(3), Abdominales Fett(4), Aufnahme(5), HU Variable(6)

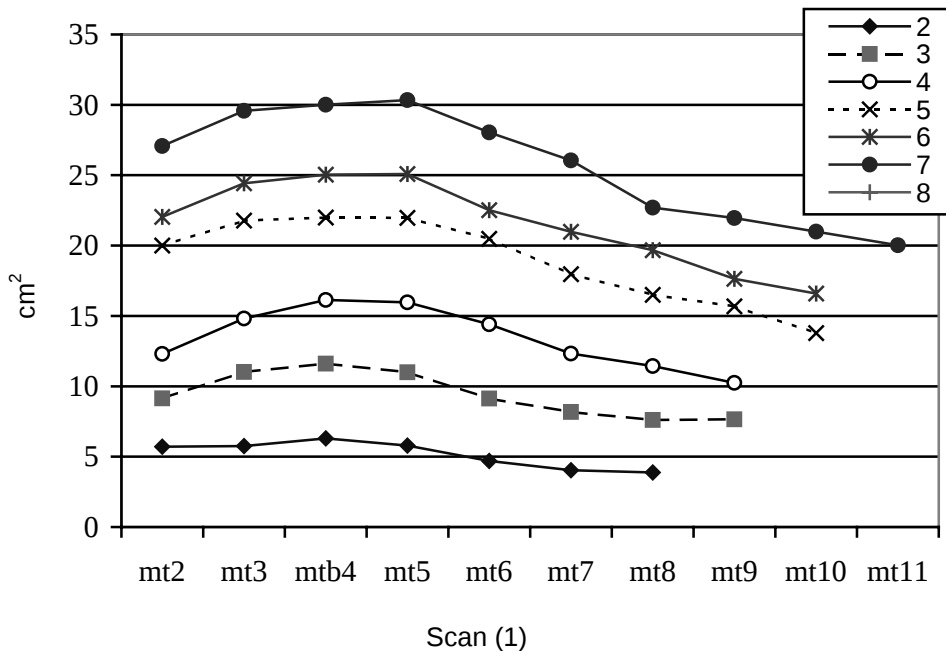
In the muscle range on the histogram there emerge two peaks, clearly distinguishable, the first representing the area of the breast, the second that of the thigh.

In the range of the fat tissue, in addition to a fat depot in the region of the neck very pronounced abdominal fat deposition in the region of the pelvis is also evident.

On the basis of the 3D histogram, *Figure 2* illustrates changes in the mean values for breast muscle cross-sectional area for the respective age groups, in the range selected for the measurement of the breast muscle; these exhibit clearly visible maximum values. The largest muscle surface area was measured in the plane intersecting the second or the third rib, and, with the birds examined lying in prone position, the end of the clavicle (s3). It can also be observed that as age progresses the highest value shifts in the caudal direction (s4), indicating changes with the progress of time in the geometric configuration of the breast muscle.

Figure 2

Mean muscle surface area values, according to age group



2. Abbildung: Durchschnittliche Muskeloberfläche nach Altersgruppen

Aufnahme(1)

Table 2 shows the largest breast muscle surface area (maximum muscle surface) for the mixed sex groups determined at each examination, and also the breast muscle volume values calculated from all of the images evaluated.

Table 2

Muscle surface area and breast volume values for the experimental stock examined, according to age group

Age (weeks) (1)	Max. muscle surface (cm ²) (2)		Breast volume (cm ³) (3)	
	average (4)	SD	average	SD
2	6.3	0.61	21.9	2.6
3	11	0.70	49.7	6.0
4	16	1.2	76.4	6,9
5	21	1.6	118	15
6	25	1.8	135	36
7	30	1.9	169	35
8	33	3,5	194	39

2. Tabelle: Brustoberfläche und Brustvolumen im untersuchten Bestand nach Altersgruppen

Alter(Wochen)(1), Maximale Muskeloberfläche(2), Brustvolumen(3), Durchschnitt(4)

In addition, the effect of sex within the respective age groups was analysed by means of variance analysis (Table 3). This table illustrates quite clearly that body weight differs between the two sexes from the age of two weeks, while sex difference in breast weight and breast volume, i.e. the highest muscle cross-section values, emerges from the age of five weeks.

Table 3

Effect of sex on the parameters examined

Age (weeks) (1)	2	3	4	5	6	7	8
Live weight (2)	NS	***	***	***	***	***	***
Breast weight (3)	NS	NS	NS	*	**	NS	**
Max. muscle surface(4)	NS	NS	NS	***	**	*	*
Breast volume (5)	*	NS	NS	*	*	*	*

* P<0.1, ** P<0.05, *** P<0.01

3. Tabelle: Einfluss des Geschlechts auf die untersuchten Parameter

Alter(Wochen)(1), Lebendgewicht(2), Brustgewicht(3), Maximale Muskeloberfläche(4), Brustvolumen(5)

The weight of the filleted breast muscle was estimated by means of a linear regression model; breast muscle volume calculated on the basis of the CT images, i.e. the highest muscle cross-sectional area value, was used as the independent variable (Table 4).

Table 4**The r values determined for the estimation of breast muscle weight**

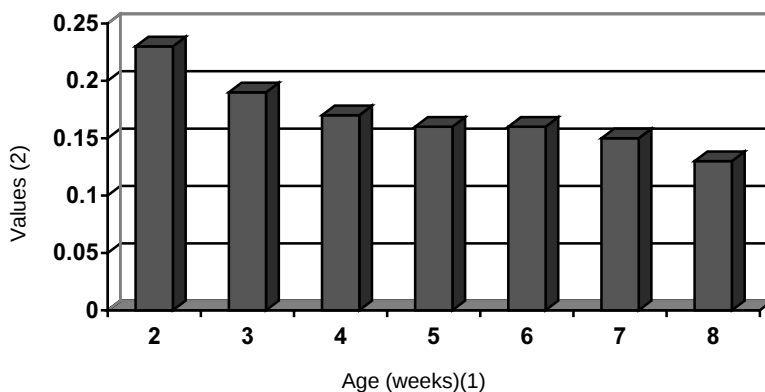
Age (weeks) (1)	Volume (2)	Max. surface (3)
2	0.40	0.33
3	0.63	0.66
4	0.46	0.49
5	0.73	0.76
6	0.68	0.83
7	0.62	0.65
8	0.51	0.58

4. Tabelle: Die r-Werte für die Einschätzung des Brustmuskengewichts

Alter (Wochen)(1), Volumen(2), Max.Oberfläche(3)

The low correlation values obtained at the age of two weeks can be explained primarily by the low body weight of the birds. This weight range (250–350 g) is near the lower limit of the CT examination. In the interpretation of the data obtained the relatively low number of samples for each group (n=12) should also be taken into account.

The ratio of maximum muscle surface area to values for muscle surface area totalled for each image, and also changes in this ratio, are illustrated in figure 3. It can be observed that with progressing age this value decreases, indicating changes in the spatial configuration of the breast muscle.

Figure 3**Ratio of max. muscle surface area to totalled muscle cross-section**

3. Abbildung: Verhältnis der maximalen Muskeloberfläche und des gesamten Muskelquerschnittes

Alter (Wochen)(1), Werte(2)

On the basis of the evaluation of the cross-sectional images and the relations depicted in figures 2 and 3 it can be ascertained that the spatial configuration of the breast muscle changes with age. In the first weeks of life muscle growth in the plane intersecting the second and third rib, taken with birds examined lying in a prone position, is characteristic; with advancing age this growth shifts along the longitudinal axis of the animal in the caudal direction.

CONCLUSIONS

By means of non-invasive CT examination the weight of the breast muscle can, where body weight is above 500 g, be determined with an appropriate degree of accuracy.

Estimation determined with a single image, based on the highest muscle cross-section value, produces results similar to those obtained by estimation of volume on the basis of 6 to 11 images.

CT provides an unequalled possibility for the geometric configuration of the breast muscle to be examined by means of repeated imaging of the same animal. Thus, an objective set for further study is the 3D portrayal of the breast muscle, and, on the basis of this, the comparison of muscle development in different genotypes.

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Current situation of the Zagorje turkey in Croatia

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ABSTRACT

The Zagorje turkey has been reared for more than four centuries in Croatia, in the region of Hrvatsko Zagorje, the major part of which today belongs to the present Krapina-Zagorje and Varaždin counties. The current population of the breeding flock is estimated at 1506 birds. The research was carried on 147 family farms in the region of Hrvatsko Zagorje which rear turkeys of the Zagorje turkey type. A total of 753 birds were weighed and the average weight of cocks and hens was 6.8 kg and 3.9 kg respectively. According to the farmers' reports, the average annual laying rate was 20.6 eggs of which 16.7 adult birds are reared. As regards feather colour, the Zagorje turkey may be subdivided into five varieties of which the bronze variety is the most numerous (50%). The body measurements of the present Zagorje turkeys, such as the body length, body width and the breast bone length and breast depth are not significantly different from those established in 1937.

(Keywords: turkey, body measurements, Croatia)

ZUSAMMENFASSUNG

Gegenwärtige Situation der Zagorianer Truthühner in Kroatien

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Die Zagorianer Truthühner werden bereits seit mehr als 4 Jahrhunderten im kroatischen Zagorje gezüchtet, was heute zum größten Teil in den Komitaten Krapina-Zagorje und Varaždin liegt. Die Zahl der Zuchttierpopulation beträgt gegenwärtig 1506 Tiere. Die Untersuchungen erstreckten sich auf 147 Familienfarmen in Zagorje, die diesen Truthühnertyp aufziehen. Insgesamt wurden 753 Tiere gewogen und festgestellt, dass das Durchschnittsgewicht der männlichen Tiere 6,8 kg, das der Truthennen 3,9 kg beträgt. Die durchschnittliche Legeleistung der Truthennen liegt bei jährlich 20,6 Stück, wovon 16,7 Tiere aufgezogen werden. Aufgrund der Farbe des Gefieders werden 5 Varianten unterschieden, aber zu 50% dominiert das bronzefarbige Gefieder. Die Körpermaße der Zagorianer Truthühner - d.h. Rumpflänge und -breite, die Brustbeinlänge sowie die Brusttiefe - weichen nur unbedeutend von den Werten ab, die 1937 festgestellt wurden.

(Schlüsselwörter: Truthühner, Körpermaße, Kroatien)

INTRODUCTION

Turkeys arrived in Europe soon after the discovery of America and spread very fast throughout Europe, at an annual rate of 40-50 km (Crawford, 1992).

In Croatia, to be precise in Hrvatsko Zagorje, the first records on turkeys date back as far as 1561 (quotation from: Kodinetz, 1940) and ever since turkeys have been reared in this geographically small but culturally and historically precisely defined region. During the said four-century period, the influence of turkeys from other regions was very small. This conclusion is based on the oral tradition and non-existence of written documents on turkey trading in the otherwise well documented, ecclesiastical and secular history of Hrvatsko Zagorje. The only known influence of other breeds (turkey populations) on the breeding of the Zagorje turkey might be through sixty birds imported from France in the second half of the 19th century (Kodinetz, 1940). All this is an indication of a long and isolated turkey rearing tradition in the region of Hrvatsko Zagorje, which has resulted in specific features by which this kind of poultry may be characterised as a breed called the Zagorje turkey.

In Europe the Zagorje turkey became known in the thirties of the 20th century when it was exported to many European countries and the annual exports amounted to 40,000-50,000 birds. This activity ceased at the beginning of the World War Two, when the Zagorje turkey fell into oblivion, in the economic, rearing and scientific sense.

The first and the only research results on the Zagorje turkey were collected and published by Kodinetz in 1940. Within the period between 1936 and 1937 Kodinetz investigated the situation of the Zagorje turkey population in the region which is today included, by its major part, in the Krapina-Zagorje and Varaždin Counties. The author estimated that the population of the breeding flock in that region was about 28,000 birds at that time.

Among other examinations, Kodinetz (1940) took the weights and measures of a sample of some hundred birds during their growth within the age between 0 and 28 weeks. The main conclusion drawn from this research was that in the Zagorje turkey skeleton growth is completed, i.e. maturity is reached at the age of 26-28 weeks when the body measurements are taken for the purpose of the exact external assessment, and the body weight in week 28 was 6.01 kg for cocks and 3.95 kg for hens. Jaap et al. (1939) (quotation from Nixey and Grey, 1989) came to a similar conclusion and reported that skeleton growth in the turkey ended after 22 weeks in hens and 24-26 weeks in cocks. Kodinetz also mentions 8 turkey varieties as regards feather colour, with bronze and grey colours prevailing.

In the course of 1996 a project for the preservation, protection and expansion of the Zagorje turkey was initiated in Croatia, which included research of the current situation of the Zagorje turkey population in its century-old habitat. The aim of our work is to establish the present number and body measurements of the Zagorje turkey breed in Croatia.

MATERIALS AND METHODS

In early spring 1999 a survey of the Zagorje turkey of Krapina-Zagorje and Varaždin counties was performed, which included visits to turkey rearing family farms, the measurements involving only birds which, by their phenotypic appearance,

corresponded to the description provided by Kodinetz in 1940 and which were selected for reproduction in the following year. The following indicators were taken into account:

- number of birds selected for reproduction per farm
- body weight
- body length
- body width
- breast bone length
- breast depth
- feather colour subdivided in five basic varieties
- number of reared young turkeys per hen, as reported by farmers
- estimate of the total number of Zagorje turkeys based on the data collected at the farms surveyed.

Body weights and measurements were taken in accordance with the procedure described by Kodinetz in 1940. The age of the birds examined ranged between 9 and 11 months, which, according to the data from the literature (Kodinetz, 1940) coincides with the time when skeleton growth has been completed.

RESULTS AND DISCUSSION

During the Hrvatsko Zagorje survey a total of 147 turkey rearing family farms were visited. This is about one half of the turkey rearing farms in the region, but we estimate with high probability that the number and ratio of the types of birds on these farms are equal to the farms covered by this research.

The *Table 1* shows that the population of the breeding turkeys in Hrvatsko Zagorje is very limited and amounts to as few as 1500 birds. The sex ratio of the birds examined was 1 : 3.73 and an average of 4.79 birds per farm were selected for reproduction. As regards feather colour, i.e. varieties of the Zagorje turkey, the prevailing colours are bronze (50%), grey (18%) and bright (22%).

The comparison between the current number of the Zagorje turkey population and that established in 1937 (Kodinetz, 1940) revealed a drastic reduction, by almost 18 times, and this was the main reason for the initiation of the action aimed at saving this interesting and valuable poultry species.

As regards the body weight of the Zagorje turkeys surveyed we have to express certain reserve in respect of the results shown in *Table 2*. That is to say, the current population of the Zagorje turkey is being reared in small flocks and under so-termed 'free conditions', i.e. the birds spend some time on meadows, pasture grounds, in orchards and in tufts, with quite varied nutritional regimes, and all these elements affected the body weight and resulted in relatively high variation coefficients. Yet, if we compare the current body weight of Zagorje turkeys with that reported by Kodinetz in 1940, we can see that the figures are very much alike, but we must point out that Kodinetz's results refer to younger and, therefore, lighter, birds.

The annual laying rate of the turkey hens examined was 20.6 eggs, which is a relatively high rate in view of the total population, but considering the high variability of the results (var. coeff. = 46.72%) and the fact that they were based only upon the breeders' reports, it is not possible to draw a more specific conclusion. The same is true as regards the number of turkey chickens reared per hen, but still, we can see that the hatching and rearing loss is small and amounts to approx. 20%.

Table 1

Number of Zagorje turkeys in the counties of Krapina-Zagorje and Varaždin

Sex (1)	County(2)						Total (11)		
	Krapina-Zagorje			Varaždin					
	Variety (3)	Examined* (4)	Estimated# (5)	Variety	Examined*	Estimated#	Variety	Examined *	Estimated #
♂	black(6)	8	16	black	5	10	black	13	26
	bronze(7)	51	102	bronze	30	60	bronze	81	162
	grey(8)	18	36	grey	10	20	grey	28	56
	bright(9)	25	50	bright	9	18	bright	34	68
	yellow(10)	2	4	yellow	1	2	yellow	3	6
	Total	104	208	Total	55	110	Total	159	318
♀	black	31	62	black	16	32	black	47	94
	bronze	186	372	bronze	116	232	bronze	302	604
	grey	66	132	grey	41	82	grey	107	214
	bright	92	184	bright	39	78	bright	131	262
	yellow	4	8	yellow	3	6	yellow	7	14
	Total	379	758	Total	215	430	Total	594	1188
							Grand total* ♂+♀ (12) 753		
							Grand total# ♂+♀ 1506		

* Number of birds covered by the research (*Versuchstierbestand*)

Estimated number of birds at approx. 50% family farms not covered by this research (*Von der geschätzte Gesamtzahl der Truthühner wurden nur 50% in den Versuch einbezogen*)

1. Tabelle: Bestand an Zagorianer Truthühnern in den Komitaten Krapina-Zagorje und Varaždin

Geschlecht(1), Komitat(2), Farbe(3), Anzahl der Versuchstiere(4), Geschätzte Bestandszahl(5), Schwarz(6), Bronzefarbig(7), Grau(8), Hellglänzend(9), Gelb(10), Gesamt(11), Insgesamt(12)

Table 3 shows average body measurements for the Zagorje turkeys examined at an average age of 10.5 months, which means that skeleton growth was completed and that the results may be compared with those of *Kodinetz* from 1940. At that time the birds presented the body measurements shown in Table 3.

The comparison of the Zagorje turkey measurements from 1937 and 1999 shows that the body lengths are quite similar and that the present-day hens feature a somewhat narrower body. The breast bone length of the current population is some 1.5 cm longer and the breast depth of the 1999 hens is, on average, 0.7 cm larger.

Table 2**Weight of adult birds, annual laying rate and number of young turkeys per hen**

Sex (1)	Statistical indicator (2)	Body weight in kg (3)	Annual laying rate No. of eggs(4)	Young turkeys per hen/year(5)
♂	n	159	-	-
	☒	6.87	-	-
	S	1.27	-	-
	V	18.48	-	-
♀	N	594	159	159
	☒	3.97	20.68	16.69
	s	0.63	0.54	8.66
	V	19.90	46.72	51.89

2. Tabelle: Gewicht der aufgezogenen Truthühner, jährliche Legeleistung, aufgezogene Küken pro Truthenne

Geschlecht(1), Statistische Kennziffer(2), Körpergewicht(3), Jährliche Legerate, Eierzahl(4), Aufgezogene Küken pro Truthenne(5)

Table 3**Zagorje turkey body measurements in 1999 and 1937**

Sex (1)	Statistical Indicator (2)	Body(3)				Breast(6)			
		Length cm(4)		Width cm(5)		Breast bone length cm(7)		Breast depth cm (8)	
		1999	1937	1999	1937	1999	1937	1999	1937
♂	N	159	48	159	48	159	48	159	48
	☒	29.80	29.06	9.98	10.61	16.35	14.06	20.53	20.47
	S	2.31	0.26	0.97	0.34	1.38	0.24	1.61	0.28
	V	7.75	0.91	9.73	3.23	8.44	1.77	7.87	1.4
♀	N	594	70	594	70	594	70	594	70
	☒	24.40	24.44	8.81	9.43	12.71	11.76	15.70	16.40
	S	1.42	0.29	0.92	0.19	1.14	0.16	1.11	0.23
	V	5.85	1.21	10.53	2.06	9.04	1.33	7.09	1.4

3. Tabelle: Körpermaße der Zagorianer Truthühner 1999 und 1937

Geschlecht(1), Statistische Kennziffer(2), Körper(3), Länge(4), Breite(5), Brust(6), Brustbeinlänge(7), Brusttiefe(8)

CONCLUSIONS

The number of the current population of the Zagorje turkey reproduction flock is estimated at as few as 1500 birds, which is about 18 times fewer than in 1937.

The external features of the Zagorje turkey, body length and width, breast bone length and breast depth of the remaining population did not change even slightly in the period between 1937 and 1999.

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SECTION 4

WATERFOWL AND OTHER SMALL ANIMAL BREEDING SCIENCE



Effects of two different watering tray types on the behaviour of geese

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ABSTRACT

For the development of rearing and laying technologies under intensive conditions the examination of the behaviour of geese is of great importance. Feeding, drinking, resting, preening, playing and social behaviour types were examined with two different watering tray types (free flow and ventile). On comparison of the results obtained with those presented in the literature it could be established that changes in comfort behaviour types in geese in the first 6 weeks are similar to those observed in Pekin, Muscovy and mulard ducks. Differences were found in the frequency of occurrence of the various behavioural forms. The decrease observed in feeding, drinking and playing time and the higher proportion of resting time inform us that activity in geese is lower than in ducks in the first weeks of rearing. In accordance with the results of the experiment it may be suggested that ventile watering trays be used for geese, as is already the practice with ducks. The introduction of this watering method could help to minimise the extent of feed and water wastage, since it induces the feed searching behaviour pattern. Lack of this behaviour, as is common with intensively kept geese, causes boredom resulting in behavioural anomalies.

(Keywords: geese, behaviour, watering tray type)

ZUSAMMENFASSUNG

Einfluß von zwei verschiedenen Tränketypen auf das Verhalten von Gänsen

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Zur Entwicklung einer intensiven Haltungsmethode für Gänse hat die Erfassung der Verhaltensformen eine große Bedeutung. In unseren Untersuchungen, bei der zwei verschiedene Tränken - die herkömmliche Trogränke und die Nippeltränke - verwendet wurden, haben wir folgende Verhaltensformen unterschieden: Fressen, Trink-, Ruhe-, Spiel-, Putz-, und Sozialverhalten. Beim Vergleich unserer Ergebnisse mit denen der Fachliteratur konnte festgestellt werden, daß das Verhalten der Gänse in der ersten sechs Lebenswochen dem der Peking-, Flug-, und Mulard Enten sehr ähnlich ist. Unterschiede konnten in der prozentualen Häufigkeit der einzelnen Verhaltensformen beobachtet werden. Beachtet man die Unterschiede im Fressen, Trinken und Spielen und die längeren Ruhezeiten, kann man schlussfolgern, daß die Gänse in den ersten sechs

Lebenswochen weniger aktiv sind als Enten. Laut unseren Forschungen kann es sinnvoll sein, die bei Enten schon bewährten Nippeltränken zu verwenden. Deren Benutzung könnte die Futter- und Trinkwasserverluste reduzieren, denn diese lösen das Weideverhalten aus, aber infolge des Weidemangels können in der Intensivhaltung durch Langeweile und das daraus resultierende Verhalten Anomalien auftreten.

(Schlüsselwörter: Gänse, Verhalten, verschiedene Tränketypen)

INTRODUCTION

During intensive animal production various factors are prerequisite regardless of seasonal changes. To achieve optimal circumstances it is of crucial importance to study the behavioural response of geese to the conditions provided.

This experiment was aimed, on one hand, at mapping the basic activities of the goose within closed, intensive keeping conditions, based on literature data relating to other types of fowl (Muscovy and Pekin duck), and on the other hand at studying the effects of two different watering tray types (free flow and ventile) on the behavioural patterns of the goose.

MATERIALS AND METHODS

The experimental group for the ethological study was taken from Grey Landes goose stock of the Pannon University of Agriculture Experimental and Study Farm. Ten birds of each sex were placed in each of 18 boxes in a random block arrangement. Two watering tray types were divided evenly between the boxes. The experimental stock was reared under closed, intensive conditions following common nurturing and feeding technology. The experiment and the observations were conducted in accordance with recent studies on ducks (Reiter *et al.*, 1995) and with our previous experiments (Molnár *et al.*, 1998).

Observations were made in 6 of the 18 boxes, representing 3 boxes per watering tray type. Video recordings were made of the behaviour of the birds 3 times a week, these lasting one hour per box.

During analysis of the tapes data for further analysis were taken in one minute intervals. Six behaviour patterns – feeding, drinking, resting, social behaviour, preening and playing – were observed on the tapes, to determine in practical terms their presence or absence at a given moment and also their frequency, i.e. how many of the 10 birds showed the given behaviour at that time. Behaviour terms were standardised by use of the relevant entries in the Lexicon of Ethology (Czakó, 1985). Statistical analysis was performed by χ^2 test and percentage rate.

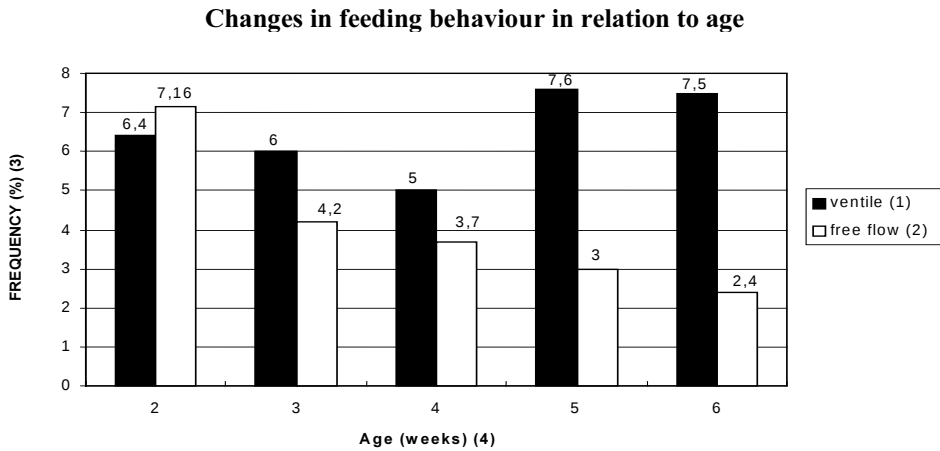
RESULTS AND DISCUSSION

The main points of the results obtained can be listed as follows.

During intensive keeping all the 6 behaviour patterns changed with advancing age in the case of both watering tray types.

Time taken up by *feeding* and its frequency (*Fig. 1*) decreased where the free flow watering tray was used, with a significant ($p \leq 0.05$) value between weeks 2 and 3. It decreased by 4.5% during the experimental period, calculated on the basis of total frequency. Where the ventile watering tray was used the frequency also decreased until week 4 but during weeks 5-6 it suddenly showed a significant ($p \leq 0.05$) upswing, reaching 7.5-7.6%, which exceeded even the initial value of 6.4%.

Figure 1

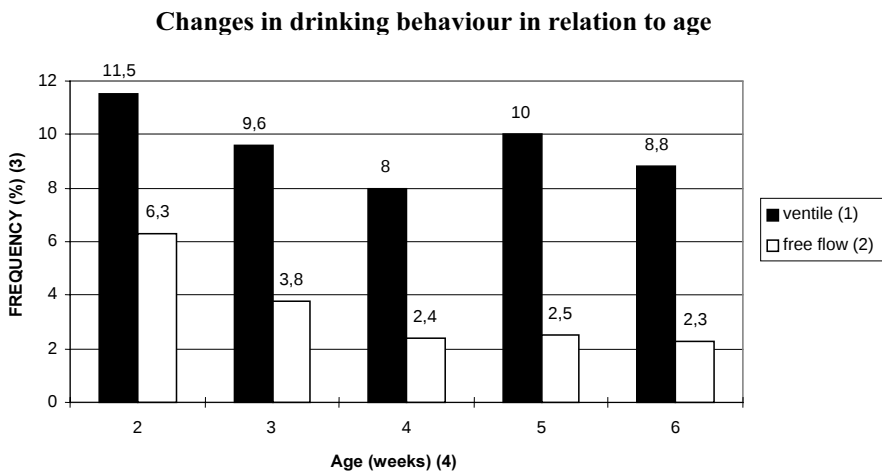


1. Abbildung: Das Fressverhalten in den verschiedenen Lebenswochen

Nippeltränke(1), Trogtränke(2), Häufigkeit des Verhaltens(3), Lebenswochen(4)

Frequency of occurrence of *drinking* behaviour (Fig. 2) followed the pattern shown above. Significant difference ($p \leq 0.05$) was observed with the free flow watering tray in weeks 2-3 and 3-4. Total reduction in drinking frequency was 4% during the experimental period. Where the ventile watering tray was used a significant upswing occurred after week 4.

Figure 2

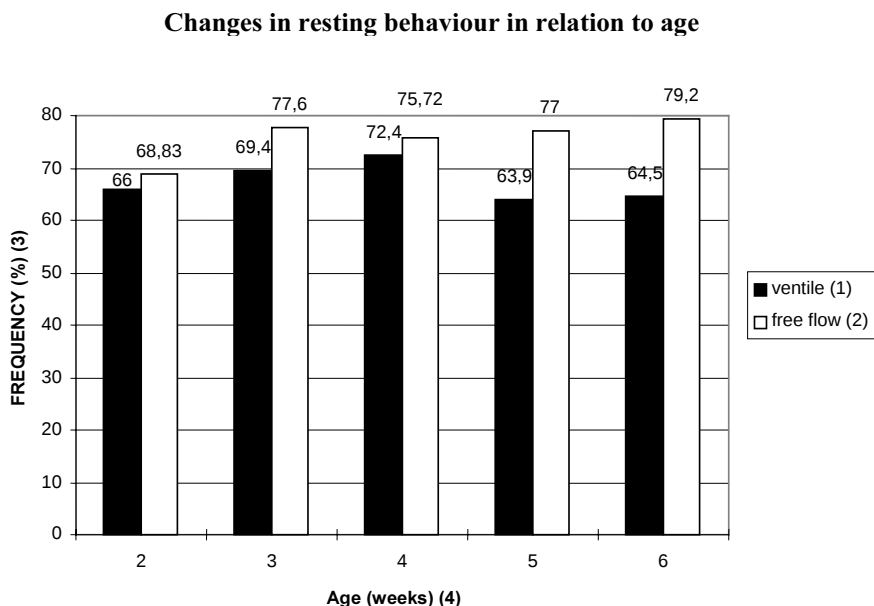


2. Abbildung: Das Trinkverhalten in den verschiedenen Lebenswochen

Nippeltränke(1), Trogtränke(2), Häufigkeit des Verhaltens(3), Lebenswochen(4)

Resting frequency (Fig. 3) turned out to be the opposite of the two previous patterns. Where the free flow watering tray was used the frequency of resting increased from the initial value of 68.8% to 79.2%. Between weeks 2 and 3 significant difference ($p \leq 0.05$) was found between the data. The resting rate increased until week 4 where the ventile watering tray was used (66% and 72.4%), followed by a considerable drop (63.9-64%). Differences showed significance ($p \leq 0.05$) between weeks 2-3, 3-4 and 4-5.

Figure 3



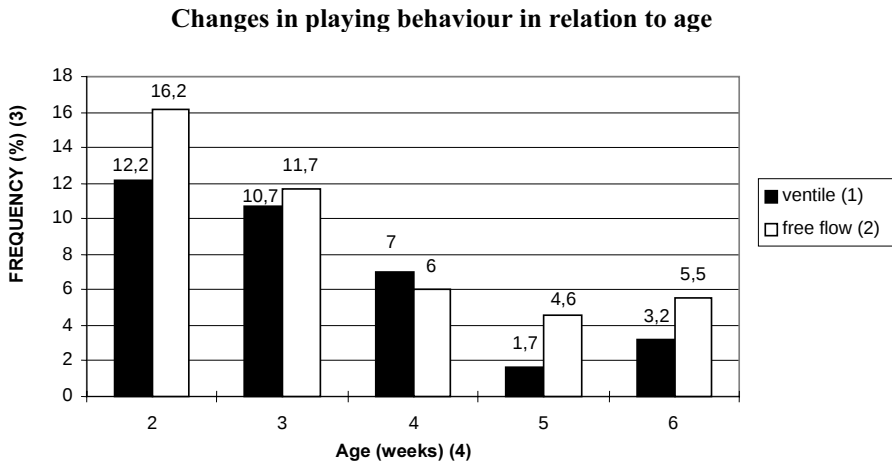
3. Abbildung: Das Ruheverhalten in den verschiedenen Lebenswochen

Nippeltränke(1), Trogtränke(2), Häufigkeit des Verhaltens(3), Lebenswochen(4)

Playing frequency showed a similar pattern with the geese using both types of watering tray (Fig. 4). It decreased steadily up to week 5, then began to rise in both cases but failed to reach the original value. Statistical analysis showed significant differences ($p \leq 0.05$) in all instances.

As can be seen in Fig. 5, where the free flow watering trays were used the occurrence of *social* behaviour remained below the frequency of the other behaviour patterns throughout the experimental period (at 0.4-0.7%), except for an upswing between weeks 4 and 5 (1.5%) followed by a drop back to the initial value. The difference was significant ($p \leq 0.05$). In the other group the increase began in week 4, but a real upswing (reaching 6.2%) could be observed in week 5, also followed by a drop back to the initial value of 0.6-0.7%. Changes were also significant at $p \leq 0.05$ level.

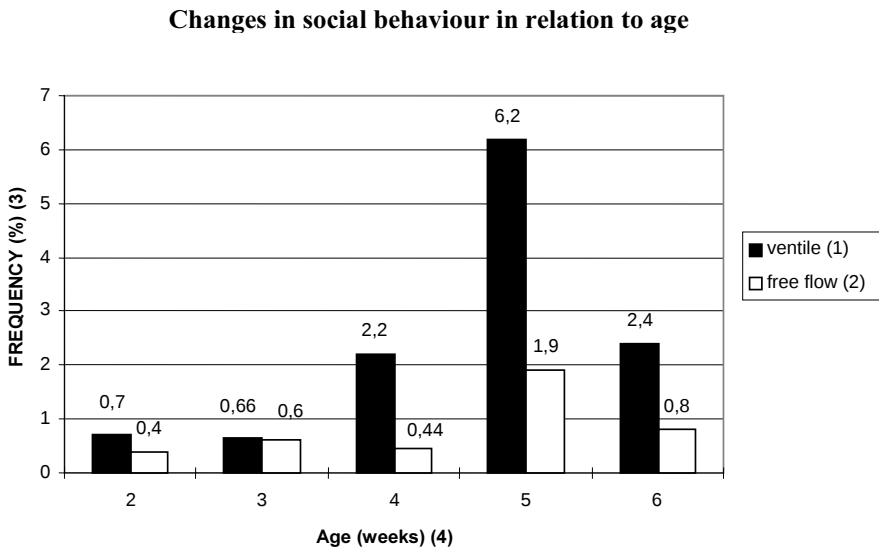
Figure 4



4. Abbildung: Das Spielverhalten in den verschiedenen Lebenswochen

Nippeltränke(1), Trogränke(2), Häufigkeit des Verhaltens(3), Lebenswochen(4)

Figure 5



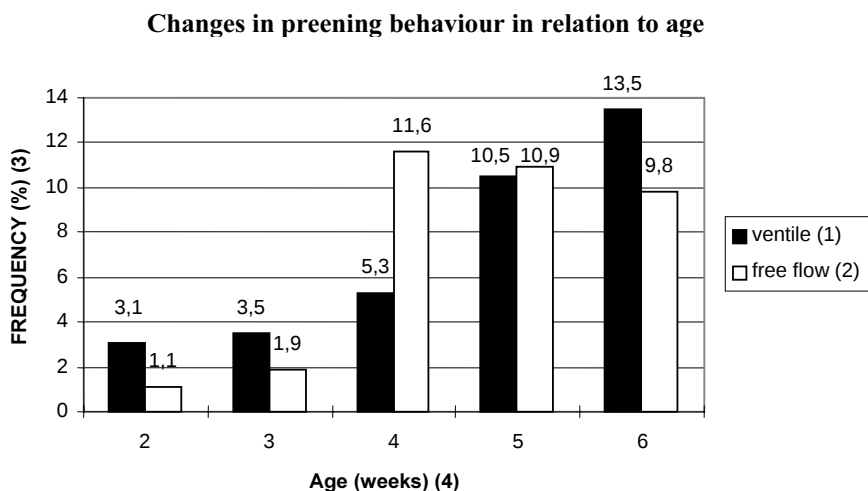
5. Abbildung: Das Sozialverhalten in den verschiedenen Lebenswochen

Nippeltränke(1), Trogränke(2), Häufigkeit des Verhaltens(3), Lebenswochen(4)

In the *preening* behaviour pattern (Fig. 6) a peak was apparent in week 4. Before the peak this type of behaviour could be hardly detected, and low frequency values were

also recorded after the peak. In the groups with the ventile watering tray this peak failed to appear but frequency of occurrence increased steadily until week 6. This increment was significant ($p \leq 0.05$) between weeks 3-4, 4-5 and 5-6.

Figure 6



6. Abbildung: Das Putzverhalten in den verschiedenen Lebenswochen

Nippeltränke(1), Trogtränke(2), Häufigkeit des Verhaltens(3), Lebenswochen(4)

The effect on behaviour of the differences between the two types of drinking technology is indicated clearly by the fact that in most cases the resulting differences were significant at $p \leq 0.05$ level. In two instances, resting in week 2 and feeding in week 4, the values showed significance at $p \leq 0.1$ level. No significance of watering tray type effect could be verified in the following instances: playing in weeks 3-4, social behaviour in weeks 2-3, feeding in week 2 and preening in week 5.

Feeding occurrence rates were always higher after week 2 in groups with the ventile watering tray, in week 6 exceeding 3 times the frequency values recorded for the groups with free flow watering trays.

Drinking showed a more emphasised of the above pattern: where the ventile watering tray was used the frequency of this type of behaviour proved higher as early as week 2, and by week 5 the respective values were 4 times higher than those of the other group. In accordance with the above, *resting* rates reached 13-15% higher values by weeks 5-6 in the group with free flow watering trays than in the others.

The frequency of *playing* with litter and other box furnishings was higher, while the occurrence of *social behaviour* patterns (greeting, threatening and aggression) was lower where the free flow watering tray was used. Frequency of *preening* behaviour showed smaller differences, but in the first occurrence greater differences: when the ventile watering trays were used the birds seemed to begin cleaning their feathers later.

In four of the 6 weeks of the experiment the *individual rates* of the various behaviour patterns were of a varying nature, while in weeks 5 and 6 their occurrence values were more steady.

The individual occurrence values for the different behaviour patterns within basic activity showed the following average composition in the groups with free flow watering trays: feeding 4.1%, drinking 3.6%, resting 75.6%, playing 8.8%, social behaviour 0.8% and preening 7.0%. The same values for the groups with ventile watering trays were 6.5%, 7.9%, 67.2%, 6.7%, 2.4% and 7.2%.

The above data show that feeding and drinking occurred more frequently in the groups with the ventile watering tray; hence, resting rate remained below that recorded in the group with the free flowing watering tray. Preening showed no considerable difference between the two groups. Playing rate was found to be lower in the group with the ventile watering tray than in the other group.

On comparison of these findings with those of experiments performed in Germany (Reiter and Bessei, 1995) it can be seen that in the first weeks of rearing the basic behaviour pattern of the goose is very close to the tendencies obtained from experiments with Pekin ducks, Muscovy ducks and mulard ducks. Differences are apparent in the percentage frequency rate distribution of the various behaviour patterns. In ducks the frequency of playing behaviour decreases from 12% to about 8%, while in the case of geese it can decrease from 12% to a frequency as low as 1.7%. This drop is the strongest in weeks 2 and 3. After week 2 the decrease slows down as the animal discovers its environment and learns other movements required by other behaviour patterns. This may also explain the observation that resting time begins to increase in weeks 2 and 3. Resting rate has been found to increase from 35% to 50% in the case of ducks, but from 66-68% to 77-79% in the case of geese, indicating that the goose is less active during the first weeks of rearing than the duck.

Decrease in feeding and drinking rates during weeks 3 and 4 corresponds to the end of the first phase of the periodical growing pattern of the goose (Bogenfürst, 1992). This phenomenon can be explained both by the perfect learning of movement sequences and by the lengthening of the oesophagus, enabling the bird to take up more feed. However, where the ventile watering tray was used it could be observed that the birds would have been able to take up more feed, but the quantity of water which it was possible to drink on each occasion limited feed intake, and so the goose spent more time 'searching' for feed than did the goose in the groups with free flow watering trays. This means that time spent playing decreased, so the use of ventile watering trays could reduce the 'urge for destruction' caused mainly by boredom.

With respect to the social behaviour pattern the results for the ventile watering tray are not positive in every case, since they are higher than the corresponding values for the group with the other type of tray, but through special care (i.e., removing aggressive birds from the group) the average value of 2.3% could be maintained successfully during the nurturing period.

The peak in preening between weeks 3 and 4 indicates the effects of the first moulting, which entails a rather uncomfortable feeling for the birds. Full maturing of the feathers can be expected by weeks 8-10 (Bögre and Bogenfürst, 1971). Differences in time between the two watering types can also be explained by the presence or absence of boredom: bored birds play not only with the box furnishings but also with their own feathers and those of their groupmates, resulting in feather picking in extreme cases. Where ventile watering trays are used young geese do not overpreen; they occupy themselves with their feathers only as much as is really necessary. The latter result is also assisted by the fact that the birds can hardly 'take a bath' in the ventile watering tray, and thus the need to dry the feathers is eliminated, alongside the minimisation of water wastage.

CONCLUSIONS

In accordance with the results of the experiment described above it can be recommended that ventile watering trays be used for geese, as is already the practice with ducks. The introduction of this watering method could help in minimising the extent of feed and water wastage, since it induces the feed searching behaviour pattern. Lack of this behaviour, as is common with intensively kept geese, causes boredom, resulting in behavioural anomalies. Greater knowledge of the daily feeding and drinking rhythm of geese could also assist in the attainment of better understanding of the above phenomenon. (A new experiment is to be conducted to clarify these points.)

Due to the simultaneous appearance of preening and social patterns in weeks 4-5 special attention should be paid to the avoidance of any possible behavioural anomalies (i.e., feather picking and aggression), in order to eliminate their negative effects on the efficiency of goose production.

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Einfluss verschiedener Fütterungstechnologien auf die mit der Befruchtung zusammenhängenden Eigenschaften der Gänse

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ZUSAMMENFASSUNG

Die Gänseeltern werden während der Legeperiode bei der sogenannten traditionellen Zuchtgänsehaltung ad libitum mit Kraftfutter gefüttert. Der weit über den Bedarf hinausgehende hohe Energiegehalt des Futters bedeutet ein großes Problem bei den Zuchttieren, da die Gans im Gegensatz zu anderen Geflügelrassen nicht fähig ist, ihre Futteraufnahme dem Energiegehalt des Futters anzupassen (besonders bei Kraftfutter mit sehr hohem Energiegehalt). Deshalb neigt sie zu dem bei Zuchttieren nicht erwünschten Übergewicht und zur Überkonstitution. Da wir im Fall der Mastgänse bei den Broiler-Elterntieren keinen nennenswerten Unterschied zwischen Kopfdurchmessers und Größe von Vater- bzw. Muttertier feststellen konnten, hatten wir keine Möglichkeit, die beiden Geschlechter getrennt zu füttern. Dennoch haben wir in unseren Experimenten eine Antwort darauf gesucht, welchen Einfluss eine limitierte Fütterung während der Legeperiode der Elterntiere auf ihre Fruchtbarkeitsmerkmale hat. (Schlüsselwörter: Gans, limitierte Fütterung, Eierproduktion, Befruchtung)

ABSTRACT

The effect of different feeding programmes on reproduction parameters in breeding geese

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In the process of the so-termed traditional housing of breeding geese the breeding birds are fed laying feed ad libitum. The high energy level of the feed, exceeding the requirements of the birds, represents a serious problem for breeding geese, as the goose, unlike other poultry species, is unable to limit feed consumption according to the energy level of the feed (particularly in the case of high energy level feed mixes); therefore it is susceptible to fatness, i.e. over-condition. Since in the case of the goose the authors found no differences like the ones observed with broiler parent stocks, that is difference in the diameter of the head and the height of males and females, it was not possible to feed the geese separately by sex. In spite of this the authors endeavoured to establish what effect restricted feeding for goose breeding stocks in the laying period has on their reproduction traits.

(Keywords: goose, restricted feeding, fertility, egg laying)

EINFÜHRUNG

Die Elterntiere werden während der Legeperiode bei der sogenannten traditionellen Zuchtgänsehaltung ad libitum mit Kraftfutter versorgt. Zur Arteigenschaft der Gänse gehört es, daß unter natürlichen Haltungsumständen sechs Wochen vor Beginn der Legeperiode ein spontaner Überverzehr zu beobachten ist, was ein Plus von 600g Futter pro Tag bedeuten kann (*Seaveur und Rousselot-Pailey, 1982*). Diese Erscheinung hängt wahrscheinlich mit der wanderlustigen Lebensweise dieser Tierart zusammen. Später nimmt der Futterverbrauch wieder ab, erreicht seinen Tiefpunkt auf dem Höhepunkt der Legeperiode, um danach wieder anzusteigen.

Seaveur und Rousselot-Pailey (1982) untersuchten, welche Auswirkung das völlige Weglassen von *frischem Gras* auf die Tiere hat. Auf Grund seiner Ergebnisse wurde festgestellt, daß sich die Eierproduktion der einjährigen Gänse durch Fütterung mit erhöhtem Eiweißgehalt und ohne Gras verbessert. Gleichzeitig verschlechterte sich aber die Legeleistung der mehrjährigen Gänse. Die Fruchtbarkeit ging in jedem Falle zurück, was im großen und ganzen ein Verlust von 3-4 Gänseküken bedeutet.

Die negativen Auswirkungen fehlenden Grünfutters auf die Fruchtbarkeit kann mit dem Mangel an Vitaminen und Spurenelementen zusammenhängen. *Kovács (1972)* hat nachgewiesen, daß eine differenzierte Vitaminergänzung die Fruchtbarkeit um 5-14 % verbessern kann.

Zur Klärung der optimalen Energie- und Eiweißversorgung führte *Bielinski et al. (1983 und 1984)* Untersuchungen durch. Es wurde festgestellt, daß 15 % Rohprotein mit 2750 kcal ME/kg für die Fruchtbarkeit am günstigsten ist.

Um den Energiebedarf der Gänse während der Legeperiode zu erforschen, führte *Seaveur (1988)* 5 aufeinander folgende Experimente durch. Die Schlussfolgerungen waren, daß Zuchtgänse kaum fähig sind, bei einer erhöhten Portion an Kraftfutter ihre Energieaufnahme konstant zu halten. Die Daten der Untersuchungen bestätigten, dass das Füttern mit Grünfutter sowohl für die Eierproduktion als auch für die Fruchtbarkeit sehr positiv ist. In den Versuchen wurde das Eiweißniveau dem Energiegehalt anteilmäßig gleichgestellt. Die Gänse nahmen infolge des hochkonzentrierten Kraftfutters mehr Eiweiß zu sich als notwendig, da ihre Bedarfsregelung nicht perfekt ist. Auch bei anderen Geflügelarten (Huhn, Perlhuhn, Ente) wurde bemerkt, daß die Fertilität durch höhere Eiweißaufnahme ein bestimmtes Niveau erreicht und danach wieder absinkt. Das hat besonders negative Auswirkungen auf die männlichen Individuen (*de Revier, 1988*). Dieser ungünstige Einfluss wurde ebenfalls durch die obigen Experimente bestätigt.

Mehrere Autoren berichten aber auch über positive Auswirkung der während der Legeperiode angewandten Fütterungsregelung. *Sellier et al. (1994)* begrenzten den Futterverbrauch der grauen Landgänse parallel zur Senkung der Eierproduktion in zwei verschiedenen Varianten. Die leistungsabhängige Regelung war brutaler als die konstante. In beiden Fällen kam es zum Rückgang der Eierproduktion. Die Fertilität in der Gruppe der 660 kcal/Tag/Gans verbesserte sich jedoch (13% höher als die Kontrollgruppe), daß heißt, die Anzahl der Küken pro Legegans erhöhte sich, allerdings nicht signifikant, und die Produktionskosten gestalteten sich günstiger. Auch die Ganter haben bei diesem Fütterungsversuch nicht zugenommen, was für die Fertilität eindeutig von Vorteil war.

Bogenfürst (1998) untersuchte den Fertilitätsindex von separat intensiv aufgezogenen und gezüchteten Weißfleischgänsen mit Hilfe eines 2x2 faktoriellen Versuches (Fütterung ad libitum, ad libitum + Biometin-Ersatz, Futterlimit 220g/Tag mit

begrenztem Biometin-Ersatz). Die Ergebnisse zeigten, daß die Begrenzung für die Fertilität günstig ist, aber einen Rückgang der Eierproduktion verursacht, was jedoch durch einen Biometin-Ersatz zu kompensieren wäre.

Bielinska et al. (1993) untersuchte den Einfluss von weniger Eiweiß- und Energiegehalt im Futter auf die Weißen Italienischen Gänse. Es wurde festgestellt, daß ein Futter mit 13,5% Rohprotein und einem Energiegehalt von 9,0 MJ ME/kg mit Lysin und Methionin-Zystin- Ersatz ein entsprechendes Ergebnis sichern kann.

Dennoch wurde in unseren Experimenten eine Antwort darauf gesucht, wie sich eine limitierte Fütterung während der Legeperiode auf die Fruchtbarkeit auswirkt.

Die Zweckmäßigkeit der Versuche wird auch durch die Tatsache begründet, daß die angenommenen Fütterungskosten 70 % der Haltungskosten ausmachen, wenn man mit der niedrigsten Fruchtbarkeit (bezüglich der Gössel) rechnet. Eine Senkung der Futterkosten bei steigender Fruchtbarkeit wäre eine attraktive Möglichkeit.

MATERIAL UND METHODE

Versuchsziel

Die Auswirkung verschiedenen Fütterungstechnologien auf die mit der Befruchtung zusammenhängenden Eigenschaften.

Versuchstiere

Zu den Versuchen mit unterschiedlicher Fütterung wurde ein dreijähriger Elterntierbestand eingestellt. Insgesamt wurden 4 Gruppen gebildet: Die erste Gruppe mit 162 Legegänsen + 40 Ganter = 202 Tiere, die zweite Gruppe mit 166 Legegänsen + 41 Ganter = 207 Tiere, die dritte und vierte Gruppe mit je 200 Legegänsen + je 50 Ganter = 250 Tiere. Alle Gruppen wurden zwei Monate vor Beginn der Legeperiode eingestellt. Gemäß den 4 Gruppen gab es vier 4 Behandlungen, wobei die erste Gruppe als Kontrollgruppe diente, die anderen drei als Versuchsgruppen.

Methodische Beschreibung der mit den Fütterungstechnologien zusammenhängenden Versuche

Die während der Versuche angebotenen Nährstoffe in der Futtermischung wurden mit Berücksichtigung der Nährstoffkodex-Empfehlungen zusammengestellt.

Die Tiere der ersten Behandlung, die Kontrollgruppe, wurden während der Legeperiode nach der traditionellen Elterntierhaltung ad libitum gefüttert. Das Gewicht der Legegänse betrug 4,81 bis 5,4, das der Ganter 6,01 bis 6,5 kg. Insgesamt handelte es sich um 162 Legegänse und 40 Ganter. Diese Gruppengröße ergab sich so, daß die Zahl der zur mittleren Gewichtsklasse gehörenden Tiere halbiert wurde.

Die Tiere der drei Versuchsbehandlungen wurden zwei Monate vor dem Beginn der Legeperiode limitiert gefüttert (200 g/Tag/Tier). Die erste Versuchsgruppe gehörte zur gleichen mittleren Gewichtsklasse wie die Kontrollgruppe und bestand aus 166 Legegänsen und 41 Gantern.

Die zweite Versuchsgruppe mit 200 Legegänsen und 50 Gantern gehörte zur niedrigeren Gewichtsklasse (Legegänse: $4,2 < x < 4,8$ kg; Ganter: $x \leq 6$ kg). Die dritte Versuchsgruppe gehörte mit 200 Legegänsen und 50 Gantern zum höheren Gewicht (Legegänse: $5,4 < x < 6,5$ kg; Ganter: $x \geq 6,51$ kg).

Nach der Einstellung erhielten die Tiere aller Gruppen einheitlich bis zur Steigerung der beleuchteten Stunden 200 Gramm Elterntierfutter. Die erste Tabelle zeigt den

lebenserhaltenden Nährstoffgehalt des Elterntierfutters an. Ab der höheren täglichen Lichtdauer erhielt die Kontrollgruppe die Futtermischung ad libitum. Für die drei Versuchsgruppen betrug die tägliche Futtermenge pro Tier bis zum Ende der 5. Woche 220 g, ab der 6. Woche 240 g, ab der 9. Woche 260 g, und ab der 19. Woche wieder 240 g.

ERGEBNISSE UND BEWERTUNG

Ergebnisse der Versuche mit limitierter Fütterung

Als Basis der Versuche dienten die vorherigen Ergebnisse, nach denen die Gans im Gegensatz zu den anderen Geflügelarten nicht imstande ist, die Nahrungsmenge gemäß ihrem Energiebedarf zu regeln. Sie verzehrt im Falle einer Futtermischung mit hohem Energiegehalt weit mehr, als es ihrem Bedarf entspricht. Nach den ungarischen Erfahrungen werden die Zuchtgänse während der Legeperiode mit einem Energiegehalt von 12 MJ/kg im metabolisierbaren Futter versorgt. Unserer Meinung nach kann dies zu einem bedeutenden Überverbrauch führen. Die Folge davon ist, daß besonders die Ganter während der Legeperiode eine bedeutende Überkondition erhalten und dadurch die Fertilität der Zuchteier beschränkt wird. Ziel der Experimente war es, die Wirkung der limitierten Fütterung während der Legeperiode auf des Körpergewicht und die Fruchtbarkeitsmerkmale der Elterntiere zu erforschen. Abbildung 1 stellt die ad libitum verbrauchte Futtermenge der Kontrollgruppe und die limitierte Futtermenge für die Versuchsgruppen dar.

1. Abbildung

Futtermittelverbrauch der ad libitum gefütterten Kontrollgruppe und der limitiert gefütterten Versuchsgruppen (g)

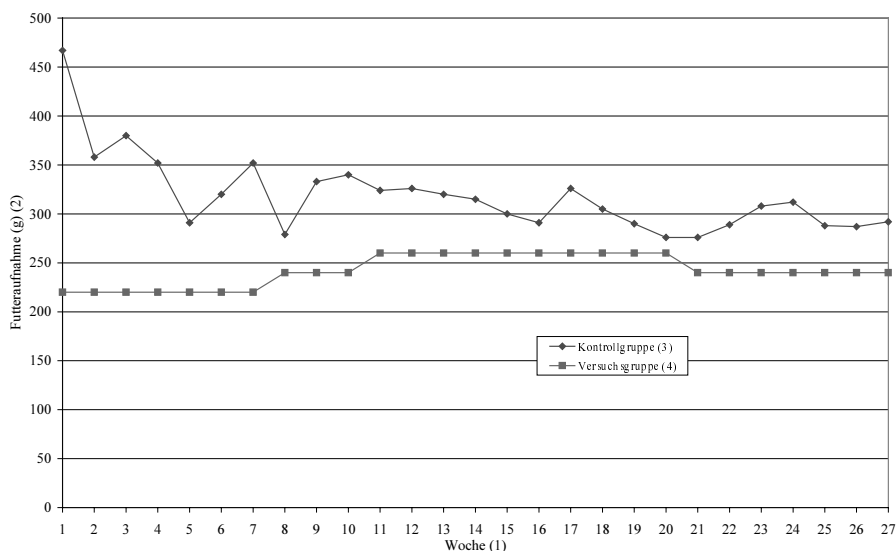


Figure 1: The feed consumption of the ad lib consuming control and feed restricted experimental group

Week(1), Feed consumption(2), Kontroll(3), Experimental(4)

Aus der Abbildung ist gut zu ersehen, daß das Niveau des ad libitum Verbrauchs die limitierte Ration weit übersteigt. Von dem metabolisierbaren Futter mit einem Energiegehalt von 11,09MJ/kg wurden 467 g verbraucht, was 5,18MJ/Tag bedeutet. Während der Legeperiode konsumierte die Kontrollgruppe täglich durchschnittlich 318 g, was einer Energiemenge von 3,53 MJ/Tag entspricht. Die Versuchsgruppen erhielten dagegen 220 g (2,44MJ/Tag), 240 g (2,66MJ/Tag), 260 g (2,88MJ/Tag) und wieder 240 g (2,66MJ/Tag), das heißt im Durchschnitt 240 g, was um 0,9MJ unter dem Tagesenergie-Niveau der ad libitum gefütterten Gruppe liegt.

Das 220-Gramm-Niveau wurde gemäß den Experimenten der französischen Forscher vor Beginn der Legeperiode festgelegt. Nachdem sich diese Menge als zu wenig zum Erreichen einer intensiven Eierproduktion erwies, wurde die Futterdosis zuerst auf 240 g und danach auf 260 g erhöht. Im letzten Viertel der Legeperiode wurde der tägliche Verbrauch wegen der Zunahme des Lebendgewichtes wieder auf täglich 240 g Verbrauch beschränkt.

Einfluss der limitierten Fütterung auf die Legeintensität

Die Eierproduktion der Kontrollgruppe begann fast unmittelbar nach der Legepause. Bei den Versuchsgruppen wurde die bisherige 200 g-Ration auf 220 g erhöht, dann wurde Legekraftfutter vorgelegt, und mit steigender Beleuchtungszeit nahm schließlich die Eierproduktion ihren Anfang. Die Legeintensität der Kontrollgruppe entsprach dem Lichtprogramms, die der Versuchsgruppen war aber weniger erfolgreich. Unserer Meinung nach liegt der Grund dafür in einer nicht ausreichenden Nährstoffversorgung. Das Niveau des ad libitum Verbrauchs wurde durch einmaliges Zurückmessen des nicht verbrauchten Futters pro Woche festgestellt. Die Legeintensität der vier Gruppen ist grafisch in der 2. Abbildung zu sehen.

2. Abbildung

Legeintensität der mit limitierter Fütterung behandelten Gruppen, bzw. der sich ad libitum ernährenden Kontrollgruppe (%)

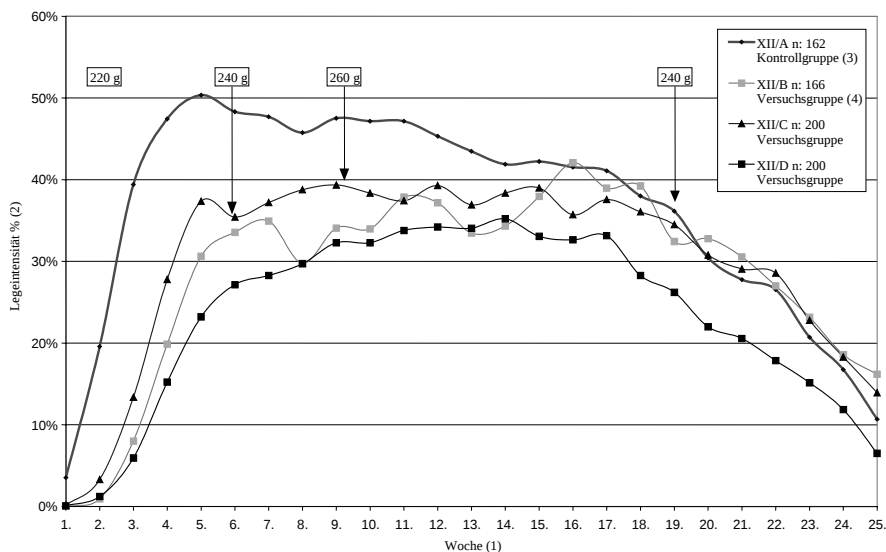


Figure 2: The laying intensity of the feed restricted and ad lib consuming groups

Week(1), Intensity(2), Kontroll(3), Experimental(4)

Die Legeintensität der Versuchsgruppen blieb unter derjenigen der Kontrollgruppe, also war die Eierproduktion wesentlich geringer. Die einzelnen Versuchsgruppen wurden nach drei verschiedenen Gewichtsklassen gebildet. Die Intensität der zur unteren Gewichtsklasse gehörenden Gruppe war durchschnittlich 30%, der zur mittleren Klasse gehörenden Gruppe 28%, und die obere Klasse hatte ein Wert von 23%. Die Daten zeigen, dass die durchschnittliche Intensität der Eierproduktion mit der Erhöhung des Körpergewichtes ständig abnimmt.

Statistische Analyse der Versuche

Bei der statistischen Analyse der Legeleistungsdaten wurde eine Signifikanzanalyse durchgeführt. Die Wahl fiel auf die Kruskal-Wallis H Probe, die den Erwartungen der funktionellen Varianzanalyse entspricht

Einfluss der limitierten Fütterung auf die Befruchtung der Eier

Bei der Beurteilung der Fütterungslimitierung in der Legeperiode muss auch die Fertilität der Eier beachtet werden (3. Abbildung).

3. Abbildung

Befruchtete und unbefruchtete Eier in der Kontrollgruppe und den Versuchsgruppen

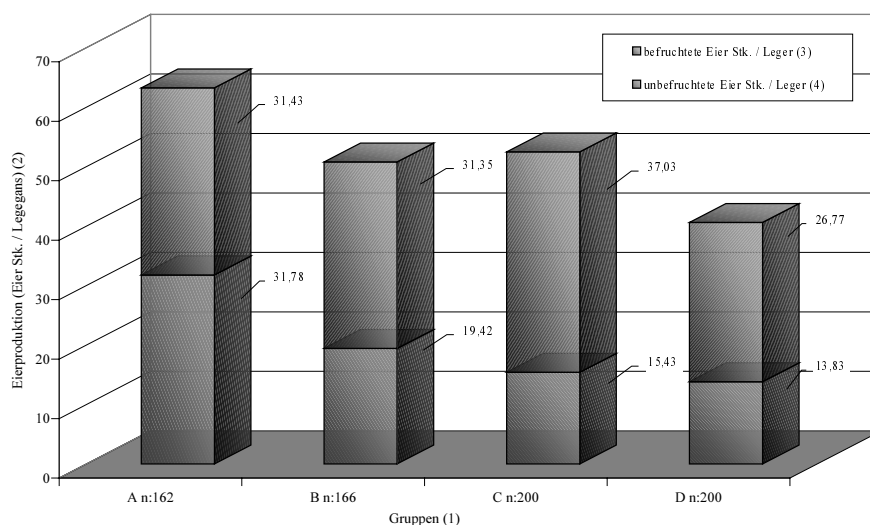


Figure 3: Fertile and unfertile eggs in the experimental and control groups

Groups(1), Egg production (egg pcs./female)(2), Fertile egg pcs./female(3), Unfertile egg pcs./female(4)

Aus der Abbildung ist gut zu erkennen, daß der Anteil der befruchteten Eier in den limitiert gefütterten Gruppen (ausgenommen Gruppe d) wesentlich höher ist als bei der sich ad libitum ernährenden Kontrollgruppe. Es wurde aber schon darauf hingewiesen, daß die Legeintensität der Versuchsgruppen wegen der ungenügenden Nährstoffversorgung zurückgeblieben ist. Von weiteren Forschungen wird erhofft, daß mit einer besseren Dosierung der gleichen oder annähernd gleichen Futtermenge auch die Zahl der Eier dem Produktionsniveau der sich ad libitum ernährenden Kontrollgruppe angeglichen werden kann.

Das Futterverbrauch pro befruchtetes Ei war in allen Versuchsgruppen bedeutend niedriger als in der Kontrollgruppe und betrug durchschnittlich 20,81 %. Wenn wir den Futterverbrauch hinsichtlich der eingestellten Gewichtsklassen überprüfen, dann ist zu erkennen, daß der Anteil an Futter, der für die Lebenserhaltung und die Gewichtszunahme aufgewendet wird, parallel mit der Körpergewichtszunahme steigt, aber zu Lasten der Eierproduktion geht. Daraus geht hervor, daß der Futterverbrauch für ein befruchtetes Ei zunehmen wird. Da auch bei der Elterntierhaltung die Fütterungskosten als Basis dienen, kann die obengenannte Einsparung von 20,81 % als bedeutend angesehen werden.

Bei der Untersuchung über die Fruchtbarkeit der Eier wurde festgestellt, daß das Ergebnis der Versuchsgruppen weit über dem der Kontrollgruppe liegt. Das macht auch die 4. Abbildung deutlich.

4. Abbildung

Befruchtungsergebnisse der limitiert gefütterten Versuchsgruppen (%)

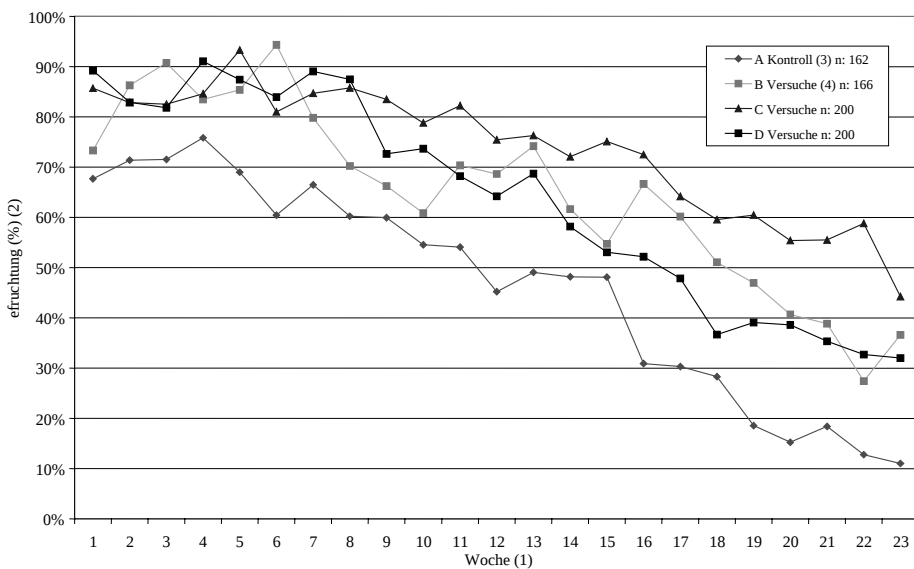


Figure 4: The fertility ratio of the groups participating in feed restriction experiments

Weeks(1), Fertility(2), Kontroll(3), Experimental(4)

Der Grund für die sehr großen Unterschiede ist in der Fertilität der Eier zu suchen. Als erste Ursache muss der entstandene Unterschied im Lebendgewicht bei den einzelnen Gruppen als Folge der limitierten Fütterung erwähnt werden. Die Gewichtsklassen bedeuten bei der Einstellung eine genetische Auswahl, so dass es sein kann, daß sich die Fertilität der Eier mit der Zunahme des Lebensgewichtes in indirekter Proportionalität verschlechtert. Der im Lebendgewicht entstandene Unterschied wird pro Geschlecht getrennt in der 5. und 6. Abbildung dargestellt.

5. Abbildung

Durchschnittsgewicht der limitiert gefütterten Legegänse vom Versuchsbeginn bis zum Ende der Legeperiode

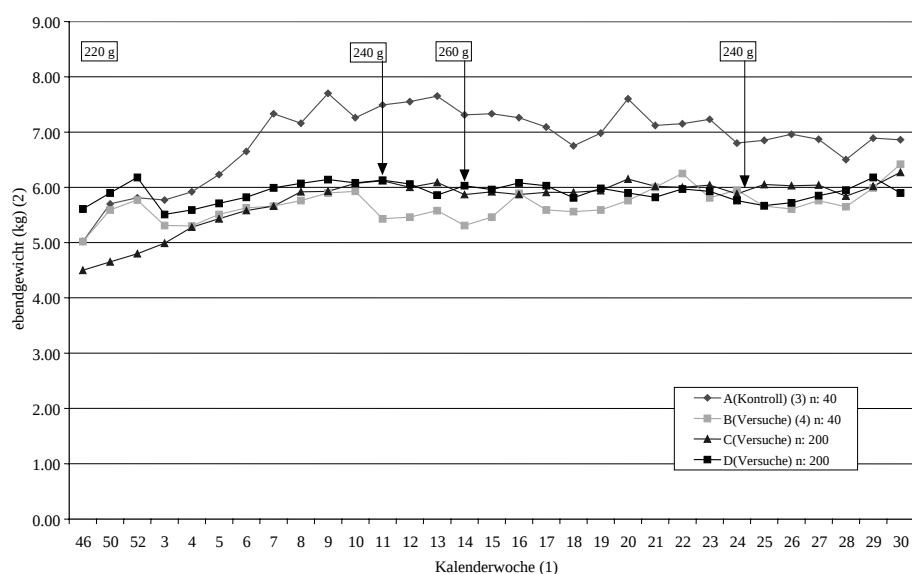


Figure 5: The average live weight of the female birds participating in feed restriction experiments shown for the period between the begin of the experiments and end of laying

Calendar weeks(1), Live weight (kg)(2), Kontroll(3), Experimental(4)

6. Abbildung

Durchschnittsgewicht der limitiert gefütterten Ganter vom Versuchbeginn bis zum Ende der Legeperiode

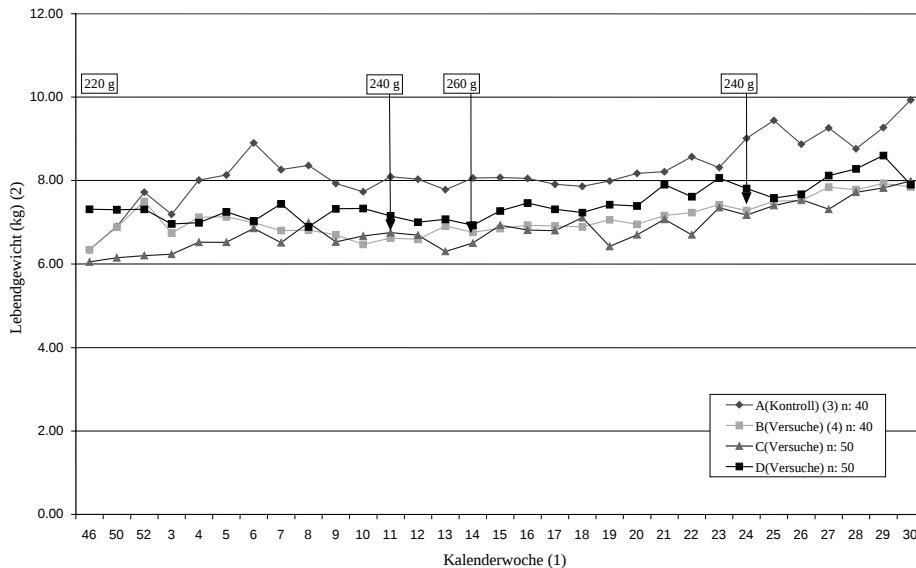


Figure 6: The average live weight of the ganders participating in feed restriction experiments shown for the period between the begin of the experiments and end of laying

Calendar weeks(1), Live weight (kg)(2), Kontroll(3), Experimental(4)

Einfluss der limitierten Fütterung auf das Lebendgewicht der Elterntiere

Die Unterschiede im Lebendgewicht der Legegänse bei der Einstellung zu Versuchsbeginn ist deutlich sichtbar, die sich aber in der 7. Woche nach der Einstellung ausgeglichen haben. Das Lebendgewicht in den Versuchsgruppen betrug während der ganzen Legeperiode ca. 6 kg, das in der Kontrollgruppe aber 7 kg oder noch mehr. Im Gewicht der Ganter ist eine ähnliche Tendenz zu beobachten. Hier sind die Unterschiede zwischen den einzelnen Gruppen deutlicher, und trotz der strengen limitierten Futtermenge erreichten sogar die Ganter ein Gewicht von 8 kg. In der ad libitum gefütterten Kontrollgruppe erreichten die Ganter am Ende der Legeperiode ein Gewicht von 9-10 kg. Aus den Untersuchungen zum Lebendgewicht geht hervor, daß die von uns angewandte Futterlimitierung für die Legegänse viel zu streng ist, trotzdem die Ganter unter den gleichen Umständen 1-1,5 kg zunahmen. Die Schlußfolgerung also ist, daß für eine Fütterungsoptimierung bei Gänsen eine nach Geschlechtern getrennte Fütterung sowohl in Qualität als auch in Menge erforderlich wäre.

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Development of the fourth primary wing feathers in three types of duck

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ABSTRACT

This study examined the development of the 4th primary wing feathers in three types of duck of greatly different genotype: the Pekin, the mule and the muscovy duck, in the first 12 weeks of life of the birds. The end-products of 200 Pekin type ducks, 200 muscovy ducks and 200 mule ducks originating from the Palotási Kacsafarm Kft. (Hungary) were the subject of the investigations carried out in this study. The ducks were raised separated according to sex. Each duck was fitted with a wing band, to enable the individual parameters to be monitored. The ducks were accommodated in 6 pens, separated according to genotype and sex. The ground area of the pens was 14 m². The initial stock density of birds per m² was gradually reduced to a level of 2.8 birds per m². Lighting was provided for a period of 23 hours per day in the first week, 18 hours per day in the second week and 12 hours per day from the third week. The initial lighting intensity was 18-20 Lux, being reduced gradually to 6-7 Lux. This was important, particularly due to the violent temperament of the muscovy ducks. The ducks were fed ad libitum. On the basis of the results obtained it was established that plumage growth both began and reached completion in the Pekin type first. By the 9th-10th week of life these birds had also reached slaughter maturity with respect to plumage development. The muscovy stock was the last to begin feather growth. Subsequent processing of the birds, mature for slaughter with respect to live weight, was hampered by the presence of feather sheaths. The mule ducks produced values between those observed in the Pekin type and in the Muscovy ducks for the parameters examined, but these had also failed to reach slaughter maturity as defined on the basis of plumage by the end of the experimental period. For the purposes of ensuring economically efficient processing of waterfowl, the requirement in the practical field is for ducks with rapid feather development; thus, the authors judge the developmental breeding of the faster fledging lines of the mule and the muscovy duck to be of great importance in breeding activity.

(Keywords: ducks, plumage, feather development)

ZUSAMMENFASSUNG

Entwicklung der 4. Handschwinge bei drei Ententypen

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In der Untersuchung wurde die Federentwicklung an der 4. Handschwinge bei den Genotypen Pekingente, Flugente und Mulard festgestellt. Die Tiere wurden 24 Wochen

lang unter kommerziellen Entenmastbedingungen gehalten und nach Geschlechtern getrennt aufgezogen, 100 Tiere pro Genotyp und Geschlecht. Nach dem Einsetzen des Federwachstums wurde bei allen Enten jede Woche der linke Flügel gemessen. Bei den Erpeln der drei Genotypen begann zwar die Entwicklung der Handschwinge zu verschiedenen Zeitpunkten, aber die Wachstumsintensität war bei allen gleich. Die Barbari-Erpel zeigten von allen das langsamste Wachstum. Nach einer Woche trat bei den untersuchten Genotypen eine intensive Wachstumsphase der Federn ein, die bei der Pekingente bis zur 9., bei den Mularden bis zur 11. Lebenswoche andauerte, und bei den Barbari-Enten war sogar noch am Versuchsende ein kräftiges Wachstum festzustellen. Bei den weiblichen Tieren begann die Federentwicklung zuerst bei der Pekingente und erst nach zwei Wochen folgten die Barbari und Mularden. Nach einer 1-2 Wochen dauernden, anfangs weniger intensiven Phase konnte bei allen drei Genotypen eine kräftige Federentwicklung festgestellt werden, die bei den Pekingtonen bis zur 9. Woche andauerte. Bei den Mularden und Barbari war das Federwachstum sogar noch in der 12. Versuchswoche intensiv.

(Schlüsselwörter: Enten, Befiederung, Federentwicklung)

INTRODUCTION

The significance of this topic can be appreciated from the fact that it is probable the rôle of duck meat products on the Hungarian market is to change considerably in the years to come, i.e. products with a low fat content and higher meat quality seem set to become predominant.

The following types were examined:

- the Pekin type, a domestic duck;
- the muscovy duck;
- the hybrid of these, the mule duck.

Each of the three genotypes examined represents a product in its own right on the market. Only the domestic duck is marketed as a roasting duck in Hungary; muscovy ducks and mule ducks are used exclusively for the production of duck liver by means of cramming.

MATERIALS AND METHODS

The end-products of 200 Pekin type ducks, 200 muscovy ducks and 200 mule ducks originating from the Palotási Kacsafarm Kft. (Hungary) were the subject of the investigations carried out in this study.

The ducks were raised separated according to sex. Each duck was fitted with a wing band, to enable the individual parameters to be monitored.

The ducks were accommodated in 6 pens, separated according to genotype and sex. The ground area of the pens was 14 m². The initial stock density of birds per m² was gradually reduced to a level of 2.8 birds per m². Lighting was provided for a period of 23 hours per day in the first week, 18 hours per day in the second week and 12 hours per day from the third week. The initial lighting intensity was 18-20 Lux, being reduced gradually to 6-7 Lux. This was important, particularly due to the violent temperament of the muscovy ducks. The ducks were fed ad libitum, and the feed composition for each genotype is given in *Table 1*.

Table 1**Duck diets**

Weeks of life(1)	Composition (2)	Pekin	Muscovy	Mule
1-2	crude protein (3) ME(4)	English duck starter feed (5) 20% 12.37 MJ/kg	Muscovy starter feed(6) 18.9% 12.47 MJ/kg	Muscovy starter feed(6) 18.9% 12.47 MJ/kg
3-24	crude protein(3) ME(4)	English duck rearing feed (7) 18.5% 13.0 MJ/kg		

1. Tabelle: Fütterung

Lebenswoche(1), Inhaltsstoffe(2), Rohprotein(3), Umsetzbare Energie(4), Starterfutter für Peking Enten(5), Starterfutter für Flugenten(6), Mastfutter für Peking Enten(7)

Measurements were taken on 56 ducks of each of the three genotypes (28 males and 28 females, the same individual birds being used each time). In the course of the experimental period the following were examined: changes in feather length on the abdomen, back, and length of primary feathers.

The length of the feathers was measured by means of a purpose-adapted ruler, in such a way that the ruler was placed close behind the feather to be measured, perpendicular to the body surface, after which the length of the part of the feather protruding from the skin was read off.

Feathers to be measured were in each case chosen so as to give a fair representation of the given area of feather growth. Digital scales were used for the purpose of recording live weight.

The measurements were, for the most part, taken by the same person. However, the measurement data obtained were nevertheless distorted slightly by deviations in the length of the feathers of the various regions of the body and the individual areas of feather growth.

On each occasion, the recording of feather length was accompanied by subjective observations. These were focussed chiefly on monitoring the various phases of feather development and the degree of feather cover attained, and on establishing the degree and nature of damage occurring in the feathers.

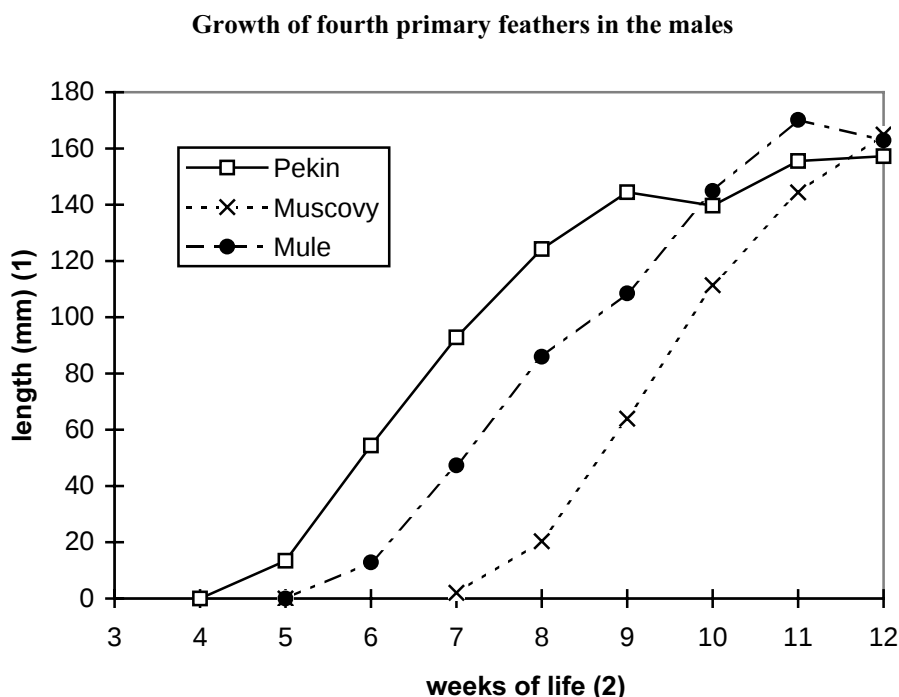
RESULTS AND DISCUSSION

Very great significance is often attributed to examinations connected with the state of development and the increase in length of the fourth primary feathers; the reason for this is that the growth of these feathers is linked to the level of development of the plumage as a whole and to increase in body weight. On examination of the above parameters, *Löhle* (1967), working with hens, and *Gehre* (1975), with geese, ascertained significant correlations in this respect.

In this experiment the development of the fourth primary feathers in Pekin, mule and Muscovy ducks was studied. The main objective was to detect differences among the three genotypes and between the sexes.

On the basis of the data obtained in the course of the study it was established that by the 4th week of life neither the Pekin, nor the mule, nor the Muscovy males had produced feathers of measurable length, i.e. the growth of the wing flight feathers had not begun by that point (*Figure 1*).

Figure 1



1. Abbildung: Entwicklung der 4. Handschwinge bei Erpeln

Länge (mm)(1), Lebenswoche(2)

Feather growth was observed to commence first in the Pekin males. In the 5th week of life it was possible to record data on feather length for approximately 85% of the genotype group; the remaining 15% and every individual in the mule and Muscovy groups showed no fourth primary feathers of such a length as to be measurable.

By the 6th week of life feather growth had also begun in 81% of the mule males; however, a wide range of deviation between the data recorded was ascertained (feather lengths of between 7 and 40 mm having been recorded).

By that point, 100% of the Pekin genotype group had measurable fourth primary feathers. The level of development of these developed in a similar manner in every

individual bird, this being corroborated by the very slight degree of divergence between the values recorded.

The Muscovy ducks were the last to begin fourth primary development. In this study only a few individual Muscovy ducks had primary feathers of measurable length by the 7th week of life.

Feather development in the Muscovy ducks only began substantially in the 8th week of life; at that point a period of intensive growth commenced and was still evident at the end of the study period. However, the Muscovy ducks were so far behind the other genotypes that even this intensive development only enabled them to catch up with the Pekin and the mule males by the 12th week of life.

In the 7th week of life the 4th primary vexilla on the mule males were half open, those on the Pekin males already totally open. In the 9th week of life the Pekin males began to approach the mean 120 mm feather length characteristic of fully developed feathers, while the mule males showed intensive development in feather growth up to the 11th week of life.

In the 10th week a reduction in feather length was observed in the Pekin males. In 40-50% of these drakes this was due to the abrasive effect of the various furnishings of the boxes. As the wing flight feathers approached maturity the birds tended to try out their wings, in consequence of which the wing feathers gradually became increasingly worn and damaged after collision with the feeders, the cage grating, etc.

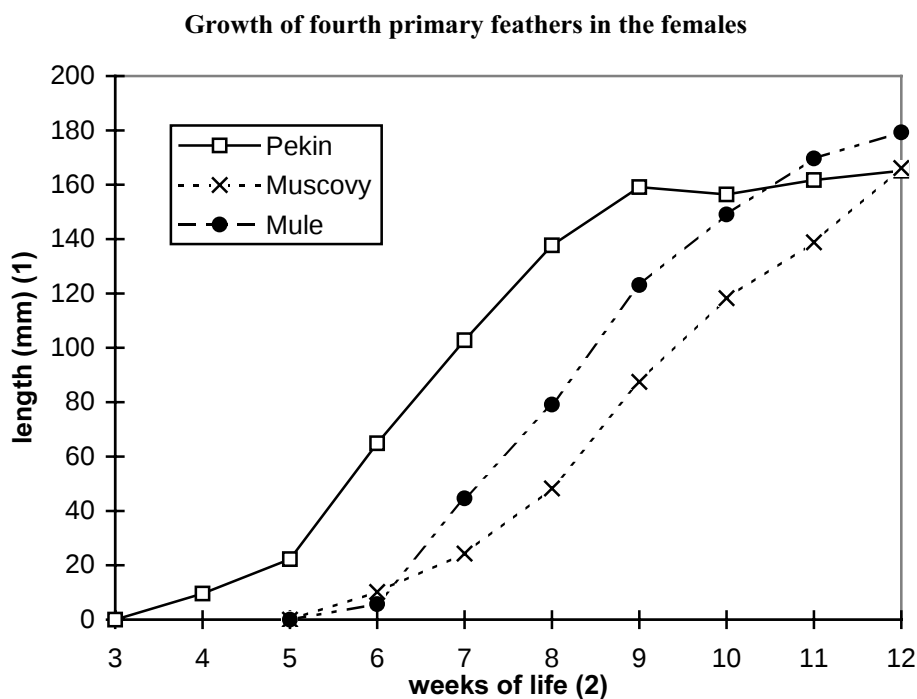
By the 11th week of life the vexilla of the wing flight feathers on the males of all three genotypes were open. In the case of the Pekin and the mule males the fourth primary feathers had reached the size characteristic of fully developed feathers by this point. This length was, on average, 157 mm in the Pekin males and 161 mm in the mule males.

In summary it can be established that feather development began at different points in time, but proceeded at approximately the same pace in the three genotypes. The greatest lag in feather growth was observed in the Muscovy males. In the genotypes examined the first week of feather growth was followed by a period of more intensive feather development, this period lasting until the 9th week of life in the Pekin males and until the 11th week in the mule males. However, vigorous feather growth was observed in the Muscovy males even at the end of the study period.

On examination of the females, (*Figure 2*) development of the fourth primary feathers was also observed to begin first in the Pekin genotype: this took place in the 3rd week of life, approximately one week earlier than in the Pekin males. By the 4th week of life the primary feathers of 77% of the Pekin females had already developed sufficiently for it to be possible to measure their length. In the 5th week of life, alongside both sexes of mule ducks, fourth primary feather growth was also observed to have begun in the Muscovy females; two weeks earlier than in the Muscovy males.

By that point in time the primary feathers were already of measurable size in every individual of the Pekin female group; the mean length of these feathers was found to be around 23 mm. By the 6th week of life the level of feather development in the Pekin females was seen to exceed substantially that of the females of the other genotypes. This was also verified by the fact that while in the majority of the Pekin females the vexilla of the fourth primary feathers were already half open, the mule females showed still undeveloped primary pin feathers, which on many birds were badly damaged, and in the Muscovy females these feathers were still in the early stages of development.

Figure 2



2. Abbildung: Entwicklung der 4. Handschwinge bei Enten

Länge (mm)(1), Lebenswoche(2)

By the 7th week of life the Pekin females had fully open feather vexilla; on the other hand, in the mule females only some individuals showed fourth primary feathers beginning to unfold; however, in the majority of these birds the wing flight feathers were found still to be undeveloped pin feathers, and also damaged. In the 7th week of life the least developed wing flight feathers of all were those of the Muscovy females. In addition to this shortfall in feather development a high degree of divergence was also observed between individual birds with respect to increase in feather length. (This genotype group included birds with wing flight feathers 5 mm and 50 mm long.)

Alongside the heterogeneity in feather length observed, the majority of the Muscovy females showed badly damaged wing flight feathers; this was caused by abrasion by the furnishings of the boxes and by feather pecking. The latter was presumably related to the temperament of the Muscovy duck (through boredom, lack of fibre, etc.).

By the 8th week of life the mean feather length in the Pekin females, 138 mm, began to approach that of full-grown primary feathers. On the other hand, the primaries of the mule females were still undergoing vigorous development at this point, showing a mean length of 83 mm. By the 8th week of life the deviations in feather length between individual Muscovy females had increased still further, as demonstrated by the fact that

in these females the feather lengths recorded ranged from 46 to 109 mm. In addition to heterogeneity, damage to the primaries was also found to be characteristic of the Muscovy genotype group. By the 9th week of life a highly homogeneous genotype group had developed with respect to the fourth primaries among the Pekin females. With a mean primary feather length of 159 mm these females then approached fully developed primary length. Subsequent to this point only slight changes in feather length were observed in the Pekin females. At the same time, the mule and the Muscovy females, lagging behind the Pekin genotype, continued to show strong feather growth even in the 12th week of life.

Thus, to summarise it can be established that the Pekin females were the first to begin fourth primary feather development, this commencing only two weeks later in the Muscovy and the mule females. Following the less intensive initial period of 1 to 2 weeks, vigorous feather development was observed in all three genotypes, this being maintained up to the 9th week of life in the Pekin females. On the other hand, feather growth in the mule and Muscovy females still proved intensive in the 12th week of the study.

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Effect of dietary crude protein level on reproductive traits of commercial pigeons in different production terms

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ABSTRACT

The experiment was conducted to measure the effects of feeding diets containing 12,14,16,18 and 20% crude protein to utility pigeons in the first and second production terms. The traits studied were: egg production, egg weight, hatchability of eggs laid, mortality of breeding pairs, growth of squabs up to weaning and feed intake. 30 breeding pairs per treatment were kept in pairs in a specially designated three tier cage system, in a windowless environmentally controlled house at a constant 12-hour light period throughout the year. The test period was 12 months in each production terms. Different protein levels failed to affect the length of egg cycle, annual egg production, egg weight, hatchability of eggs laid and mortality of squabs. Increasing dietary crude protein content and the weaning weight of squabs increased significantly ($P<0.05$). Annual squab production and feed intake of parents increased when higher protein diets were fed. The feed conversion ratio of squabs decreased with increase in the protein content of the diet.
(Keywords: pigeon, diet, protein, reproduction, meat)

ZUSAMMENFASSUNG

Einfluss des Rohproteingehaltes im Futter auf die Reproduktionsleistung von Masttauben in verschiedenen Produktionsperioden

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In einem Versuch wurde das Futter für Masttauben mit unterschiedlichem Rohproteingehalt in den ersten beiden Produktionsjahren angereichert, und zwar mit 12, 14, 16, 18 und 20% Rohprotein. In jeder Versuchsgruppe standen 30 Zuchtpaare zur Verfügung. Die einzelnen Paare wurden in Käfigen gehalten, der Stall war fensterlos, die Belichtungsdauer betrug 12 Stunden pro Tag. Die Testperiode betrug 12 Monate in jeder Produktionsperiode. Legezyklus, Eierzahl und Eimasse, individuelles Eigewicht, Schlupfrate und Verlustrate wurden vom Rohproteingehalt des Futters nicht signifikant beeinflusst. Erhöhung des Rohproteingehaltes im Futter erhöhte die Anzahl der geschlüpften Jungtauben und der pro Zuchtpaar aufgezogenen Jungtauben signifikant

($P < 0.05$). Mit steigendem Rohproteingehalt im Futter erhöhte sich auch das Lebendgewicht der Masttauben im Alter von 4 Wochen signifikant ($P < 0.05$). Futteraufnahme stieg parallel mit dem höheren Rohproteingehalt im Futter, wobei die Futtermittelverwertung - bezogen auf das Lebendgewicht der aufgezogenen Jungtauben - mit steigendem Rohproteingehalt signifikant ($P < 0.05$) verbessert werden konnte.

(Schlüsselwörter: Tauben, Futter, Mast, Protein, Reproduktion)

INTRODUCTION

Pigeons are monogamous and squabs are raised by their parents, both male and female, which feed the young pigeons with 'crop milk' in the first 5-7 days of their life. Because of this special characteristic the feeding system of pigeons differs markedly from that of other poultry species.

Few studies have been published on the protein requirements of pigeons. *Goodman and Griminger* (1969) found that a pigeon diet containing 16.5% crude protein increased weaning weights of squabs compared to a 14.7% crude protein diet. *McNabb et al.* (1972) reported higher weaning weight in pigeons fed wheat compared to soybean meal. *Little and Angell* (1977) found that a 10% crude protein diet containing 10% corn oil did not cover the requirements of pigeons. On the other hand, 20% and 40% crude protein failed to result in significant change in the weaning weight of young pigeons. *Böttcher et al.* (1985) established that 14% dietary crude protein content is enough for good squab production of breeding pairs.

Waldie et al. (1991) reported that a 22% CP diet with or without corn and a 16% diet without corn gave similar responses for production of breeding pairs and 4-week body weight of squabs.

In this experiment the effects of diets with different protein levels (12, 14, 16, 18 and 20%) on the production of auto-sexing utility type pigeons in the first and second production term were measured.

MATERIALS AND METHODS

The pigeon population

The utility-type pigeons used originated from auto-sexing Texan and King populations imported in the mid 1970s from the USA and later from France. All stocks were homozygous or hemizygous for the St^F (faded) gene described by *Hollander* (1942), which causes great differences in feather colour between the sexes, and in down feathering at the juvenile stage. During the last decade the whole population was bred as a single auto-sexing utility pigeon stock. More details regarding this population were published by *Meleg and Horn* (1998).

Management

The birds were housed in an environmentally controlled, windowless pigeon house. All pairs were randomly allocated to individual pigeon breeding cages (*Ballay*, 1976) designed to keep pigeon pairs separately. In each breeding cage the parents were able to feed their squabs up to the age of 28 days, the weaning stage. At this age squabs are ready and in prime condition for slaughter or are transferred to colony cages to be reared further. In this way the performance data for each pair and their offspring could be recorded separately.

The duration of the test period in the experiment was 12 months. The lighting programme was 12 light hours, with a light intensity of 2.5 w/m², provided by incandescent tubes throughout the year. The heating system ensured that the indoor temperature was at least 15°C in winter. Ventilation provided a maximum of 5 m³ air per kg live weight per hour.

Feeding

Five pelleted low and high protein diets (from 12 to 20%) with ad libitum feeding were compared. Each experimental diet was fed to 30 breeding pairs. Pelleted diets were fed ad libitum during the whole test period. Water and mineral grit were also provided ad libitum. The composition of the experimental diets is shown in *Table 1*.

Table 1

Composition and nutrient content of experimental diets

Ingredient (%) (2)	Protein levels (%) (1)				
	12	14	16	18	20
Maize (3)	73	67.5	62	56.5	51
Wheat (4)	10	10	10	10	10
Bran (5)	5	5	5	5	5
Soybean meal (46% CP) (6)	3	8	13	18	23
Sunflower (40% CP) (7)	4	4.5	5	5.5	6
Vitamin mix (8)	5	5	5	5	5
Total (9)	100	100	100	100	100
Calculated nutrient content (10):					
ME (MJ/kg) (11)	12.92	12.64	12.37	12.10	11.83
Crude protein (%) (12)	12.14	14.05	16.03	18.01	20.00
Crude fat (%) (13)	3.19	3.10	2.99	2.89	2.80
Crude fibre (%) (14)	3.37	3.63	3.83	4.02	4.22
Met+Cys (%) (15)	0.49	0.53	0.59	0.64	0.67
Lysine (%) (16)	0.42	0.55	0.78	0.85	0.99
Met (%) (17)	0.24	0.26	0.28	0.32	0.34
Na (%) (18)	0.12	0.12	0.12	0.12	0.12
Ca (%) (19)	1.02	1.04	1.06	1.07	1.08
P (%) (20)	0.64	0.66	0.70	0.71	0.74
Vit. A (NE/kg) (21)	13200	13200	13200	13200	13200
Vit. D ₃ (NE/kg) (22)	2640	2640	2640	2640	2640
Vit. E (mg/kg) (23)	22	22	22	22	22

1. Tabelle: Zusammensetzung und Nährstoffgehalt der Futtermischungen

Anteil von Rohprotein(1), Zusammensetzung(2), Mais(3), Weizen(4), Kleie(5), Sojagriess (46% RP)(6), Sonnenblumen (40% RP)(7), Vitaminergänzung(8), Gesamt(9), Kalkulierte Futterkomponente(10), ME(11), Rohprotein(12), Rohfett(13), Rohfaser(14), Methionin + Zystin(15), Lysin(16), Methionin(17), Na(18), Ca(19), P(20), A Vitamin(21), D₃ Vitamin(22), E Vitamin(23)

Measurement of traits

During the experiment length of egg cycle, egg production, egg weight, hatchability, number of squabs hatched, number of squabs weaned, squab mortality up to 28 days of age, squab weaning weight, annual squab production per pair, annual feed consumption per pair and squab feed conversion ratio were measured.

The number of squabs hatched was recorded daily. All squabs were weighed at 28 days of age. Weighing of squabs was always carried out before 10 a.m. to reduce possible variations due to difference in feed intake. Squab mortality was recorded daily for each pair up to the age of 28 days, when the squabs were weaned. The feed consumption of the pairs was measured every day.

Statistical analysis

Hatchability and viability were analysed by Chi² test, taking into consideration the methodical recommendations outlined by *Laughlin* and *Lundy* (1976). Traits characterised by normal or close to normal distribution were compared by ANOVA (Statgraphic 5.0, 1991).

RESULTS AND DISCUSSION

The effects of the treatments on the production performance of the breeding pairs are presented in *Table 2*.

The length of the egg cycle was not affected by the treatments, either in the first or in the second production cycle. The slight increase in egg number with increase in dietary crude protein content supports the results of *Levi* (1963) and *Böttcher et al.* (1985), who found a similar tendency with utility-type pigeon populations.

The hatchability of laid and fertile eggs was also higher when pigeons were fed high protein diets, but these differences were not significant in either production period. The hatchability traits were 3-5% higher in the first than in the second cycle. The hatchability values recorded in this experiment were lower than those in the literature (*Waldie et al.*, 1991). The reason for this may have been the difference between natural matings in groups and cage matings. In pigeon populations it has often been observed that the reproductive performance of breeding pairs was reduced if sexually mature males and females were hindered in the process of choosing partners (*Levi*, 1963).

Significant differences were observed between the treatments in the number of squabs hatched and weaned. Significantly ($P<0.05$) higher values were obtained for these parameters when pigeons were fed the 20% CP diet in parallel with production cycles.

Squab mortality was also significantly ($P<0.05$) affected by the protein content of the diet. Feeding the 14% CP diet in the first and 12% CP in the second period resulted in the highest values, while the 20% CP diet led to the lowest values in both respective terms.

Parallel to increase in dietary crude protein content the 4-week body weight of squabs also increased significantly ($P<0.05$), although this difference did not exceed 6% between the diets of lowest and highest protein content in parallel with the first and second cycles. Diets containing less than 16% CP fed to pigeons kept in cages resulted in smaller weaned and marketable squabs. Similar tendencies have been observed for pigeons kept in groups in voliers (*Goodman* and *Griminger*, 1969; *Little* and *Angell*, 1977; *Böttcher et al.*, 1985). The difference in squab body weight between the 12% and 20% CP feed groups was about 25-30g in the two respective cycles. Annual squab production per pair was significantly ($P<0.05$) higher at 18% CP level compared to all the other treatments in the first and second production terms.

Table 2

Means of quantitative traits of utility-type breeding pairs fed diets containing different protein levels (30 pairs per treatment)

Trait (2)	Protein levels (%) (1)				
	12	14	16	18	20
Egg cycle (days) (3)	I.-27.84±0.97 ^a II.-28.65±1.11 ^a	28.50±1.17 ^a 29.10±1.26 ^a	29.84±1.38 ^a 28.84±1.45 ^a	30.56±1.93 ^a 28.35±1.78 ^a	27.53±1.67 ^a 30.27±1.92 ^a
Annual egg production (no.) (4)	20.18±2.17 20.50±1.58	21.18±2.72 20.96±2.94	21.08±2.43 ^a 21.49±2.69 ^a	22.10±3.67 ^a 21.24±4.33 ^a	22.53±3.25 ^a 22.85±3.85 ^a
Egg weight (g) (5)	21.16±1.63 ^a 21.12±1.09 ^a	21.75±1.38 ^a 21.30±1.65	21.51±1.57 ^a 21.99±1.78 ^a	21.55±1.52 ^a 22.01±1.42 ^a	22.09±1.23 ^a 22.24±0.97 ^a
Hatchability of laid eggs (%) (6)	59.56±18.31 ^a 62.58±12.09 ^a	61.23±17.14 ^a 63.45±17.43 ^a	59.45±19.31 ^a 63.10±20.62 ^a	61.22±21.47 64.94±19.25	62.35±16.97 ^a 64.56±18.27 ^a
Hatchability of fertile eggs (%) (7)	62.12±12.57 ^a 66.03±10.20 ^a	63.20±19.39 ^a 67.36±13.22 ^a	61.55±15.47 ^a 66.97±14.18 ^a	65.43±13.32 ^a 68.95±12.11 ^a	63.95±18.13 ^a 69.12±14.28 ^a
Hatched squabs per pair per year (no.) (8)	12.02±2.38 ^a 12.83±2.95 ^a	12.97±2.83 ^a 13.08±3.31 ^a	12.53±3.43 ^a 13.26±3.88 ^a	13.53±3.63 ^a 14.01±3.42 ^a	14.04±3.67 ^a 14.75±3.05 ^a
Weaned squabs per year (no.) (9)	8.17±3.41 ^a 8.48±3.15 ^a	8.61±4.05 ^b 8.98±3.55 ^b	8.58±3.89 ^a 9.35±3.92 ^a	9.37±3.63 ^c 9.92±3.60 ^b	10.20±3.13 ^c 11.12±2.97 ^c
Mortality of squabs up to weaning (%) (10)	32.02±15.27 ^a 33.90±16.66 ^c	33.61±17.23 ^a 31.53±18.44 ^b	31.52±18.33 ^a 29.72±19.91 ^b	30.74±20.12 ^a 29.19±19.47 ^b	27.35±19.67 ^a 24.61±18.11 ^a
4-week body weight of squabs (g) (11)	502.58±39.43 ^a 510.90±35.00 ^a	513.90±33.59 ^b 518.10±38.10 ^b	529.93±30.68 ^c 525.60±31.90 ^b	523.91±35.23 ^b 531.90±29.20 ^c	532.30±29.38 ^c 535.30±26.41 ^c
Annual squab production per pair (kg/pair) (12)	4.10±1.03 ^a 4.33±0.78 ^a	4.42±1.83 ^a 4.65±1.99 ^b	4.54±2.19 ^b 4.91±2.05 ^b	4.91±2.35 ^b 5.27±1.93 ^b	5.42±2.17 ^c 5.95±1.85 ^c

(a-c P<0.05)

I - First production term (*Erstes Produktionjahr*)II - Second production term (*Zweites Produktionjahr*)

2. Tabelle: Reproduktionsleistung von Masttauben bei unterschiedlichem Proteingehalt im Futter (30 Paare pro Behandlung)

Anteil Rohprotein(1), Merkmal(2), Zwischenlegezeit (Tage)(3), Eizahl(4), Eigewicht(5), Schlupfrate/gelegte Eier(6), Schlupfrate/befruchtete Eier(7), Geschlüpfte Küken jährlich pro Paar(8), Aufgezogenen Küken jährlich pro Paar(9), Mortalität der Jungtauben bis zur Entwöhnung(10), 4-Wochengewicht der Jungtauben(11), Jährliche Produktion an Jungtaubengewicht, kg/Paar(12)

The feed intake of the birds was also significantly ($P<0.05$) affected by the composition of the experimental diets (Table 3). Pigeons consumed higher quantities of the high-protein diets than of the others. Crude protein intake from the 20% CP diet was thus almost twice as high as that observed at 12% CP. These tendencies were the same in both production periods. The reason for the differences in feed consumption could be that the ME values of the experimental diets decreased with increase in CP (Table 1).

Since birds tend to eat in order to satisfy their energy requirement, the differences in feed intake were probably due to the lower ME rather to the CP values of the diets.

Table 3

Means of feed efficiency of meat-type breeding pairs fed diets containing different protein levels (30 pairs per treatment)

Trait (2)	Protein level (%) (1)				
	12	14	16	18	20
Daily feed intake of pairs (g/day) (3)	104.65±10.12 ^a	108.76±11.32 ^b	113.42±11.87 ^b	117.17±12.83 ^c	118.05±12.07 ^c
Daily protein intake of pairs (g/day) (4)	108.63±8.27 ^a	114.52±10.90 ^c	114.34±9.93 ^b	119.23±12.38 ^c	123.56±11.31 ^c
Daily ME intake of pairs (kJ/day) (5)	12.70±2.20 ^a	15.08±2.48 ^b	18.18±2.53 ^b	21.10±2.87 ^c	23.61±3.63 ^c
Annual feed consumption of pair (kg) (6)	13.18±1.98 ^a	16.09±2.61 ^b	18.81±2.61 ^b	21.47±3.28 ^c	24.71±3.39 ^c
Annual feed conversion of squabs (kg/kg) (7)	13.52±0.96 ^b	13.74±1.26 ^b	14.03±1.38 ^c	14.17±1.23 ^b	13.96±1.52 ^a
	14.03±0.78 ^a	14.46±1.45 ^a	14.51±1.29 ^a	14.42±1.67 ^a	14.61±1.66 ^a
	38.20±1.98 ^a	39.70±2.56 ^b	41.40±3.19 ^b	42.77±2.85 ^b	43.09±3.49 ^c
	39.65±2.62 ^a	41.80±2.26 ^b	42.83±2.94 ^b	43.52±3.19 ^b	45.10±3.78 ^c
	9.31±3.12 ^c	8.98±2.98 ^b	9.11±2.13 ^c	8.71±2.85 ^b	7.95±2.03 ^a
	9.15±2.91 ^c	8.98±3.81 ^b	8.72±2.38 ^b	8.25±2.67 ^b	7.57±2.17 ^c

(a-c P<0.05)

I - First production term (*Erstes Produktionjahr*)

II - Second production term (*Zweites Produktionsjah*)

3. Tabelle: Futterverwertung von Masttauben bei unterschiedlichem Proteingehalt im Futter (30 Paare pro Behandlung)

Anteil Rohprotein(1), Merkmal(2) Tägliche Futteraufnahme der Paare(3), Tägliche Proteinaufnahme der Paare(4), Tägliche Energieaufnahme der Paare(5), Jährlicher Futterverbrauch eines Paares(6), Jährliche Futterverwertung der Jungtauben(7)

In spite of the higher feed consumption of the 20% CP diet fed to adult birds, the feed conversion ratio of their squabs was the lowest in this case. This means that the higher feeding cost was compensated for by higher numbers of weaned squabs per breeding pair in the two consecutive terms.

From the results of this experiment it can be concluded that the protein content of pigeon diets plays an important role and effects the most important reproduction traits significantly. Feeding utility-type breeding pairs with high-protein diets increases both the number and the weight of weaned squabs. The feed conversion ratio of squabs can also be improved. The effect of difference in dietary ME value and energy: protein ratio requires further investigation.

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Möglichkeit und Perspektiven zur Entwicklung der Bienenzucht und der Bienenenerzeugnisse in der Republik Kroatien

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ZUSAMMENFASSUNG

Die Bienenzucht hat in Kroatien eine lange Tradition. Im ökologische Milieu des mediterranen und kontinentalen Teil Kroatiens kommen zahlreiche honigtragende Pflanzen vor. Die Qualität des Honigs und dessen Produkte stehen auf einem qualitätsmäßig außerordentlich hohen Niveau. Das wird sowohl von den organoleptischen Beurteilungen als auch von den chemische Analysen bestätigt, welche jedes Jahr durchgeführt werden. Um eine Entwicklungsperspektive zu ermöglichen, muss die gegenwärtige Produktionsorganisation verändert werden. Das bedeutet: Veränderung der Struktur der Bienenstöcke, Übergang von der stationären auf Wanderimkerei, höherer Verarbeitungsgrad von Honig und Pollen bei der Erzeugung von Lebensmitteln, Reformenerzeugnissen, medizinischen und kosmetischen Artikeln.
(Schlüsselwörter: Bienenhaltung, Bienenkörbe, Imker, Honig, Pollen)

ABSTRACT

Possibilities and perspectives for the development of apiculture and apiculture products in the Republic of Croatia

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Apiculture has a long tradition in Croatia. The ecological medium in the Mediterranean and continental part of Croatia is full of different vegetables appropriate for honey production. The quality of honey and honey products in Croatia is high, this being confirmed by high organic-leptic marks and chemical analyses carried out every year. In the interest of achieving progress it is necessary to change the current mode of production organisation in the following way: changing the structure of beehives and increasing the rate of modification of honey and pollen to a higher number of various food, curative and cosmetic products.

(Keywords: bee-keeping, beehive, bee-keepers, honey, pollen)

EINFÜHRUNG

Die zahlreich vorkommenden verschiedenen honigtragenden Pflanzen im mediterranen und kontinentalen Teil des Landes ermöglicht die Bienenzucht als Wirtschaftssektor. Um sichtbare Ergebnisse zu erzielen ist es wichtig, die bisherige Produktionsorganisation zu verändern. Das bedeutet die Veränderung der Struktur der Bienenkörbe, Übergang von der stationären auf die wandernde Bienenzucht und umfangreichere Verarbeitung von Honig und Pollens in eine Reihe von Produkten für Ernährung, Gesundheit und Kosmetik.

MATERIALS UND METHODE

Die sozialökonomische Lage der Bienenzucht in Kroatien

Bei der Auswertung der sozialökonomische Lage der kroatischen Bienenzucht stützten wir uns auf die Daten des Verbandes der Kroatischen Bienenzüchter (*Balint, Brence-Lazarus, Brkljačić, Dominiković, Kolega, Laktić, Majnarić, Pavlek-Moćan, Sulimanović, Tadić*, 1992).

Organoleptische Beurteilung des Honigs

Die organoleptische Beurteilung der Honigqualität wurde mit den Standardmethoden der Sinnesorgane durchgeführt (Geruch, Geschmack, Blick), (*Tucak, Puškadija, Bešlo, Bukvić, Milaković*, 1998).

Chemische Beurteilung des Honigs

Feststellung des Wassergehaltes im Honig. Die Feuchtigkeit wurde durch die übliche Methode – 48 Stunden langes Trocknen der Probe bei einer Temperatur von 105°C – bestimmt (*Bogdanov, Martin, Lullmann*, 1997).

Feststellung der gesamten Proteine

Die gesamten Proteine wurden mit Hilfe der modifizierten Methode der Biuretischen Reaktion Follin-Zowry mit dem Follin-ciocalteat-Reagensen festgestellt. Die abgelesene Konzentration der gesamten Proteine liegt an der Grenze von 3-0,3 (*Lowry, Rosenbrough, Faerr, Randall*, 1971).

Bestimmung der Säure im Honig

Der Säuregehalt wurde mit der Methode bestimmt, die sowohl in der Republik Kroatien als auch in der Europäischen Union vorgeschrieben ist. Bei dieser Methode wird die vorbereitete Probe titriert, mit Phenolphthalein, mit einer Lösung 0.1 mol/l Natrium-Hydroxyd bis zum Umschlag auf eine lichtrosa Farbe (*Bogdanov, Martin, Lullmann*, 1997; Službeni list SFRJ 4/85, 1985).

Feststellung des Invertzuckers

Der Invertzucker wurde durch die volumetrische Methode mit der Fehlingschen Lösung nach Bertrand bestimmt. Diese Methode beruht auf dem Verfahren, dass man das Kupferoxyd (Cu_2O) mit der sauren Lösung Eisenammoniumsulfat ($(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2$) bei Cu^{+2} auflöst, welches mit 0,1 m KMnO_4 titriert wird. Aus dem abgelesenen Wert des KMnO_4 wird die Menge des Kupfers berechnet, und aus der errechneten Menge Cu wird in der Tabelle die Invertzuckermenge abgelesen (*Bogdanov, Martin, Lullmann*, 1997; Službeni list SFRJ 4/85, 1985).

Ermittlung der α -Amylase

Die Methode zur Feststellung der α -Amylase ist die Standardmethode und basiert auf der Hydrolyse einer 1%-igen Stärkelösung der Enzyme aus 1 g Honig innerhalb einer Stunde bei einer Temperatur von 40°C (Bogdanov, Martin, Lullmann, 1997).

ERGEBNISSE UND DISKUSSION

Die sozialökonomische Situation der Bienenzüchter in Kroatien

Nach den Daten des Bienenzuchtverbandes gibt es in Kroatien insgesamt 6.720 Bienenzüchter, die mit 205.904 Bienenstöcken arbeiten. Ungefähr 35% aller Bienenzüchter ist in Bienenzüchtervereinen, wo sie Möglichkeiten haben zur Weiterbildung, Zugang zu Fachliteratur haben, neue Technologien kennenlernen und von neuen Behandlungsmethoden für kranke Bienen erfahren (1. Abbildung).

1. Abbildung

Organisation der Bienenzucht in Kroatien

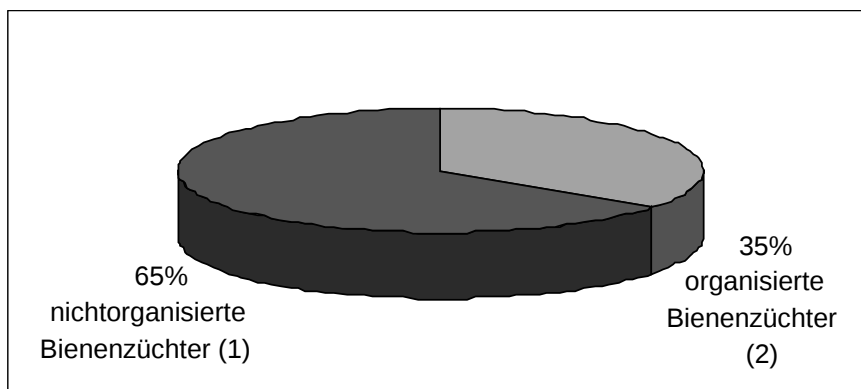


Figure 1: Organized and anorganized beekeeping in croatia

Anorganized beekeeping(1), Organized beekeeping(2)

Da aber die Anzahl der nichtorganisierten Bienenzüchter viel höher ist, sind auch die zur Verfügung stehenden Daten des Verbandes nicht ausreichend. Man kann davon ausgehen, dass es in Kroatien insgesamt ca. 7-8000 Bienenzüchter gibt mit durchschnittlich je 45 Bienenstöcken (Hrvatski pčelarski savez, 1999).

In der Republik Kroatien hat ein durchschnittlicher Bienenzüchter ca 30 Bienenstöcke, was in dieser Größenordnung gleichzeitig Hobby und Nebenerwerb ist. Aber ca 10% der Bienenzüchter verfügen über 100 und mehr Bienenstöcke, und auf diese stützen sich die Bemühungen, eine moderne Bienenzucht in Kroatien zu entwickeln.

Die Bienenzucht wird zu etwa 31% als Hobby betrieben, wobei wir die Anzahl der Bienenstöcke bis zu 20 Stück annehmen, 68% fallen auf die Imkerei als Nebenerwerb - mit etwa 20-200 Bienenstöcken – und als Vollerwerb, wo wir mehr als 200 Bienenstöcke pro Unternehmen annehmen. Die Zucht von Schwärmen und Mutterbienen ist nur zu 1% vertreten (2. Abbildung).

2. Abbildung

Die Kategorien der Bienenzucht

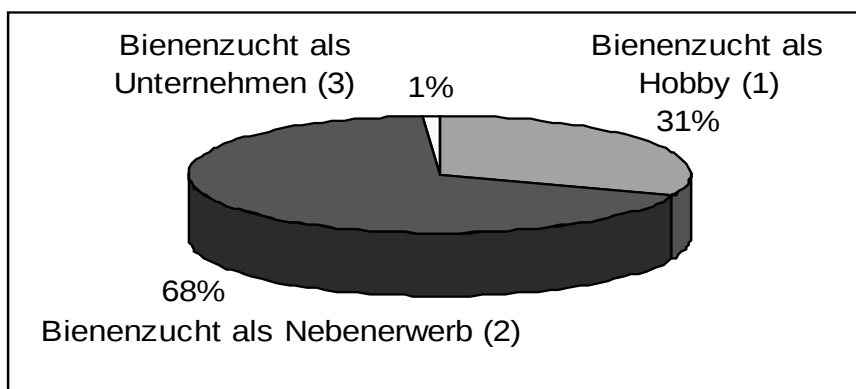


Figure 2: Categories of beekeeping

Beekeeping as hobby(1), Beekeeping as second job(2), Beekeeping as profession(3)

Die Haupteinnahmequelle der Imker ist der Honig, und erst danach folgen die übrigen Bienenprodukte - Schwärme, Wachs, in der letzten Zeit Mutterbienen, Propolis und Blütenpollen. Obwohl der Honig das Hauptprodukt ist, ist der Ertrag pro Bienenstock auf dem niedrigen Niveau von 10-15 kg (1. Tabelle).

1. Tabelle

Honigertrag je Bienenstock in Kroatien

Jahr (1)	Honigertrag je Bienenstock (2)
1990.	10,8
1991.	7,5
1992.	13,0
1993.	13,3
1994.	13,4
1995.	16,9
1996.	15,2

Table 1: Production of honey per beehive

Year(1), Production of honey per beehive(2)

Es wird aber angenommen, dass der Honigertrag höher ist, da diese Daten aufgrund der aufgekauften Menge errechnet wurde. Die Honigmenge für den Selbstverbrauch und den Direktverkauf ist jedoch unbekannt.

Bei der Bienenzucht in Kroatien werden hauptsächlich zwei Typen von Bienenstöcken verwendet: LR und AZ. Beide Typen haben je einen Anteil von 45% an

der Gesamtzahl. Die verbleibenden 10% bestehen aus dem Typ Dadant-Blatt und zu einem geringen Teil aus Stroh geflochtenen Bienenstöcken (3. Abbildung).

3. Abbildung

Bienenstocktypen in Kroatien

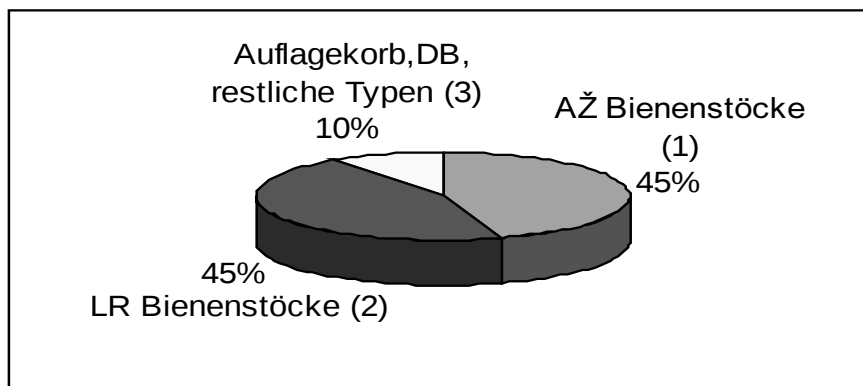


Figure 3: Types of bee hives in Croatia

AŽ type of beehive(1), LR type of beehive(2), Other types of beehives(3)

50% der Imker arbeitet mit den LR-Körben, 23% mit den AZ Körben und 28% mit allen beiden Typen. Daraus ist zu schließen, dass mit den LR Körben zwei mal mehr Imker arbeiten, als mit den AZ.

4. Abbildung

Stationäre und wandernde Imkerei in Kroatien

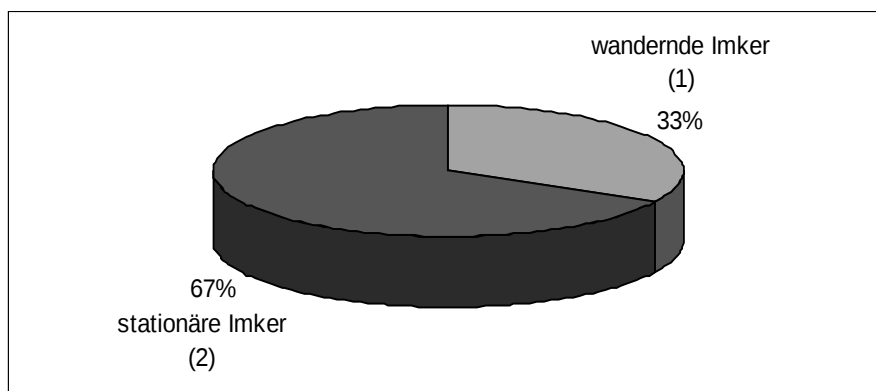


Figure 4: The rate of moving and staying at one place beekeeping

Moving beekeeping(1), Staying at one place beekeeping(2)

Fast 100% der Bienenstöcke bestehen aus der amerikanischen Ausführung mit 10 Rahmen, denn der AZ-Typ wurde aus den Standard-Bienenstöcken mit 10 Rahmen und dem AZ-Typ mit 12 Rahmen entwickelt.

Heutzutage ist es bekannt, dass es keine intensive Bienenzucht ohne Wanderung gibt. Bei uns wandern nur 1/3 der Imker. Die wandernden Imker besitzen hauptsächlich AZ Bienenstöcke. Sie haben unter den wandernden Imkern einen Anteil von 60%, während die restlichen 40% über LR-Stöcke verfügen (4. *Abbildung*).

Das durchschnittliche Alter der kroatischen Imker ist 55 Jahre. Vielleicht liegt in dieser Information die Antwort für den niedrigen Honigertrag je Bienenstock, für die niedrige Anzahl der Stöcke je Imker, für das Fehlen der Unternehmungslust und für fehlendes Interesse an neuen Produktionswegen. Die Imker in diesem Lebensalter betreiben die Bienenzucht zu ihrer Regeneration und als gesundes Hobby, bei dem sogar noch einige Einnahmen entstehen (Balint, Brence-Lazarus, Brkljačić, Dominiković, Kolega, Laktić, Majnarić, Pavlek-Moćan, Sulimanović, Tadić, 1992).

Die Honigbiene Kroatiens

Die kroatische Honigbiene ist eine von den vier europäischen Bienenrassen und wird "Kranjer-Biene" - *apis mellifera carnica* - genannt. Diese Biene ist im Donauebiet, den südöstlichen Alpen und auf dem ganzen Balkan verbreitet. In diesen Gebieten kommen spezielle Arten dieser Biene vor: die Kroatische, die Banatische, die Macedonische und die Karpatische (Dadant, 1975).

Diese Biene ist heller als die europäische. Im Frühling entwickelt sie sich mit großer Intensität. Sie überwintert sehr gut auch bei strengen Wintern. Im Frühling hat sie wegen ihrer schnellen Entwicklung und Vitalität einen stärker ausgebildeten Schwarmtrieb. Zum Glück ist sie ruhig, von guter Natur und laut einiger Autoren sogar die ruhigste und sanfteste Bienenart (Belčić, Katalinić, Loc, Lončarević, Peradin, Sulimanović, Šimić, Tomašec, 1990).

Die Honigpflanzen Kroatiens

Pflanzen aus Wald, Wiese und Weide sowie angebaute honig- und pollentragende Pflanzen (Kranjčević, 1990).

- | | |
|---|--|
| – Ahorn - <i>Acer Campestre</i> L. | – Wilde Kirsche - <i>Prunus avium</i> L. |
| – Schwarze Esche - <i>Alnus glutinosa</i> Gartn | – Schwarze Pappel - <i>Populus nigra</i> L. |
| – Zigeunerfeder - <i>Asclepias syriaca</i> L. | – Steineiche - <i>Quercus robur</i> L. |
| – Kriechendes Weidengebüsch - <i>Aiuga reptans</i> L. | – Wilde Brombeere - <i>Rugos fruticosus</i> L. |
| – Amorfa - <i>Amorpha fruticosa</i> L. | – Akazie - <i>Robinia pseudacacia</i> L. |
| – Weisse Birke - <i>Betula alba</i> L. | – Weiße Weide - <i>Salix alba</i> L. |
| – Weißdorn - <i>Crataegus oxyacantha</i> L. | – Goldrute - <i>Solidago serotina</i> Ait. |
| – Hasel - <i>Carpinus betulus</i> L. | – Linde - <i>Tilia</i> sp. |
| – Weißbuche - <i>Carpinus betulus</i> L. | – Ölrap - <i>Brassica oleracea</i> |
| – Edelkastanie - <i>Castanea sativa</i> L. | – Sonnenblume - <i>Helianthus annuus</i> L. |
| – Waldbeere - <i>Fragaria vesca</i> L. | – Zahme Nuss - <i>Jubans revija</i> L. |
| – Schneeglöckchen - <i>Galanthus nivalis</i> L. | – Apfel - <i>Malus pumila</i> Mill. |
| – Efeu - <i>Hedera helix</i> L. | – Hauspflaume - <i>Prunus domestica</i> L. |
| – Weißer Maulbeerbaum - <i>Morus alba</i> L. | – Weinrebe - <i>Vitis vinifera</i> L. |
| – Schwarzdorn - <i>Prunus spinosa</i> L. | – Mais - <i>Zea mays</i> L. |

Die oben angeführte Pflanzen aus Wald, Wiesen und Weiden sowie die angebauten honig - und pollentragenden Pflanzen stellen nur einen Teil der reichen Bienenweide in Kroatien dar. Da sich in Kroatien sowohl kontinentale Gebiete als auch Küstenlandschaften befinden, kann man auch die Honigpflanzen danach einteilen, d.h. in jene der kontinentalen Landschaft, des Küstenbereiches und des Kalkebirges.

Neben den Honigpflanzen im Kontinentalgebiet - wie z.B. Linde (*Tilia* sp.), Akazie (*Robinia pseudacacia*), Edelkastanie (*Castanea sativa* L.), Amorre (*Amorpha fruticosa* L.) - und einer Vielzahl verschiedener Wiesenpflanzen wächst die Bedeutung der angebauten Pflanzenkulturen, angefangen vom Obst bis zum Ölrap (*Brassica oleracea*) über die Sonnenblume (*Helianthus annuus* L.). Die Anbaufläche letzterer nimmt von Jahr zu Jahr zu.

Bienenprodukte

Da in Kroatien der Honig das Haupterzeugnis der Imkerei ist und davon auch die Haupteinnahmen stammen, wird hier nicht weiter auf die sonstigen Erzeugnisse der Bienenzucht eingegangen.

Wie es aus der *Tabelle 2* zu sehen ist, sind die Honigarten nach der Menge ihrer Erzeugung aufgeführt in der Reihenfolge: Akazienhonig, Blütenhonig, Lindenhonig, Laubbaumhonig und Nadelbaumhonig, Sonnenblumenhonig und Rapshonig. Jede Honigarten hat ihre charakteristische organoleptische Beschreibung (*2. Tabelle*), (*Tucak, Bačić, Horvat, Puškadija, 1999*).

2. Tabelle

Die organoleptische Eigenschaften von Honig – 1998

Lfd. Nr.	Honigart (1)	organoleptische Eigenschaft (2)
1.	Akazienhonig (3)	gelb, fließend, angenehmer Geruch und Geschmack
2.	Blütenhonig (4)	dunkler, gelb, von sehr angenehmen Geruch und Geschmack, ein wenig kristallisierend
3.	Laubbaumhonig (5)	dunkelfarbig, herb im Geschmack, intensiv riechend und sehr dick.
4.	Lindenhonig (6)	gelb, duftet nach Lindenblüten, angenehmer Geschmack, ein wenig kristallisierend
5.	Nadelbaumhonig (7)	rötlich dunkel, fließend, derb im Geschmack, schwache Geruchsintensität, dick

Table 2: Organic – leptic characteristic of honey –1998

Type of honey(1), Organioleptic properties(2), Acacia(3), Flowery(4), Decidious honey-dew(5), Linden(6), Conifer honey-dew(7)

Gemäß ihren physikalischen und chemischen Eigenschaften erfüllen die Honigarten aus Kroatien die Kriterien der Europäischen Union (*3. Tabelle*), (*Bogdanov, Martin, Lullmann, 1997; Službeni list SFRJ 4/85, 1985*).

3. Tabelle

Ergebnisse der chemischen Analyse von Honig

Lfd. Nr.	Honigart (1)	Pollen analyse % (2)	Wasser % (3)	Proteine gesamt % (4)	Säuren (5)		α -Amylase (6)	Red. zucker (7)
					ph	mmol kis/kg		
01.	Akazienhonig (8)	22-26	21,51	3,049387	6,44	13,01	26,09-40,00	70,6
02.	Blütenhonig (9)	-	26,91	2,220048	6,45	13,39	27,27-35,29	72,5
03.	Laubbaumhonig (10)	-	21,61	2,249669	6,79	29,47	29,27-37,50	69,1
04.	Lindenhonig (11)	30-48	22,91	1,467099	6,78	28,71	29,27-35,29	70,5
05.	Nadelbaumhonig (12)	-	24,03	0,344320	6,73	25,61	35,29-37,50	72,4

Standard nach amtlicher Vorschrift (15)

Republik Kroatien (13)	-	Do 21	-	-	do 40	min. 8	*min. 65
Europäische Union (14)	-	Do 21	-	-	do 40	min 8	*min. 65

* und mehr (*and over*)

Table 3: Results of chemical analysis of honey

Honey type(1), Pollen analysis(2), Water(3), Total proteina(4), Acidity(5), α -amylase(6), reduc. sugars(7), Acacia(8), Flowery(9), Deciduous honey-dew(10), Linden(11), Conifer honey-dew(12), Republic of Croatia(13), European Union(14), Official standard(15)

SCHLUSSFOLGERUNGEN

- Um die Bienenzucht als Sektor der Landwirtschaft zu entwickeln, muss die gegenwärtige Produktionsorganisation verändert werden.
- Die Bienenzucht sollte immer mehr als Produktionsform zum Haupterwerb entwickelt werden und sollte als Nebenerwerb oder Hobby aufgegeben werden.
- Die Struktur der Bienenstöcke muss verändert werden.
- Man sollte von der vorwiegend stationären auf die vorwiegend wandernde Imkerei übergehen.
- Erhöhung der Verarbeitung von Honig und Pollen in verschiedenartige Nahrungsmittel, Reformertezeugnisse, medizinische und kosmetische Artikel
- Die organoleptische Beurteilung des Honigs hat gezeigt, dass alle getesteten Proben jene Eigenschaften haben (Farbe, Geruch und Geschmack), die für jede einzelne Art charakteristisch sind.
- Die chemische Analyse zeigt die reichen Inhaltsstoffe des Honigs an (Proteine, Zucker und restliche Parameter), welche auch den Kriterien der Republik Kroatien und der Europäischen Union entsprechen.

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SECTION 5

ECONOMICS AND AGRICULTURAL ORGANISATION AND MANAGEMENT



The influence of producer prices on livestock production development in Croatia

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ABSTRACT

An aggregate indicator of the influence of producer prices on the whole of agricultural production in the Republic of Croatia for the period 1981-1997 shows that the prices of agricultural products did not determine the level of production in great measure. The coefficient of determination shows that only 41% of the change in agricultural production can be explained by changes in producer prices, and 59% by the influence of other factors. It is well known that a more significant influence on changes in some production levels is exerted by producer prices from the previous year or years. Shifted by one year, the influence of producer prices on production (the price in year X in relation with production in year X+1) is much more significant, so the coefficient of correlation for the period analysed is $R=0.75$ and the coefficient of determination is 0.55. The higher the producer price for the next year or period, the higher the level and quality of agricultural inputs consumed. This research shows that in the production of basic livestock products there exists no substantial relation between producer prices and changes in production level. (Keywords: agricultural production, livestock production, producer prices)

ZUSAMMENFASSUNG

Einfluss der Produzentenpreise auf die Erzeugung tierischer Produkte in Kroatien

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Der gemeinsame Indikator des Einflusses der Produzentenpreise auf die gesamte landwirtschaftliche Produktion in der Republik Kroatien für den Zeitraum von 1981 bis 1997 zeigt, daß die Preise für landwirtschaftliche Produkte das Produktionsniveau nicht wesentlich beeinflussen haben. Der Determinierungskoeffizient zeigt uns, daß nur 41% der Änderungen der landwirtschaftlichen Produktion durch Produktionsänderungen erklärt werden können und 59% durch andere Faktoren. Es ist bekannt, daß die Produzentenpreise aus dem Vorjahr einen bedeutenden Einfluß auf die Änderungen in einigen Produktionsbereichen haben. Den Einfluß der Produktionspreise auf die Produktion (um ein Jahr) zu verschieben (der Preis im Jahre X im Verhältnis zu der Produktion im Jahre X+1) ist viel aufschlussreicher, da der Korrelationskoeffizient für den analysierten Zeitraum $r^2=0,75$ beträgt, der Determinierungskoeffizient 0,55. Ein höherer

Produktionspreis im Folgejahr bedeutet ein höheres Niveau und eine bessere Qualität der verwendeten landwirtschaftlichen Aufwendungen. Unsere Untersuchung zeigt, daß bei der Produktion der dominierenden Tierprodukte keine bedeutende Verbindung zwischen den Produzentenpreisen und den Änderungen im Produktionsbereich besteht.

(Schlüsselwörter: Landwirtschaftliche Produktion, Tierproduktion, Produktionspreise)

INTRODUCTION

The producer prices of agricultural products influence the production level to a more or less intensive degree. The intensity of this relation is most often determined by a biological cycle of individual production, and this analysis has shown either stronger or weaker influence of producer prices on the level of agricultural production during the period analysed. There are considerable differences between individual products due to the duration of the production cycle.

The familiar problems caused by the situation in agriculture as a whole as well as in livestock production adversely affected the changes in livestock production. In the years analysed, although there were some attempts by the state to stimulate development in livestock production (by means of subsidies and premiums), the lack of other measures, together with uncontrolled imports which have often been on the verge of the illegal import of goods of dubious quality, posed an obstacle to more comprehensive changes. The quantity of livestock destroyed, particularly in the cattle and pig breeding sectors, led to an increase in producer prices for beef cattle, and producer prices consequently increased for almost all categories of beef cattle.

The changes in livestock production were also caused by a number of non-economic factors: change in the social-economic system, dissolution of the market of the former state, war damage, bans and lack of export possibilities for some types of livestock and meat, problems related to the transformation of former state-owned companies (agricultural complexes), and the like.

METHODOLOGY AND DATA SOURCES

The trends in production and producer prices were determined by the application of trend methods (rectilinear and curvilinear), where the trend applied was the best illustration of a change during the period analysed.

Regression and correlation analyses were used to determine interrelation between production and price. To that end, a model of the following general form was used:

$$PM=f(\check{CPM}) \quad \check{C}=1,2,3, \dots, N$$

The producer prices are the buying off prices established by the agricultural producers, which do not include the state and/or processor subsidies. Because of changes in local currency and inflation, all prices in the calculations are expressed in German Marks (medium exchange rate of the Privredna Banka Bank in Zagreb). The data on livestock production were obtained from the State Bureau of Statistics of the Republic of Croatia.

RESULTS AND DISCUSSION

Production of major livestock products in Croatia (period 1981-1997)

Meat cattle production

Since 1981 meat cattle production has constantly been on the decrease. The difficult economic situation in Croatian agriculture has been reflected most strongly in meat cattle

production. The highest decrease has been recorded since 1992, and the negative trend has not yet stopped. Taking into consideration the duration of the reproductive cycle in cattle breeding, recovery in production and the attainment of the pre-war level will demand considerable investment for a lengthy period of time. It is particularly alarming that the disappearance of meat cattle production on large, formerly state-owned farms was not followed by an adequate increase in family farm production. Recovery in this production will be an indicator of increase in total production in the Republic of Croatia (due to the comparatively large proportion of this production in total agricultural production).

In 1981 meat cattle production was 150,000 tonnes, to drop by 1997 to less than half (61,780 tonnes). The average for the entire period was 54,238 tonnes.

Meat pig production

Pig breeding production is closely related to corn production and the general standard of living. The pig supply sector is dominated by small producers (1-5 sows) accounting for 75% of production. Large-scale producers, which hold more interest for the market, make up only 30% of production. Family farms must increase their productivity in pig breeding and maintain high quality. Pork consumption requirements have not been adequately met. However, the prominent position in this production sector will be occupied by quality products. Pork has the highest share in consumption, so state interest in supporting loans for production is obvious.

Pork production during the period in question indicates a reduction from 266,000 tonnes in 1981 to 162,702 tonnes of pig meat produced in 1997. The average production for the entire period was 165,994 tonnes per year.

Meat poultry production

Poultry (i.e., fowl) meat production and consumption (particularly that of hens, i.e. broilers) depends mostly on changes in beef/pork prices and changes in the general standard of living.

Poultry meat production has made the greatest progress, and its share in total meat consumption is increasing constantly. This has been achieved by good results of selection based on the following characteristics: animal feed conversion, daily weight gain, and a shorter fattening period.

By the end of the eighties meat poultry production was on the increase, followed by a period of stagnation and finally a considerable decrease.

The greatest decrease recorded after 1990 was that which occurred in 1995, when production fell to the level of the end of the previous decade. In 1996 and 1997 a slight increase in production was observed. In 1997 meat poultry production was about 7,000 tonnes.

Cow's milk

The production of (milked) cow's milk showed a decrease from 1,020 million litres in 1981 to 576 million litres in 1997.

Milk production is affected by numerous adverse factors, along with the human factor reflected in demand for cost-effectiveness, or rather for a high production rate. To achieve an adequate production rate and work efficiency, and to provide an environment suitable for both humans and cattle, high investment in cattle, structures and equipment is necessary. High investment in basic production resources, labour and fodder may be justified only if the milk production per head is high. High milk production demands quality fodder, intensive feeding and an adequate meal structure. The average annual production for the period analysed was about 603 million litres.

Hen's eggs

The fastest growth within the sector of agricultural, particularly livestock production was realised in poultry production. The application of scientific results and the development of technology have increasingly reduced the dependency on natural conditions of this field of production. The results attained in meat and egg production have demonstrated an exponential increase.

Production of consumer hen's eggs shows no significant annual fluctuations. The level of this was recently somewhat above 800 million eggs per year.

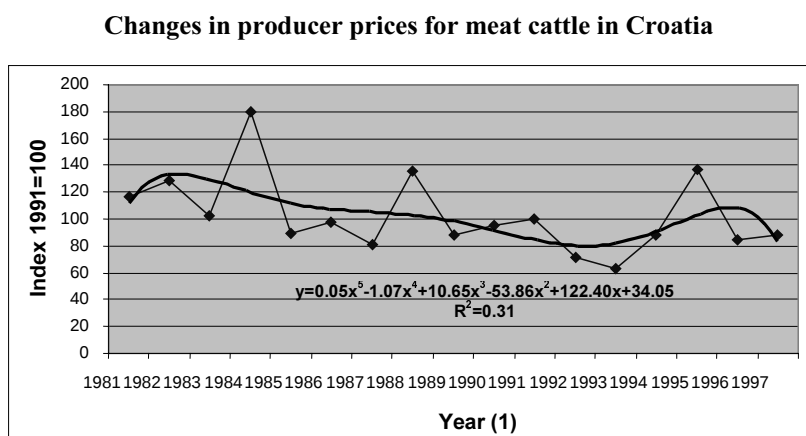
This production is significantly affected by the unregulated import regime.

Egg production in Croatia is concentrated on large farms and family farms. The large farms have introduced industrial production technologies which enable continuous production throughout the year. The small family farms still have low external input production. The family farms usually have several dozen hens which start laying eggs in February and stop mid-year, while during the rest of the year production is negligible. The low and variable laying rate is affected by the low genetic potential of domestic breeds, insufficient feeding and inadequate keeping systems. During the period of the higher laying rate the surplus production is offered on the market. During this period production considerably exceeds demand, it is difficult to sell eggs on the market and prices drop. For the rest of the year the situation is the opposite. Therefore fluctuations in egg production have a considerable impact on the egg market. The egg supply is not uniform throughout the year, and the price is high from September to January, which affects demand in that period.

Change in producer prices and their influence on production of major livestock products Meat cattle production

Producer prices in cattle breeding, particularly in meat cattle production, are influenced significantly by the market, along with state foreign trade policy (import/export regime, domestic production protection against illegal or uncontrolled import, export incentives and the like). Recently beef production was generally governed by foreign trade measures and a considerable change in price was observed during the period studied.

Fig. 1



1. Abbildung : Veränderungen der Produzentenpreise für Rindern in Kroatien

Jahre(1)

The lowest producer price for the buying off of cattle (live weight) was recorded in 1993, when Croatian export into the traditional European markets was obstructed (due to alleged foot-and-mouth disease). The subsequent price increase lasted until 1995, to drop subsequently to 3.5 DEM/kg live weight.

During the period analysed the annual changes in producer prices in cattle production were significant; the producers' reaction to price changes was slower because of the longer biological production cycle (coefficient of determination 0.14). The greatest proportion of meat cattle production is achieved by those producers who, on average, have a small number of cattle per farm. At the same time, the former state-owned sector, which had been a large producer of beef, has been almost eliminated, so the current low level of production is not capable of fast reaction to changes in producer prices.

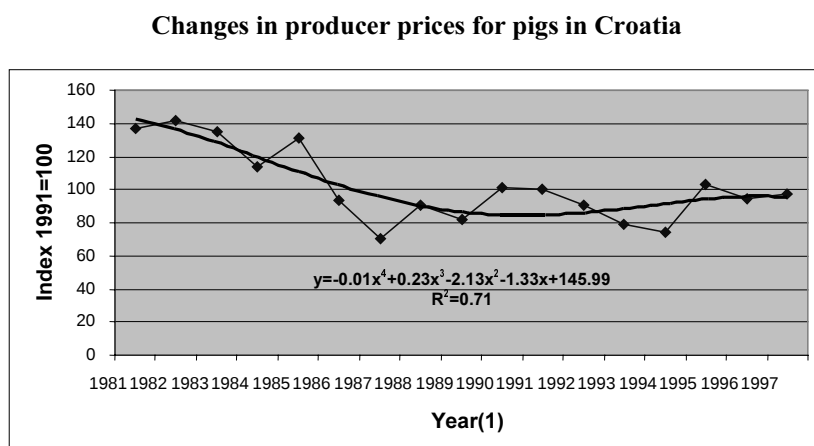
Meat pig production

Producer prices for pigs are most affected by changes in the corn market. The known pork production cycles are also applicable in Croatia.

Pork prices take shape on the market, based on the effects of supply and demand. An unregulated pig market, such as that in Croatia, displays a constant imbalance in pork supply and demand caused by the pig cycles. The most important influence on the pig supply is not that of absolute pig price but rather that of the relation between the price of pig per kg and the price of 1 kg fodder, in this case corn.

As already stated, producer prices for pigs reveal the classic, predictable pattern of change. The first cycle during the period analysed was up to 1987 and the second from 1987 to 1994, while the third is the current period of increase in producer prices. The highest producer prices were recorded at the beginning of the period analysed (over 4 DEM/kg live weight), and they have since decreased to stabilise at about 3 DEM/kg during the past few years.

Fig. 2



2. Abbildung: Veränderungen der Produzentenpreise für Schweine in Kroatien

Jahre(1)

As compared to meat cattle production, producer prices in pig production have somewhat more significant influence on the level of production ($R=0.40$). The influence of producer

prices on production level shifted by one year is also low ($R=0.46$), which might be explained by the following facts.

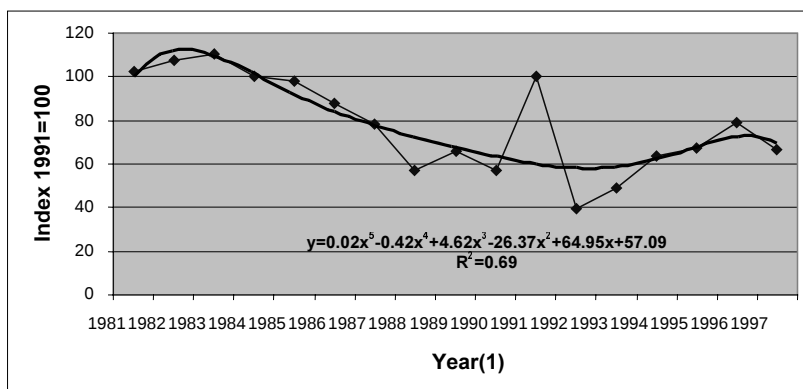
- Pig production is closely correlated with corn production and changes in producer prices of corn (known as ‘pig’ cycles).
- A comparatively high proportion of pig trade is carried out among peasant farmers, and statistics for a considerable proportion of trade and pig prices remain unrecorded at the end of the year.
- A considerable share of the total quantity of pig meat produced is accounted for by natural production and selling on the family farms.

Meat poultry production

Until 1990 poultry producer prices (particularly those for fattened chickens, i.e. broilers) had been showing a decreasing trend. In that period, when the signs of economic crisis were becoming obvious, poultry meat was a substitute for other kinds of meat, particularly beef. The system of protection of the general standard of living was partly based on chicken meat prices because during that period the majority of market surpluses were generated by large state-owned farms. At the same time, the number of both state-owned and private farms suddenly increased, and industrial production technology was predominant.

Fig. 3

Changes in producer prices for poultry in Croatia



3. Abbildung: Veränderungen der Produzentenpreise für Geflügel in Kroatien

Jahre(1)

A large increase in producer prices for poultry meat was recorded in 1991 (at the beginning of the war), but even as early as 1992 prices dropped to approximately 1.5 DEM/kg live weight. Prices subsequently increased with a slight drop in 1997.

The producer price of meat poultry for the period 1981-1997 did not significantly influence the changes in production. The coefficient of determination shows that change in production of only 8% may be explained by changes in producer prices, and change of 25% by the effect of price from the previous year. The other influential factors include the following.

- In the pre-war period poultry meat consumption was on the decrease and the consumption of other, higher quality kinds of meat on the increase.

- Total poultry meat production was based on the production of family farms with low average numbers of poultry.
- A significant part of production was intended for natural consumption with a high proportion of unregistered trade.

Hen's eggs

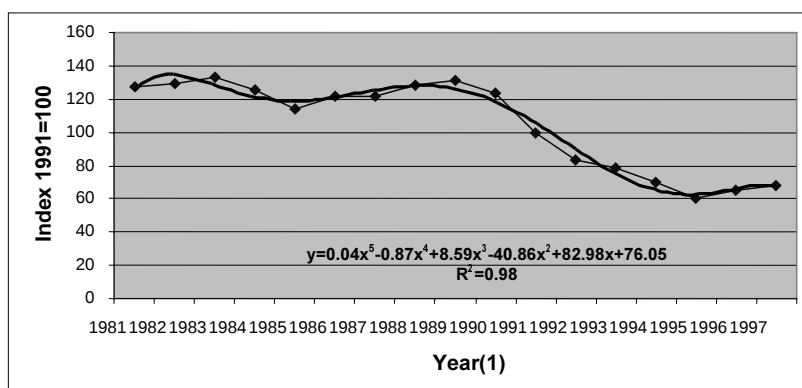
Producer prices for consumer hen's eggs are mostly determined by supply and demand and, recently, by the effects of the unregulated and often legally dubious system of foreign trade exchange in Croatia.

During the period analysed the total production of hen's eggs did not show any significant reaction to changes in producer prices. The changes in the market were affected by foreign trade measures (primarily import) rather than by domestic production.

The increase in egg production affected consumption and the egg market. The prices were on the decrease, and demand/consumption was on the increase. Eggs ceased to be an expensive food in many countries, which was the reason that the major egg importers became exporters.

Fig. 4

Changes in producer prices for hen's eggs in Croatia



4. Abbildung: Veränderungen der Produzentenpreise für Hühnereier in Kroatien

Jahre(1)

From 1981 to 1988 producer prices for consumer eggs decreased. After that period the prices went up, the highest prices having been recorded in 1991. After that, egg prices decreased and are now about 0.175 DEM per egg.

Due to a number of factors already mentioned producer prices have no significant impact on the level of hen's egg production.

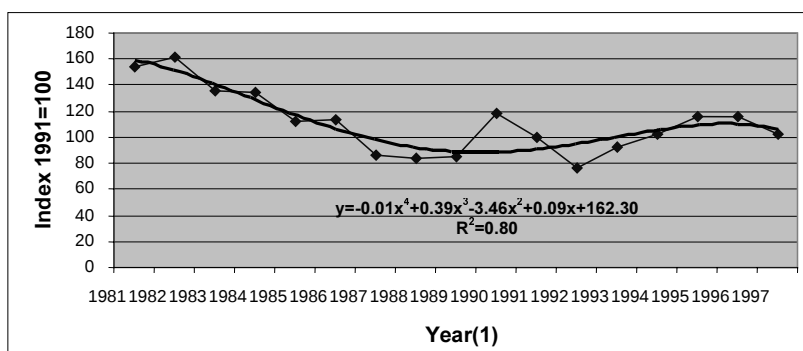
Cow's milk

For a prolonged period of time the state has been subsidising milk production, and the subsidies have occasionally changed as regards method, level and form. Milk prices are controlled by the state. The lower prices set are intended for the protection of the poorer groups of the population. This affects the participants in the milk market. The dairies

make only minimum profit from consumer milk and the trade margin is not high, which discourages traders from selling milk. Most of milk production is cow's milk production, a negligible proportion being accounted for by that of goat and sheep milk. Average milk production in Croatia is based on average low milking capacity per cow. During the recent years an increase has been recorded in total milk buying off and price.

Fig. 5

Changes in producer prices for cow's milk in Croatia



5. Abbildung: Veränderungen der Produzentenpreise für Kuhmilch in Kroatien

Jahre(1)

From 1981 to 1989 producer prices for milk decreased. A significant increase was recorded in 1990, and the next two years were a period of new decrease in price. After that, milk prices increased to about 0.4 DEM per litre of bought-off milk (premiums not included).

Producer prices for milk did not significantly influence the change in production level during the period analysed. The coefficient of determination was rather low (0.13), and producer price had more influence on the buying off level. So the loose relation between producer price and production might be explained as follows.

- Producer prices for milk have long been under direct influence and subject to intervention by the state in the interest of protecting the consumer standard of living (social character).
- The number of cows in Croatia has decreased for a lengthy period of time (on family farms because of the shortage of labour and on formerly state-owned farms because of the economic transformation), and there has been no significant increase in their average milking capacity.
- A considerable part of milk production is accounted for by the family farms with 1-2 cows on average; thus, neither production nor any increase in the number of cows is set to reflect on change in price soon.
- Natural consumption, both in households and on farms, is high.
- Some of the milk produced is processed on the farm and sold on the green markets, which presents a major problem from the aspect of milk price determination.

CONCLUSIONS

The annual changes in producer prices for cattle breeding production are significant for the period analysed; however, due to the longer biological production cycle the reaction of producers to price changes is slower (coefficient of determination 0.14). The most significant proportion of meat cattle production is accounted for by farms with a small average number of cattle. At the same time the former state-owned sector, which was a large producer of beef, has been almost eliminated, so the current low level of production could not react faster to changes in producer prices.

Producer prices in pig production, as compared to meat cattle production, have a somewhat stronger influence on the level of production ($R=0.40$). The influence of producer prices on production level shifted by one year is still low ($R=0.46$).

Producer prices in meat poultry production for the period 1981-1997 had no major effect on change in production volume. The coefficient of determination shows that a change in production of only 8% may be explained by changes in producer prices, and a change of 25% by the effect of price from the previous year.

Total hen's egg production showed no significant reaction to changes in producer prices during the period analysed. Changes in the market were influenced by foreign trade measures (primarily import) rather than domestic production.

Producer prices for milk during the period analysed had only a slight influence on changes in production. The coefficient of determination was 0.13, and the producer price had more influence on the level of buying off.

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The competitiveness and future perspectives of Hungarian meat sector

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ABSTRACT

The Hungarian meat processing industry plays an important role in satisfying domestic demand and in Hungarian foreign trade. Based on stable former COMECON export, considerable state subsidies and a safe position on the home market, the meat industry developed rapidly before 1990. The rapid collapse of COMECON, the decline of domestic purchasing power and import liberalisation have created a new situation. The paper analyses the chances and possibilities of the application of economic policy conforming to the market for upgrading the competitiveness of the Hungarian meat processing sector. Using Porter's approach of competitiveness, the utilisation of primary resources (agro-ecological potential, capital and labour), market structure, company strategies, the domestic food market and the role of other sectors connected with the meat industry are all analysed as elements of competitiveness. The paper emphasises that some of the fundamental conditions for increasing competitiveness are more expedient exploitation of the possibilities deriving from the present comparative advantages, the stimulation of competition between the participants in the meat industry, the building up of the domestic food market and the development of other fields connected to the meat industry, with special emphasis on material and financial infrastructure as well as on collective marketing activity.

(Keywords: systems analysis, resource utilisation, consumption, economic policy)

ZUSAMMENFASSUNG

Die Wettbewerbsfähigkeit und Perspektiven der ungarischen Fleischindustrie

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Die vielfältigen ökonomischen und politischen Veränderungen in Ungarn zwingen die ungarische Fleischindustrie zu erheblichen Anpassungsvorgängen. Deshalb ist es zweckmäßig, die Wettbewerbsfähigkeit dieses Sektors zu untersuchen, was Gegenstand des vorliegenden Beitrages ist. Wie die deskriptive Analyse zur Lage der ungarischen Fleischwirtschaft zeigt, hat dieser Sektor innerhalb der Lebensmittelindustrie eine grosse

Bedeutung. Nach dem Modell des weltberühmten amerikanischen Ökonomen Porter sind die wesentlichen Determinanten der Wettbewerbsfähigkeit die faktoriellen Bedingungen, die Unternehmensstrategie und Struktur der Branche, die Existenz ebenfalls wettbewerbsfähiger Vorleistungsindustrien und verwandter Industriebranchen sowie die Nachfragebedingungen. Darüber hinaus wird die Wettbewerbsfähigkeit durch staatliche Eingriffe bedeutend beeinflusst. Ein Vorteil der ungarischen Fleischwirtschaft besteht in den agrarökologischen Bedingungen und den hochqualifizierten Arbeitskräften. Die Verbesserung der zukünftigen Wettbewerbsposition verlangt, die Vorteile der ungarischen Fleischwirtschaft und die economies of scale besser zu nutzen und mit einer zielgerichteten ökonomischen Politik zu kombinieren.

(Schlüsselwörter: Systemanalyse, Quellennutzung, Wirtschaftspolitik, Verbrauch)

INTRODUCTION

The Hungarian meat processing sector plays an important role in the food industry, and is the most important market of Hungarian animal production (*Table 1*). Unlike the rest of the national economy during the transition to the market economy, the Hungarian meat industry achieved some *important, profound results towards market economy* (e.g. meat processing firms owned by agricultural producers and the dissolution of the former trust system) from the middle of the sixties, long before such reforms were seriously considered in the food economy of other so-termed socialist countries, or in other branches of the Hungarian economy .

Table 1

The role of the meat industry in the Hungarian national economy, 1997

Number of jobs in the meat industry (1)	21100
Share of the meat processing industry in food industry employment (2)	18.1%
Value of production (3)	1.12 bn USD
Share of the meat industry in GDP (4)	2.4%
Export of meat products (5)	367 million USD
Meat industry share in Hungarian export (6)	5.2%

Source: Own calculations on basis of statistical yearbooks. (*Quelle: Verschiedene statistische Jahrbücher sowie eigene Berechnungen.*)

1. Tabelle: Die Rolle der Fleischwirtschaft in der ungarischen Nationalökonomie

Beschäftigtenzahl in der Fleischindustrie(1), Anteil der Beschäftigten in der Fleischindustrie im Verhältnis zu den Beschäftigten in der gesamten Lebensmittelindustrie(2), Bruttoproduktion der Fleischindustrie(3), Anteil der Fleischindustrie am GDP(4), Fleisch- und Fleischwarenexport(5), Anteil der Fleischindustrie am ungarischen Export(6)

After the changes in the social and economic paradigms (change from a centrally planned and regulated economy to a market economy) the Hungarian meat industry is now facing numerous *new problems and challenges*. At the same time drastic changes have also taken place in the environment of the Hungarian national economy. In the light of international comparison it is obvious that Hungary is an important net exporter yet, as *Table 2* shows, if the results for Hungarian meat production and meat product export are compared with

results from some other states, there is a large field for improvement. For example, *the export volumes per hectare of arable land territory of some western European states are ten or fifteen times higher than the corresponding Hungarian values.* The rapid and unpredictable collapse of COMECON, the emergence of the Single European Market and the increasing need for import liberalisation (as a consequence of Hungary approaching the EU and the formation of the WTO) sharpen the competition not only on export markets, but also on the home market. These processes necessitate an up-to-date analysis of the competitiveness of the Hungarian meat industry.

Table 2

**Foreign trade of meat products: an international comparison
(1990-1996 averages)**

	Gross export value per ha, USD (1)	Net foreign balance (1000 USD) (2)	Export/import ratio (%) (3)	Net export value per ha (USD) (4)
Austria	167.606	47.571	124.981	33.501
Belgium and Luxembourg	3644.537	1702.286	282.509	2354.475
Croatia	47.135	-32.200	64.459	
Czech Republic	17.423	6.250	113.089	2.017
Denmark	1590.316	3370.143	1144.774	1451.397
European Union	295.855	1357.571	106.379	17.740
France	211.481	-27.714	99.289	
Germany	200.881	-2881.429	45.208	
Hungary	150.043	676.286	1584.013	140.571
Italy	104.838	-3011.714	22.005	
Netherlands	5765.617	3985.571	456.810	4503.471
Poland	19.035	131.714	196.545	9.350
Slovenia	386.147	18.000	125.281	77.922
United Kingdom	243.757	-1802.000	45.202	

Source: FAO SOFA 98 database, own calculations. (*Quelle: FAO SOFA 98 elektronische Datenbank sowie eigene Berechnungen.*)

2. Tabelle: Export und Import von Fleisch und Fleischwaren - ein internationaler Vergleich im Durchschnitt der Jahre 1990-1996

Gesamtexport/ha(1), Netto Außenhandelsbilanz(2), Export/Import Verhältnis(3), Wert Nettoexport/ha(4)

CONCEPTUAL FRAMEWORK AND METHOD OF RESEARCH

In his 'The Competitive Advantage of Nations' (1990) the famous Harvard economist Michael Porter outlined a new approach to the socio-economic system of competitive sectors of countries, and the influence on international competitiveness. In Porter's model four interrelated sets of factors determine the competitive strength of branches. The four determinants are:

- factor conditions,

- demand conditions,
- firm strategy, structure and rivalry,
- related and supporting industries.

Using the above framework this paper analyses the main features of the competitiveness of the Hungarian meat industry, and outlines the possible development strategies. This article does not analyse the problems of structural changes in the industry, since this question is analysed in the paper titled ‘The transformation of Hungarian meat sector: lessons and experience’ in this volume.

The data used for the analysis, are based on the database of the Hungarian Central Statistical Bureau (HCSB) if not indicated otherwise.

FACTORS DETERMINING THE COMPETITIVENESS OF THE HUNGARIAN MEAT SECTOR

The factor conditions of the meat industry

Agro-ecological potential and its utilisation

In the cost structure of meat industry production the costs of raw materials play a decisive role (40-90% of the total production cost, depending on the grade of processing), so agro-ecological potential and the level of agricultural production are the main factors of meat industry competitiveness. The agro-ecological potential of Hungary is quite high (Széles, 1990), but this competitive advantage is decreasing steadily due to environmental pollution. The obsolete technology used in industry and transport, the low standard of the social and economic culture of waste disposal and the intensive pressure of western European governments on their companies to relocate their environmentally risky plants into less developed (e.g. central and eastern European) countries have a harmful effect on the natural environment of agricultural production, although agriculture in itself is also an important agent in causing pollution (Szabó, 1998). In the race for high yields Hungarian co-operatives and state farms have often used such large amounts of fertilisers that the chemical balance has suffered a drastic change; the pH value of the soil increase by 0.6 between 1980 and 1988 (Sárközi, 1992). From the beginning of the transition in agriculture numerous new farmers have begun agricultural production with hardly any experience in using agrochemicals, but with a strong determination to achieve as high a yield from their small area of land as possible. This situation underlines the importance of building up-to-date extension service networks.

As a result of decreasing profitability and widening ‘agricultural scissors’ (Fig. 1) the livestock feed base of Hungarian animal production decreased considerably.

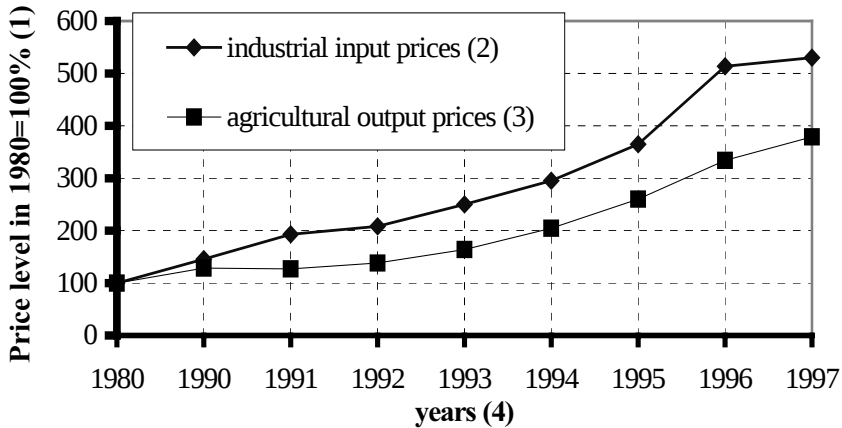
Hungarian livestock feed production and animal production have decreased considerably during the past ten years (Figs. 2 and 3).

Labour

The profitability of production worsened drastically after the transformation in the system. This is why the ‘competitiveness’ of animal products deteriorated in comparison with more intensive products (Table 3).

Fig. 1

The increasing disparity between industrial input and agricultural output prices in Hungarian agriculture



Price level in 1980=100% (1), years (4)

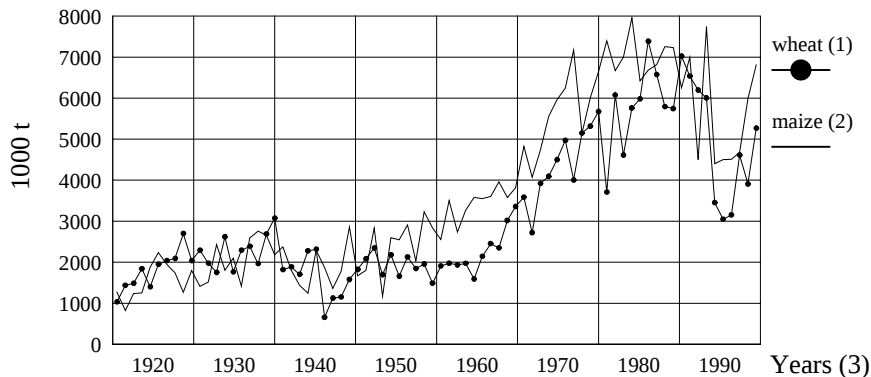
Source: Own calculations based on statistical yearbooks. (*Quelle: Verschiedene Statistische Jahrbücher sowie eigene Berechnungen.*)

1. Abbildung: Die Disparität zwischen In-und Outputpreisen in der ungarischen Agrarproduktion.

Preisniveau(1), Industrielle Input- Preise(2), Landwirtschaftliche Output-Preise(3), Jahre(4)

Fig. 2

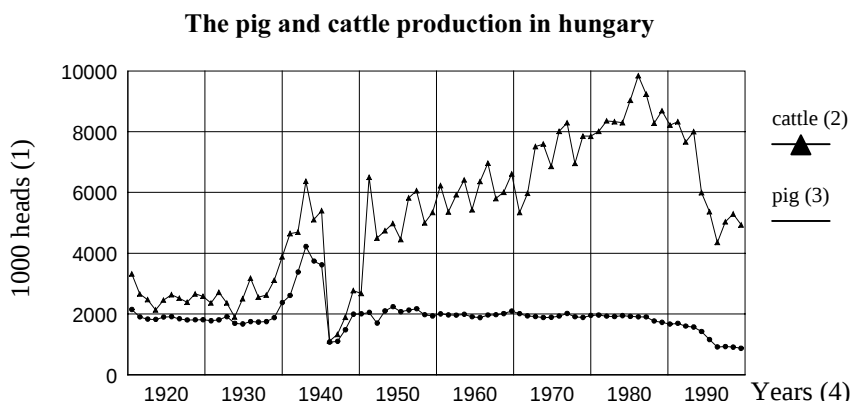
The change of wheat and maize production in Hungary



Source: Hungarian statistical yearbooks, own calculations. (*Quelle: Verschiedene statistische Jahrbücher sowie eigene Berechnungen.*)

2. Abbildung: Weizen und Maisproduktion in Ungarn

Weizen(1), Mais(2), Jahre(3)

Fig. 3

Source: Hungarian statistical yearbooks, own calculations. (*Quelle: Verschiedene statistische Jahrbücher sowie eigene Berechnungen.*)

3. Abbildung: Die Schweine- und Rinderproduktion in Ungarn

Stück(1), Rinderproduktion(2), Schweineproduktion(3), Jahre(4)

Table 3

Gross profit for various agricultural products in small-scale production as %age of cost

Product (18)	1990	1991	1992	1993	1994	1995	1996	1997	Average (16)	S.D. (17)
potato (1)	40.8	29.44	24.73	34.53	34.94	41.36	-2.7	19.95	29.01	15.17
tomato (2)	41.7	26.27	30.62	15.45	41.55	23.34	37.83	21.79	30.96	9.961
tomato under glass (3)	48.3	37.89	23.24	36.99	25.72	30.55	32.45	31.3	33.59	8.42
green pepper (4)	41.1	47	50	44.15	47.49	44.24	49.08	41.37	46.15	3.13
green pepper under glass (5)	51.4	54.5	49.73	53.76	50.98	38.61	43.76	49.82	48.96	5.75
red pepper (6)	64.8	48.2	49.04	40.4	30.11	19.45	47.15	60.2	42.73	14.62
apple (7)	34.9	48.1	35.98	25.37	31.14	43.13	33.8	27.96	36.06	7.52
persic (8)	55.1	57.61	44.41	29.76	52.51	61	48.95	51.28	49.90	10.43
grape (9)	28.6	-9.53	0.2	-14.45	13.27	39.71	29.29	73.75	12.44	20.99
milk (10)	33.6	26.2	22.82	24.8	22.14	28.95	14.6	21.5	24.73	5.93
cattle (11)	10.7	13.8	6.82	5.6	10.12	15.4	1.8	1.2	9.17	4.76
pig (12)	13.5	4	7.63	6.4	14.65	19	1.1	8	9.46	6.41
egg (13)	9.8	17.9	25.81	36	31.56	15.6	3.5	18	20.02	11.71
poultry (14)	2	2	1.08	4.1	8.11	3.6	2.4	-0.3	3.32	2.34
rabbit (15)	15.8	20.8	20.15	13.8	5.46	7	-0.7	5.3	11.75	8.06

Source (*Quelle*): Pátkainé, 1998, S.D.: Standard Deviation

3. Tabelle: Rentabilität von verschiedenen Agrarprodukten in Kleinbetrieben

Kartoffeln(1), Tomaten(2), Tomaten unter Folien(3), Paprika(4), Paprika unter Glas(5), Gewürzpaprika(6), Äpfel(7), Pfirsiche(8), Weintrauben(9), Milch(10), Schlachtrinder(11), Schlachtschweine(12), Eier(13), Geflügel(14), Kaninchen(15), Durchschnitt(16), Standardabweichung(17), Produkte(18)

It is a rather difficult problem to determine the real profitability of production, because the current statistic does not register the value of the living labour of farmers. This is why the profitability of production can only be estimated by the use of various calculated hourly wages. Utilising various wage levels, it is obvious that the economic efficiency of living labour is rather low in animal production (*Table 4*).

Table 4

**Calculated profitability of products on small-scale farms at various hourly wages
(in dimensions of products, USD)**

Product (2)	Calculated hourly wage (1)		
	(USD)		
	0.70	0.86	1.15
1 t potato	14.58	12.60	8.70
1 t tomato	13.47	9.89	2.86
1 t tomato under glass	35.78	15.85	-23.27
1 t green pepper	69.33	60.09	41.95
1 t green pepper under glass	156.47	130.74	80.22
1 t red pepper	157.23	147.66	128.87
1 t apple	22.25	19.31	13.54
1 t persic	96.98	78.32	41.68
1 t grape	7.03	-4.66	-27.60
1 t milk	-0.06	-0.08	-0.12
1 t cattle	-0.70	-0.85	-1.14
1 kg pig	-0.16	-0.22	-0.32
1 piece egg	0.01	0.01	0.004
1 kg poultry	-0.04	-0.05	-0.06
	1.50	-1.84	-2.48

Source (*Quelle*): Pátkainé, 1998

4. Tabelle: Die Rentabilität von Agrarprodukten bei verschiedenen Bruttolöhnen

Kalkulierter Bruttolohn pro Stunde(1), Die Produkte sind die gleichen wie bei Tabelle 3(2)

It is well known that meat industry production is labour intensive (often involving great skill in and knowledge of e.g. bone removal); this is why human factor quality and productivity are much more important than in sectors with less expressed manpower components. The labour force is relatively cheap and is not very difficult to motivate, but this competitive advantage is diminishing due to the high personal income tax rate as well as high social security rates (the average personal tax burden in 1998 being 28%). The activity of joint ventures in the meat industry offers a good possibility to draw comparisons with the quality of labour in more developed countries. Most joint ventures established in Hungary are satisfied with the quality of labour, and there is more need for Hungarian employees to be trained to adapt to the requirements of a modern firm than to upgrade their level of skills or knowledge. The only exception is the lack of knowledge of foreign languages and marketing skills. The foundation for high quality human

resources is the traditionally rigorous Hungarian education system. Basic education and vocational training are still at an acceptable level. The development of the Hungarian schooling system is seriously jeopardised by increasingly dramatic financial constraints. The entry of Hungary into the EU constitutes a good opportunity high quality professional meat processing workers to migrate into more developed western European states. This is a real threat. In the western part of Hungary (Transdanubia) the lack of meat industry professionals is a topical problem, since numerous younger skilled worker work in Austria.

Regarding the results of meat science, the Central Meat Industry Research Institute operates on an international level, which increasingly orientates its activity towards practical applications. The drastic decline in expenditure on scientific research presents a considerable threat to the high level of education and research.

Capital

The Hungarian economy suffers from a severe lack of capital, as a whole. The causes and macro-economic aspects of this question are analysed in detail in the literature (e.g. Deák 1996). From the viewpoint of meat industry enterprises this signifies great difficulties in obtaining bank credit, and the interest rates for enterprise credit are rather high (the weighted average of interest rates for credits of less than 1 year maturity being 15.6% in 1998). Due to the technological processes there is only a limited possibility to apply just-in-time logistical systems in the meat industry, and the enterprises do not have enough capital to finance their stocks; therefore, serious liquidity problems occur.

Negative earnings before taxes in both agriculture and the food industry are a reflection of the impact of financing charges on sector profitability. Neither agriculture nor the meat industry has been able to sustain profitability at current high nominal interest rates. However, the range of loss/profit estimates shown in Table 5 suggests that some segments of the meat industry have remained profitable. These data suggest that a dualism is emerging in the meat industry sector where some segments are quite profitable and are able to make investments while others generate sizeable losses.

Table 5

The financial position of meat industry enterprises

	Meat industry average (4)	Average of best quota of meat industry enterprises (5)	Average of worst quota of meat industry enterprises (6)
Own capital profitability (%) (1)	7.69	50.40	-43.20
Quick ration of liquidity (2)	0.72	1.71	0.07
Share of own capital (%) (3)	46.6	69.1	-75.5

Source: Research Institute for Agricultural Economy and Informatics. (*Quelle: Forschungsinstitut für Agrarökonomie und Informatik.*)

5. Tabelle: Die finanzielle Position der ungarischen Fleischindustrie

Profitabilität des Eigenkapitals (%) (1), Liquiditätsrate (%) (2), Eigenkapitalrentabilität (%) (3), Durchschnitt der Fleischindustrie (4), Beste Quote der Unternehmen (5), Schlechteste Quote der Unternehmen (6)

Demand conditions for meat

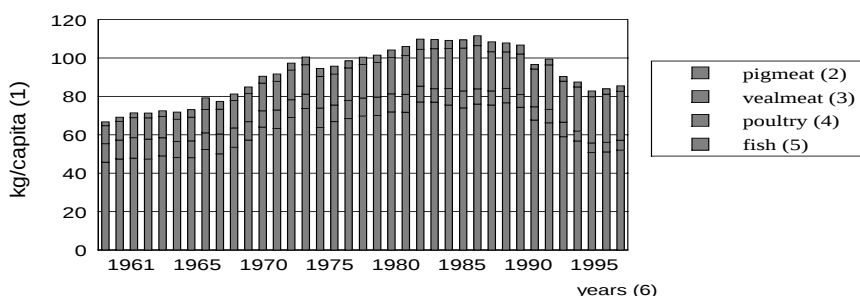
It is generally accepted that the level and sophistication of home demand plays a decisive role in the international competitiveness of a given industry.

In contrast with the situation in most central and eastern European countries, shortages of food (and meat) in Hungary were eliminated from the beginning of the sixties. Hungarian meat consumption is too quantity-oriented: energy intake is relatively high, life expectancy in Hungary is one of the lowest in Europe, and this tendency - contrary to the general trend of development in Europe - is a negative one. The unfavourable changes in average life expectancy can be partly explained by unhealthy food consumption patterns.

The share of pig meat consumption is one of the largest in Europe. This tendency goes against the trends of the more developed countries (*Fig. 4*).

Fig. 4

The changing structure of hungarian meat consumption (1961-1997)



Source: Own calculations on basis of statistical yearbooks. (*Quelle: Verschiedene statistische Jahrbücher sowie eigene Berechnungen.*)

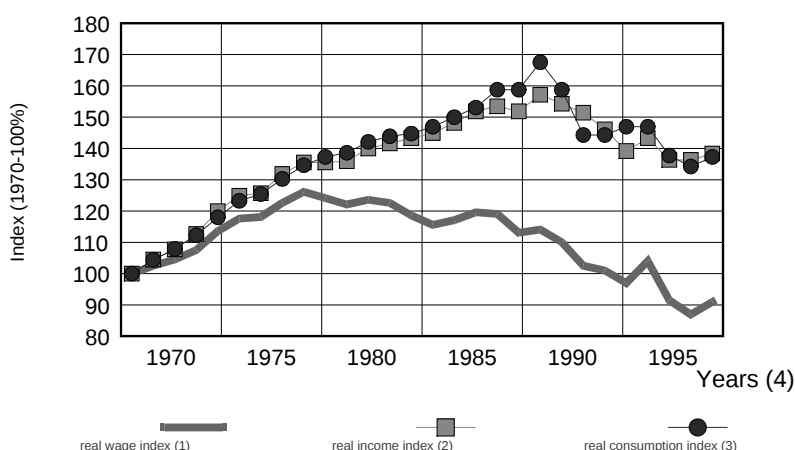
4. Abbildung: Fleischverbrauch in Ungarn

Pro-Kopf-Verbrauch(1), Schweinefleisch(2), Rindfleisch(3), Geflügel(4), Fisch(5), Jahre(6)

After a continuous increase in living standards, from the beginning of the nineties - due to serious economic problems - real income declined sharply (*Fig. 5*).

The most important characteristic features of the current market situation in Hungary are the following.

- Parallel with the decrease in aggregate purchasing power there is increasing diversification of demand. After the long decades when personal revenues were balanced, the diversification of purchasing power is increasing, and increasing pauperisation parallel with an increase in primitive capital accumulation can be observed, while the lack of a middle class is strongly felt. While incomes at the upper end of distribution are increasing, social policy at the lower end is not developing sufficiently. This segmentation is reflected in considerable differences in consumption (*Table 6*).
- The considerable grey and black economy represents a growing problem for the meat industry. There has been an increase in smuggling and illegal turnover for goods subject to government inland revenue.

Fig. 5**The income and consumption of hungarian consumers (1970-1997)**

Source: Own calculations on basis of statistical yearbooks. (*Quelle: Verschiedene statistische Jahrbücher sowie eigene Berechnungen.*)

5. Abbildung: Einkommen und Verbrauch der ungarischen Bevölkerung

Reallohn(1), Realeinkommen(2), Realverbrauch(3), Jahre(4)

Table 6

The annual per capita expenditure for meat and meat products at various income deciles among Hungarian consumers (1996, in USD)

	Raw meat and fish (1)	Meat products and canned meat (2)	Raw meat expenditure (%) of decile 1 (3)	Meat product and canned meat expenditure (%) of decile 1 (4)
1	35.36	27.45	100.00	100.00
2	46.68	37.75	132.02	137.52
3	51.85	42.08	146.63	153.29
4	61.14	45.35	172.90	165.21
5	62.07	49.26	175.54	179.44
6	63.88	52.19	180.64	190.12
7	74.13	54.96	209.65	200.22
8	76.11	59.88	215.22	218.13
9	83.02	68.96	234.77	251.22
10	88.16	83.22	249.32	303.18

Source: Own calculations on basis of statistical yearbooks. (*Quelle: Verschiedene statistische Jahrbücher sowie eigene Berechnungen.*)

6. Tabelle: Ausgaben der ungarischen Verbraucher für Fleisch und Fleischwaren in verschiedenen Einkommensgruppen

Ausgaben für Frischfleisch(1), Ausgaben für Fleischprodukte(2), Ausgaben für Frischfleisch in % im Verhältnis zu Spalte 1.(3), Ausgaben für Fleischprodukte und Konserven in % im Verhältnis zu Spalte 1.(4)

Related and supporting industries

Privatisation provides a good opportunity to improve the efficiency of the retailing sector and to attract investment, often from the Hungarian population. Indeed, there was a rapid development of small shops in the first wave of privatisation. At the same time there is still a need for development of the national infrastructure in terms of communication, transport and financial services, which will still require foreign capital. Foreign capital is also playing an important role in food processing and in larger-scale retailing. Consumer prices have risen considerably faster than producer prices with consequent improvements in margins in the distribution sector.

THE ECONOMIC POLICY AS A TOOL FOR THE UPGRADING OF COMPETITIVENESS

The strengths-weaknesses-opportunities-threats (SWOT) analysis of the Hungarian meat industry offers a good possibility to evaluate the current position of this industry.

On analysis of the competitive advantages of the Hungarian meat sector it can be determined that the favourable agro-ecological potential, rich traditions of agricultural production, highly qualified human resources, considerable experience and well established brand names in former Soviet member states, and large production capacities provide a rather good possibility for further development of the sector in the future. These competitive advantages are utilised only partially, because the utilisation of natural resources has diminished drastically during the past decades. The economic position of animal production is rather weak. Lack of economic knowledge in the farming sector is an effective barrier to quality-oriented development in the production of raw materials. The Hungarian meat industry can be characterised by heterogeneous technical and technological levels. It is often the case that even within one production line there are machines of different technological niveaux.

In the future the Hungarian meat sector could remain one of the most important branches of the Hungarian agriculture and food industry. On the basis of the comparative advantages of the sector there is a real possibility to increase the market share in developed states. From this point of view the World Trade Organisation constitutes a source of effective support for export-oriented development, but there is a danger of increasing defence of markets in the more developed states, by the utilisation of the possibilities provided by non-tariff barriers. Safety and predictability in the domestic market are a necessary precondition for future development. The decreasing aggregate demand and increasing import competition represent a real threat to the development process.

Development in the meat sector should be promoted by means of an economic policy to conform to the market. This policy should be based on the strengthening of the competitive position of meat sector. The most important elements of this policy should be as follows.

- Promotion of better utilisation of natural resources, by the development of an integrated information system to determine the optimal geographic structure of feed production and animal breeding, taking into consideration the agro-ecological, economic and social aspects.
- The agricultural support system should be reconsidered to promote not directly export, but the development of biological-technical and technological background for production.

- Better utilisation of specific agro-ecological possibilities for production in image-building and the application of a certification system.
- More rigorous environmental protection.
- Development of human resource utilisation by the stabilisation of the economic environment in animal production.
- Upgrading of the higher education system by increasing the number of students and improving the efficiency of education.
- Utilisation and upgrading of know-how and production culture in the meat industry, as well as better concentration of resources for R+D activities, and the promotion of industrial parks.
- Development of domestic demand by the prevention of illegal meat industry production and trade sophistication as means combating the ‘black economy’.
- Increasing aggregate food demand by modification of the personal tax revenue system.
- Increasing the knowledge of meat consumers concerning healthy food consumption, and the formulation and implementation of an integrated food and nutrition policy.
- One of the most important ways to promote small and medium-scale companies is to subsidise the introduction of TQM and ISO systems, as well as environmental auditing.
- Development of logistical infrastructure, as well as the modernisation and development of road and communication systems.

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The place of Croatian livestock production in European agriculture

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ABSTRACT

Livestock production is a very significant economic branch of Croatian agriculture, particularly the production of cattle and pigs. The recent years have been characterised by considerable changes in the structure of Croatian agricultural production. The importance of livestock production has decreased, such that in 1997 livestock production represented only 32.8% of the total value within the structure of Croatian agricultural production, while in 1992 it accounted for 44.4% of total agricultural production. The total number of cattle had decreased by 378,000 (45.6%) by 1997; i.e., from 829,000 in 1990 to 443,000. Trends in the numbers of other livestock species show situations which are not less unfavourable. According to official statistical data, in 1997 the total number of pigs was 1,176,000, 25.2% fewer than in 1990; that of sheep 453,000, 39.7% fewer; and that of poultry 10,954,000, 36.0% fewer. At the same time, in 1997 cattle production was 54,000 tonnes (1991: 76,000 tonnes), pig production 166,000 tonnes (1991: 185,000 tonnes) and poultry 85,000 tonnes (1991: 98,000 tonnes). Cow's milk production in 1997 was 603 million litres (1991: 749 million litres) and hen's egg production 804 million (1991: 885 million). Livestock production on the family farms in Croatia dominated in 1997, and still has the significant role. The proportions accounted for by the family farms within the total number of livestock in 1997 were 88.7% for cattle, 74.7% for pigs, 96% for sheep and 60.8% for poultry, these figures remaining the same in 1998. According to the results of the analysis and comparison of the basic characteristics of livestock production in Croatia and in the EU-15 the average number of cows per farm in the EU-15 countries is, at approximately 20, more than 3.5 times that in Croatia. In milk production (milk being the most important product in the EU market) Croatian production is about 2300 litres per cow per year (on family farms about 3100 litres), while in EU-15 average annual milk production is about 5000 litres per cow. EU-15¹ attains 7,969,000 tonnes in cattle production annually, while in Croatia this was only 54,000 tonnes in 1997. EU-15² achieves 15,960,000 tonnes in pig production annually, Croatia only 85,697 tonnes in 1997.

(Keywords: Livestock production, structure and index of production, family farms, EU-15)

¹ For EU-15 data for 1995, sources: EUROSTAT, FAO, European Commission

² For EU-15 data for 1995, sources: EUROSTAT, FAO, European Commission

ZUSAMMENFASSUNG

Position der kroatischen Tierproduktion in der europäischen Landwirtschaft

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Die Tierproduktion ist ein wichtiger Produktionszweig der kroatischen Landwirtschaft, besonders die Rinder- und Schweineproduktion. Die Struktur der kroatischen Agrarproduktion hat sich in den letzten Jahren bedeutend verändert. Die Bedeutung der Tierproduktion nahm ab: 1997 betrug der Anteil der Tierproduktion an der gesamten Agrarproduktion 32,8%, wobei dieser 1992 noch auf einer Höhe von 44,4% lag. Im Vergleich zu 1990 verringerte sich die Rinderzahl bis 1997 um 45,6% (Rinderbestand 1990: 829.000; 1997: 443.000 – also eine Verminderung um 378.000 Tiere). Auch in den anderen Bereichen der Tierproduktion ist diese Tendenz zu beobachten. Laut der statistischen Angaben betrug 1997 der Schweinebestand 1.176 tausend Tiere, 25,2% weniger als im Jahre 1990; der Schafbestand 453 tausend Tiere, 39,7% weniger als 1990, der Geflügelbestand 10.954 tausend Tiere, 36% weniger als 1990. 1997 erreichte die Rinderproduktion 54.000 t (1991: 76.000 t), die Schweineproduktion 166.000 t (1991: 98.000 t), die Kuhmilchproduktion betrug 603 Mill. l (1991: 749 Mill. l) und die Hühnereierproduktion betrug 804 Mill. Stück (1991: 885 Mill. Stück). In den kroatischen Familienbetrieben spielt die Tierproduktion eine große Rolle. 1997 und 1998 hatten die Familienbetriebe folgenden Anteil gegenüber dem Landesbestand: Rinder 88,7%, Schweine 74,7%, Schafe 96% und Geflügel 60,8%. Analyse und Vergleich zur Tierproduktion in EU-15 zeigt: Die durchschnittliche Anzahl der Kühe in Kroatien liegt unter 3,5 (EU-Durchschnitt: 20). Jährliche Milchleistung im kroatischen Landesdurchschnitt ist 2.300 l/Kuh (in Familienbetrieben: 3100 l, im EU-Durchschnitt: 5000 l/Kuh). 1997 betrug die Rindfleischproduktion in Kroatien 54.000 t (EU-Durchschnitt: 7969.000 t), die Schweinefleischproduktion nur 85.697 t (EU-Durchschnitt: 15.960 tausend t)

(Schlüsselwörter: Tierproduktion, Produktionsstruktur, Produktionsindex, Familienfarm, EU-15)

INTRODUCTION

Since Croatia attained independence great changes have occurred in the country, particularly political and economic ones. The process of transition from a centrally planned to a market economy, changes in the structure of agriculture, liberalisation of the domestic market and aggression in Serbia with all its consequences have strongly influenced the whole of the Croatian economy, and also agriculture, particularly livestock production.

Croatian integration into some of the international trade and economic associations such as the WTO³, EU⁴ and CEFTA⁵ has raised the key question of the adjustment of Croatian agriculture and livestock production not only to European but also to world integration processes.

³ World Trade Organisation

⁴ European Union

⁵ Central European Free Trade Association

Objective of the paper

This paper, as its title suggests, has the following objectives:

- to describe the current position in livestock production in Croatia, and to point out the main problems;
- to stress the relevant features of livestock production within family farms;
- to compare the situation in livestock production in Croatia with that in the European Union.

Data sources

Alongside the well known present limitations to gathering data for agriculture, particularly for livestock production, data from the State Bureau of Statistics of the Republic of Croatia are used in this paper, together with data (partly out of date) from the 1991 Census, as well as results from research on the social and economic characteristics of family farms performed by the Institute of Agricultural Economics of the Faculty of Agriculture.

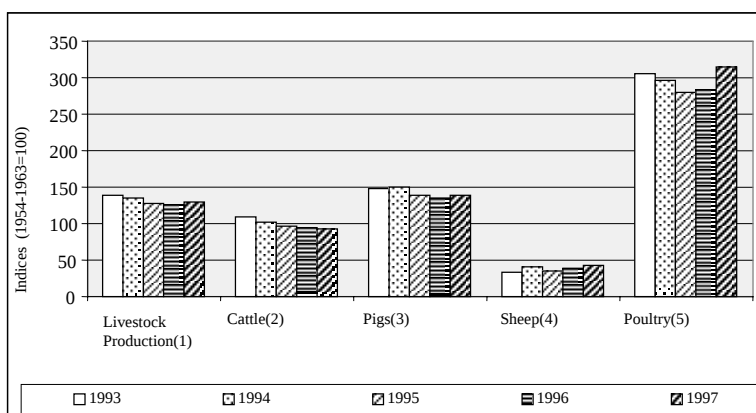
RESULTS AND DISCUSSION

Recent changes in Croatian agriculture

Livestock production in Croatia shows a considerable lag in the total value of agricultural production in relation to the previous period, and also in comparison with the more developed European countries. Therefore, considerable changes are present in the structure of agricultural production in Croatia. The importance of livestock production has diminished, livestock production within the structure of agricultural production in 1997 amounting to only 32.8% of the total value, while in 1992 livestock production represented 44.4% of the total value of Croatian agricultural production.

Figure 1

Indices of livestock production

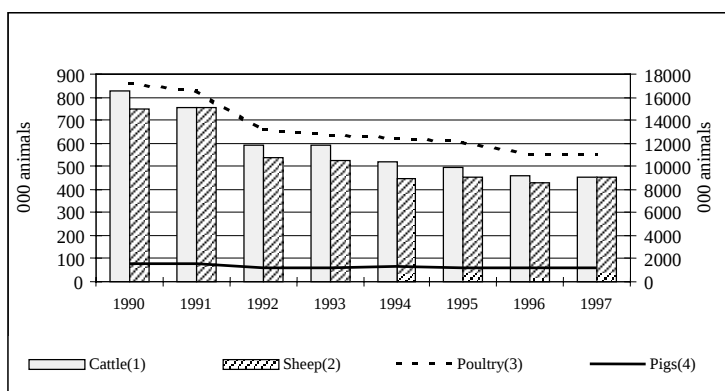


1. Abbildung: Angaben zur Tierproduktion

Tierproduktion(1), Rinder (2), Schweine(3), Schafe(4), Geflügel(5)

Figure 2

Number of livestock in Croatia



2. Abbildung: Entwicklung der Tierbestände in Kroatien

Rinder(1), Schafe(2), Geflügel(3), Schweine(4)

In the period 1990-1997 the number of basic livestock species decreased continuously. By 1997 total cattle number had diminished by 378,000 (45.6%): from 829,000 (in 1990) to 443,000. A similarly unfavourable situation can be observed in the numbers of other livestock species. According to official statistical data, in 1997 the total number of pigs was 1,176,000, 25.2% fewer than in 1990; that of sheep 453,000, 39.7% fewer; and that of poultry 10,954,000, 36.0% fewer than in 1990.

At the same time, in 1997 cattle production increased to 54,000 tonnes (in 1991 76,000 tonnes), pig production 166,000 tonnes (in 1991 185,000 tonnes), poultry 85,000 tonnes (in 1991 98,000 tonnes); 603 million litres of cow's milk (in 1991 749 million litres) and 804 million hen's eggs (in 1991 885 million) were produced.

In 1997 cattle production accounted for 15% of total livestock production. During the past few years the increase in pig production has been a little above one third of total livestock production (the figure 1997 being 38.1%). By 1997 the importance of poultry production had increased in relation to the preceding years, making up 23.4% of total livestock production. The proportion occupied by the quantity of cow's milk produced within the structure of livestock production has changed slightly, with a value of about 19% in 1997. Among the remaining livestock products the production of hen's eggs commands comparatively minor importance, the relative share of this being below 1% of total livestock production. All the above figures show clearly that none of the branches of livestock production reached pre-war levels in 1997.

The Republic of Croatia is very heterogeneous in its relief, geological structure and substances, climate and socio-economic characteristics, so regional differences are very distinct. In consequence of this, and taking into consideration the administrative and territorial organisation, three *agricultural and ecological regions* can be distinguished in the Republic of Croatia: the Pannonian region, the Mountain region and the Mediterranean region. Until now Croatia has had no defined regionalisation of

agricultural areas. Data on these agricultural regions are taken from the documentation of the Ministry of Agriculture and Forestry of the Republic of Croatia, Strategy of Agricultural Development, Zagreb, 1995.

Table 1

Number of livestock in 1991

Animals(1)	Croatia (2) (Total)	Mountain Region (3)	Percentage out of total - Croatia (%) (4)
Cattle (5)	756,813	138,942	18.36
Sheep (6)	753,267	338,018	44.87
Horses (7)	36,810	12,701	34.5
Total	1,546,890	489,651	31.65

Source (*Quelle*): 'SLJH-93', pages 132-133, Central Bureau of Statistics of the Republic of Croatia; "Stočarstvo" 49:1995 (1-2) page 31 (*Knežević, Stipić, Havranek*)

1. Tabelle: Tierbestände im Jahre 1991

Tierart(1), Kroatien(2), Berglande(3), % gegenüber ganz Kroatien(4), Rinder(5), Schafe(6), Pferde (7)

Although agriculture is an important branch of the economy, as stated above, Croatia has had no defined regionalisation of agricultural areas until now. Unfortunately, the agricultural policy has therefore so far not taken into consideration regional differences in a greater measure, and has not used selective measures to allocate production in specific areas. The new Act on Financial Incentives and Regresses (NN 29/99) anticipates special financial subsidies for the so-termed strategic Croatian regions.

Taking as the starting point the above different criteria for determining the agricultural areas and regional distribution of agricultural production (determined by natural, pedological, economic and traditional characteristics of particular regions), more than 80% of the total cattle number is located in the Pannonian region, while in the Mountain and Mediterranean regions the total numbers of cattle are comparable (i.e., roughly equal). With respect to categories, there are no significant differences in relation to the distribution of the total cattle number.

The highest number of pigs is in the Pannonian region, mostly due to maize production. The Mediterranean and Mountain regions are not represented substantially in the total number of pigs.

The Mediterranean region contains 57% of the total number of sheep. Slightly less than one quarter are located in the Pannonian region and 18.2% in the Mountain region.

Of the total number of poultry, about 76% are in the Pannonian region, 18.4% in the Mediterranean region and only 7% in the Mountain region.

Horses are located, for the greater part, in the Pannonian region (61.3%), almost one third in the Mountain region and only 11.2% in the Mediterranean region.

At the same time, there are significant regional differences in the number of livestock per unit area. The number of cattle and pigs per hectare of agricultural land is greater in the Pannonian region (0.26 cattle and 0.81 pigs), and the number of sheep is greater in the Mediterranean region (0.24).

Average milk production is higher in the Pannonian region (2259 litres per cow) than in the Mountain region (2025 litres), the lowest being in the Mediterranean region (1651 litres). In the production of hen's eggs the Pannonian region also dominates (135 per hen), compared with the Mediterranean region (126) and the Mountain region (113).

Family farms and livestock production

Family farms are the predominant part of the agricultural structure with regards to human, land and other resources, and they account for the majority of total agricultural production. The last census, taken in 1991, recorded 534266 family farms in Croatia. These held possession of about 78% of arable land and more than 80% of the total stock of livestock. The proportions represented by the family farms in livestock production in 1991 were the following: cattle 75%, horses 100%, pigs 66%, sheep 95%, poultry 50% and bee-hives 100%. Among the livestock species the family farms rear mostly pigs (46%) or cattle (38%), rather than sheep (7.4%) or horses (4.8%).

Livestock production on the family farms in Croatia was dominant in 1997, and bears the most significant role. The proportions accounted for by the family farms within the total stock of livestock in 1997 was as follows: cattle 88.7%, pigs 74.7%, sheep 96% and poultry 60.8%. These values remained unchanged in 1998.

Considering the inherited institutional and economic system of the former state, war, occupation and war devastation, inherited underdevelopment and natural limitations in some of the agricultural areas, and comparing these with the situation with respect to the registration of statistics, research performed in the period 1991-1998 shows that great changes occurred in some aspects of the so-termed *vital* family farms. These are the results of the research into the social and economic characteristics of family farms performed by the Institute of Agricultural Economics of the Faculty of Agriculture, University of Zagreb, within regional studies and a survey on family farms within the Farmer Support Service Project (MAF). It was ascertained that these farms now have at their disposal considerable resources, together with educated, mostly younger farmers and market-oriented production.

The total stock of livestock shows great differences between farms and regions, livestock production being very important in some areas, while in others it has no great importance. In some areas beef cattle production is being deserted, alongside growing interest in sheep and goat breeding.

According to preliminary results it can be ascertained that among the total number of farms (N=892) 73.88% keep cows (average annual milk production 3099 litres per cow), the average number of cows per farm being 5.4. The range is wide, some farms only keeping cow, but there are also specialised dairy farms with 30 or more cows. The greatest number of farms with cows is in the Mountain region, where 92.68% of farms keep cows and produce milk. More than half of all farms rear pigs (57.51%), and 6.84% of the total number of farms keep sheep.

The situation in livestock production within the family farms surveyed (N=892), measured by number of particular livestock species, shows that the number of commercial farms is rather small. The greatest number is accounted for by those keeping several species of livestock, which suggests that production is still natural, while intensive rearing is practised on only a smaller number of farms.

Basic problems in livestock production

The level and the structure of livestock production in Croatian agriculture are determined by several factors, such as natural conditions, traditional production, the demands of the

domestic and international markets, and also the various forms and level of state intervention (incentives, prohibitions, embargoes, etc.). *What is the key problem?*

Firstly, the small size of family farms is a limitation to the number of livestock: only 4.2% of the farms have more than five cows, 5.3% more than ten pigs, and 2.6% more than 20 sheep.

Secondly, there still exists the illusion that with only slight changes and with traditional methods of production or managing systems, together with the continuous support and care of state institutions (mostly purchase and subsidies) the new circumstances for the market economy could be achieved. However, without radical reorganisation of livestock production, coupled with fundamental and qualitative changes in the field of livestock selection, it would not be possible to ensure the development of livestock production as an economic activity.

Thirdly, productivity in livestock production remains at a low level, due to inadequate diets and feeding systems, an inefficient breeding structure, difficulties in improving farm buildings, and so on.

Fourthly, there is excessive and uncontrolled import of agricultural products, and deficiencies in the market structure which would otherwise serve to satisfy the needs of producers, wholesalers and retailers, for prices to be formed on the basis of competition.

The position of Croatian livestock production within European agriculture

The integration of the Republic of Croatia into some of the international trade and economic associations, such as the WTO, EU and CEFTA, has raised the key question of the adjustment of Croatian agriculture and livestock production not only to European but also to world integration processes.

On entry into the EU Croatia will also be incorporated into a large, well-developed and in general self-sufficient market of livestock products, which will result in even greater competition for domestic livestock production.

At the same time, it is obvious that Croatian livestock production is today faced with great difficulties. Numbers of all types of livestock are decreasing, while the level of productivity is low and below the level in western Europe. Production is mostly extensive and economically inefficient.

Table 2

Farms and their size

	Croatia	EU-15*
<i>Family farms (1991) (1)</i>		
- number (thousands)	534	7.739
- decreasing the number of farms 1981-1991(%)	6.14	2.14
<i>Average family farm size (2)</i>		
- 1991 (ha of agricultural land)	2.94	16.6
- 1993 (number of livestock**)	3.5	25.8

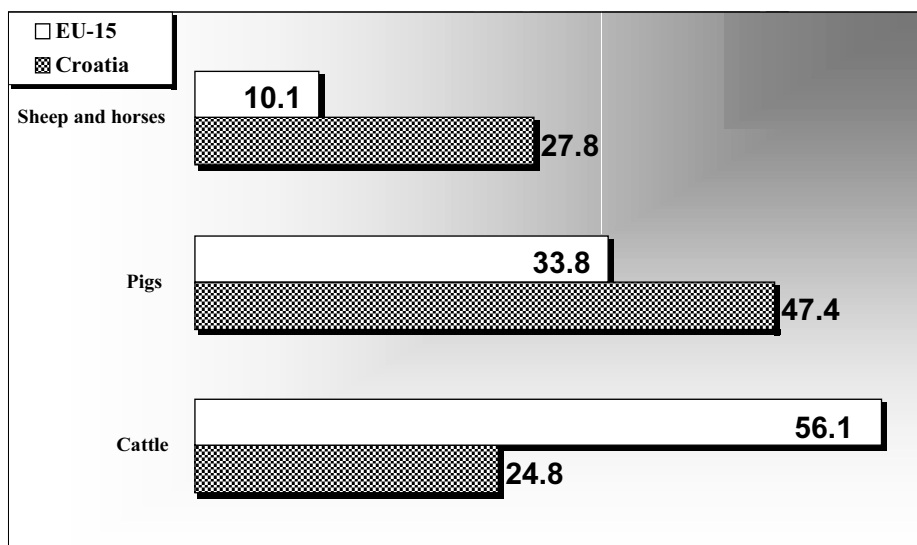
* Data for EU-15 refer to 1993 and 1983 respectively. (*Die Daten von EU-15 beziehen sich auf 1993 und 1983.*), ** Total for Croatia: cattle, pigs, sheep and horses. (*Kroatien insgesamt – Rinder, Schweine, Schafe, Pferde.*)

2. Tabelle: Farmen und ihre Größe

Familienfarmen(1), Durchschnittliche Größe einer Familienfarm(2)

Figure 3

The structure of the number of certain livestock species (1993)



3 Abbildung: Struktur einiger Tierbestände (1993)

Schafe und Pferde(1), Schweine(2), Rinder(3)

In livestock production in Croatia the majority of farms lag behind those in the EU by all criteria and measures, but there are a number of farms which, in terms of their structure and production results, are already at the level of livestock production of the EU.

On consideration of the results of the analysis and comparison of the basic characteristics of livestock production in Croatia in relation to those in the EU-15, the following should be highlighted.

- The average number of cows per farm in the EU-15 is more than 3.5 times that in Croatia (the average in the EU-15 being about 20 cows per farm).
- In the production of milk, the most important product on the EU market, Croatia produces about 2300 litres per cow per year (on family farms about 3100 litres), while in the EU-15 average annual milk production is about 5000 litres per cow.
- The EU-15⁶ attains 7,969,000 tonnes in cattle production annually, while in Croatia this was only 54,000 tonnes in 1997.
- EU-15⁷ achieves 15,960,000 tonnes in pig production annually, Croatia only 85,697 tonnes in 1997.

⁶ For EU-15 data for 1995, sources: EUROSTAT, FAO, European Commission

⁷ For EU-15 data for 1995, sources: EUROSTAT, FAO, European Commission

From the above it is evident that Croatian access to world trade integration, and further liberalisation of domestic markets for agricultural and food products, leading to increased competition and additional decreases in prices, will result in an even more difficult position for livestock production in Croatia.

Agricultural policy has a considerably important impact on the level and position of livestock production. As distinguished from the agricultural policy of the EU countries, in Croatia these measures have been considerably less complete, successful and transparent. This is particularly evident in the market share of Croatia in relation to the EU, where the livestock market is protected by various aims, mechanisms and agricultural policy measures with a clearly defined market order.

CONCLUSIONS

The future of livestock production will depend primarily on changes in the economic environment, and its ability to adjust to the new conditions. Therefore growing competition has become the precondition for the existence of this important activity, particularly production within family farms.

The stagnation and further decline in livestock production are not acceptable, for more than one reason. This is primarily because of the importance of this branch for the total Croatian economy, as well as for ensuring employment and optimal use of the existing resources. Besides increasing competition and environmental and economic aspects there are other reasons, primarily geopolitical and demographic, for which it is necessary to stop the decline and enable redevelopment in livestock production. No less important is the role of livestock production in sustainable development and environmental preservation.

Croatia has favourable preconditions for livestock production, particularly in the hilly or mountainous areas, which have considerable raw material resources for the development of cattle production and livestock production in general. For the revitalisation of livestock production the economic preconditions are crucially important, so in searching for the solution to this problem Croatia has to act as western European countries have done, particularly by granting adequate subsidy payments and financial support. Additional attention has to be paid to special valorisation of the so-called production elements in the hilly or mountainous regions, which could enable export of a smaller number of livestock products, recognisable by their characteristics and top quality, according to the demands of European consumers.

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Legal regulations governing livestock production relevant to the integration of Hungary into the EU

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ABSTRACT

This study provides an outline of the acts and directives relevant to livestock production, from the aspects of environmental conservation (nature conservation) and the protection of animals. The first part of the study gives a brief overview of the environmental conservation-related aspects of the acts on livestock production and on animal health and hygiene, and also on the manufacture and marketing of animal feeds. In the second part the Act on the Protection of Animals and the associated directives are outlined. Lastly, the authors refer to the government directive relating to the safeguarding of protected animal species, the legal base for which was provided by the 1996 Act on Nature Conservation. This overview of the above laws leads to the conclusion that viewed from the aspect of legislation, there is no obstacle to the integration of Hungarian livestock production into that of the European Union.

(Keywords: European Union, integration, livestock production, environmental conservation, protection of animals)

ZUSAMMENFASSUNG

Rechtsregelungen in der Tierzucht im Hinblick auf die EU-Integration

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In dieser Studie wird ein Überblick gegeben über die mit der Tierzucht zusammenhängenden Gesetze und Regelungen vom Standpunkt des Umwelt-, Natur- und Tierschutzes aus. Im ersten Teil werden vom Umweltschutz her die Vorschriften und Gesetze in der Tierzucht, in der Tierhygiene, bei der Herstellung von Futtermitteln und deren Vermarktung dargestellt. Im zweiten Teil wird das Tierschutzgesetz mit den dazugehörigen Regelungen vorgestellt. Weiterhin wird die Regierungsanordnung über geschützte Tierarten erwähnt, deren Gesetzesgrundlage das Naturschutzgesetz von 1996 ist. Während der Untersuchung obiger Rechtsvorschriften kamen wir zu dem Schluss, dass es rechtlich gesehen keine Hindernisse gibt, die ungarische Tierzucht in die EU zu integrieren.

(Schlüsselwörter: Europäische Union, Integration, Tierzucht, Umweltschutz, Tierschutz)

INTRODUCTION

With respect to the integration of Hungary into the European Union outstanding importance is borne by agriculture (Sántha, 1998; Szabó, 1999).

A condition for full membership of the European Union for Hungary is the full and unreserved acceptance of the achievements attained by the community (*acquis communautaire*). In this respect, the provisions which are granted greater prominence are first and foremost those relating to the common internal market, with particular regard to the Common Agricultural Policy (*European Commission of the EU*, 1995).

At the same time, when the Single European Act took effect (Tracy, 1994) it became compulsory to take issues related to environmental conservation into account in the formulation of sectoral policies; the stipulations on the protection of animals are now also, due to the pressure applied by the influential non-governmental organisations, being granted increasingly greater attention (Fekete, 1994).

Hungary cannot avoid facing the above challenges, therefore, in the past few years highly intensive and productive legislative activity has been in progress in the interest of ensuring the existence of the appropriate laws complying with EU requirements.

The objective of this study is to provide an *overall outline* of the above laws for the benefit of specialists in animal breeding science, both from Hungary and from other countries. The list of references gives the pieces of legislation cited under their Hungarian titles, to facilitate orientation for those seeking more detailed information.

THE INCLUSION OF ENVIRONMENTAL CONSERVATION ASPECTS IN THE NEW ACTS RELATING TO LIVESTOCK PRODUCTION

According to data published by the Hungarian Central Statistics Office, (1999), livestock production accounts for 45 per cent of the gross output of agricultural products, and with respect to the collective export of agriculture and the food industry a proportion approaching the same dimension (38 per cent) is accounted for by exports of live animals and products of animal origin.

The above data provide unequivocal justification for the marked attention paid to livestock production in the past few years in the field of legislation.

The act on livestock production

The following are among the objectives of the act which took effect in early 1994 (*Mezőgazdasági és Élelmezésügyi Értesítő*, 1993):

- Breeding procedures applied in livestock production should meet the requirements with respect to the protection of the environment and of nature, the protection of animals, public health, market conditions, and animal health and hygiene.
- The genes and individual animals of breeds representing national assets should be preservable in the long term, as should (the) groups and the genetic diversity of such breeds.
- Adjustment and adaptation to international stipulations should be ensured.

The protected, indigenous breeds bear substantial genetic value, their preservation in their original state is in the national interest and is a task for the state. Due to their indigenous nature, any breeds developed in the natural geographic environment of Hungary should be regarded as protected animal species, as should those for which there is a historical tradition of keeping and breeding.

The Ministry of Agriculture and Rural Development is the entity primarily responsible for the accomplishment of this task, which it undertakes with the cooperation of the Ministry for the Protection of the Environment and other bodies. The state also provides financial resources to support endeavours towards this objective.

The act on animal health and hygiene

An important part of the law which came into force in July 1996 deals with the rendering harmless of the bodies of animals and animal waste (*Magyar Közlöny*, 1995b).

As the general rule livestock breeders themselves are obliged to ensure that the remains of dead animals, by-products of animal origin and animal-derived materials of no potential use are rendered harmless. On the other hand, the rendering harmless of animal waste matter produced in the course of the prevention, detection and elimination of certain animal diseases is a task for the state, the accomplishment of this falling under the responsibility of the district animal health stations authorised by the Ministry of Agriculture and Rural Development. In such cases the breeder receives compensation for animals which have died or have been slaughtered, and any animal waste materials produced are also rendered harmless at the expense of the state.

Should it not be possible to establish the identity of the owner of dead animals, the costs of rendering the remains harmless are borne by the relevant local authority.

Enterprises undertaking the task of rendering animal-derived waste harmless have to comply with strict conditions with respect to animal health and hygiene, public health and the protection of the environment.

The sphere of authority within animal health and hygiene of the Ministry of Agriculture and Rural Development includes a number of important powers with respect to animal feeds.

These include:

- the stipulation of the range of veterinary medicinal products which can legally be added to animal feeds;
- the granting of permission for the import of veterinary medicines;
- the issuing of licences for the marketing of new animal feeds containing extraneous animal feed supplements.

Finally, note should also be made of the fact that the above ministry, with contributions from the Ministry for the Protection of the Environment and the Ministry of Public Health, issues licences for the importation of animals produced through the application of gene manipulation procedures. Licences are also required for the production, testing, distribution or import of any animal feed or veterinary medicine manufactured by the use of genetically modified organisms.

The act on the manufacture and marketing of animal feeds

This act came into force in July 1996 (*Magyar Közlöny*, 1995a).

One of the important provisions of this act is that a precondition for the establishment of any new animal feed manufacturing plant is that all stipulations relating to the protection of the environment and to environmental health should be satisfied.

With respect to the stipulations relating to the packaging and labelling of animal feeds, mention should be made of the fact that the following information, among other details, must be displayed on the packaging or the label:

- the name and registration number of any medication added to an animal feed, together with the quantity of active agent added per unit weight of feed;

- in the case of animals producing food for human consumption, the relevant withdrawal time with regard to food hygiene;
- specifications for application with respect to work safety.

In its authoritative capacity the local appointed animal health station has the power to declare a feed unfit for animal consumption, or to restrict, attach conditions to or prohibit its use or distribution; furthermore, on consideration of the specifications relating to the conservation of the environment, this station may order the destruction of such a feedstuff.

THE ACT ON THE PROTECTION OF ANIMALS AND THE ASSOCIATED LEGAL RULES IN FORCE

Following debate spanning many years, both in professional circles and in society at large, in March 1996 the Hungarian National Assembly passed an act on the protection and care of animals, which took effect on 1st January this year (*Magyar Közlöny*, 1998a).

This act and the directives following it can be regarded as unquestionably in line with EU requirements, since the relevant EEC rulings were taken by the legislators as their base in the drafting of the respective provisions.

The act on the protection and care of animals

The objective behind the passing of this act was that it should contribute to the prevention of cruelty to individual animals and lead to a greater sense of responsibility with respect to the animal world, in an endeavour to ensure that animals are treated in a humane manner, and determine the fundamental ground rules for the protection of animals.

This act extends to cover a very wide range of animal species, but the provisions of its individual laws relate to game species suitable for hunting and fish species subject to fishing, and also to animal species under nature conservation safeguard.

In setting forth the *general regulations for the prevention of cruelty to animals* the legislators specify that livestock breeders are under obligation to proceed with the *circumspection of the good farmer*, and to ensure that living conditions appropriate to species, breed and physiological requirements of any animals kept are provided. Where livestock are kept for financial purposes *environmentally sound forms of technology* are to be given preference.

The legislators go on to set down a number of stipulations relating to the proper care of animals and the prohibition of cruelty to animals. (For example, animal fighting contests are prohibited.)

Slaughterhouse activity is governed by provisions of law of a circumspect nature.

Animal experiments are bound by the requirement for licences, the granting of which involves the providing of scientifically based justification for the necessity of the experiment. In the interest of finding alternatives for such animal experiments scientific procedures involving experiments on live animals should be applied, should any such procedure be available.

In connection with the *transport of animals* endeavours should be made to ensure that animals are not subjected to pain, suffering or injury in transit.

This act also deals with the general regulations for the establishment and maintenance of zoos, establishments providing accommodation for animals, and animal sanctuaries; here, the *fulfilling of staffing conditions* is granted particularly strong emphasis.

Finance for tasks within the field of animal protection is provided from three sources:

- the central budget;
- animal protection contributions;
- animal protection fines.

Directives associated with the act on the protection of animals

The *government directive dealing with the performing of animal experiments* (Környezetvédelmi Értesítő, 1999a) stipulates for what purposes (e.g. issues related to environmental conservation) animal experiments may be carried out, defines spheres of authority, and contains specifications relating to the care and accommodation of experimental animals.

For example, with respect to *livestock buildings* this government directive stipulates that the design of such buildings should enable the elimination, or at least restriction, of damage to the construction originating from the environment and damage to the environment derived from the operation of the building (infectious matter, smell, noise, waste matter, etc.).

This law specifies conditions in connection with the following factors relating to *livestock keeping sites*:

- air quality,
- temperature,
- humidity,
- lighting,
- noise levels,
- vibration and resonance,
- accommodation of the animals,
- feeding,
- the provision of water,
- littering.

In accordance with the *government directive on the animal protection fine* (Környezetvédelmi Értesítő, 1999b), since 1st April this year those who in the course of their activity, or in negligence in this, infringe the provisions of the law on animal protection and care, or the stipulations of authority rulings, are subject to payment of the animal protection fine. The amount of the fine incurred, which varies in accordance with the severity of the infringement and its possible repetition, ranges from five thousand to one hundred and fifty thousand Hungarian forints (between 20 and 600 Euros).

A government directive sets provisions for certain functions and the sphere of authority of *local authority notaries* in connection with the protection of animals and the registering of livestock (Környezetvédelmi Értesítő, 1999c).

With respect to the profitability of livestock production and its marketability on domestic and export markets, two ministerial directives bear particular significance.

The Minister for Agriculture and Rural Development has published *rules relating to the prevention of cruelty to animals in connection with the keeping of agricultural livestock* (Magyar Közlöny, 1999b).

The *general keeping conditions* for animals are laid down as follows.

- The physiological, behavioural and social requirements of the species in question must be taken into account.
- Animals should be cared for in a professionally competent manner.

- Animals should be provided with feed and water and cared for in a manner appropriate to the species, breed, level of development and physiological condition of the animals involved.
- Animals are not to be subjected to unnecessary pain, injury or suffering.

Appendix 1 of this directive contains the regulations relating to the keeping of calves, appendix 2 to pig keeping, appendix 3 to the keeping in cages of laying hens, appendix 4 to feather plucking, and appendix 6 to the intervention procedures which may be performed on agricultural livestock species without anaesthetic.

With regard to the specifications set out in appendices 1 and 3, producers have been given a 10-year period of grace.

At the same time as the passing of the above law the joint ministerial directive on *animal transportation* was issued (*Magyar Közlöny*, 1999c).

The *sphere of force of this directive* covers the transportation and delivery of vertebrates.

The stipulations of this directive *do not apply to*:

- transportation for non-commercial purposes, including the transport of animals kept for non-commercial purposes;
- transport over distances not exceeding 50 km;
- transportation for the purposes of itinerant grazing etc., carried out by livestock breeders by means of their own livestock transport vehicles.

Prior to transportation the party or individual organising transit must produce an *itinerary* in accordance with this appendix of the directive; this itinerary should be attached to the health certificate issued by the authorised veterinary surgeon. The times and places designated for feeding, watering and resting the animals should be indicated on the itinerary.

This directive outlines and stipulates the relevant requirements according to wider groups of species, and also according to means of transport (rail, road, sea or air).

The *accommodation requirements* of animals during transport are governed by a separate law passed in 1997; this directive merely contains certain supplements.

However, with regard to *intervals between feeding and watering breaks, duration of transit and rest periods* this directive specifies in detail the conditions to be met.

Mention should lastly be made of the fact that a joint ministerial directive relating to the regulations governing the breeding (i.e., reproduction), keeping and marketing of experimental animals has also been issued (*Magyar Közlöny*, 1999a).

THE GOVERNMENT DIRECTIVE RELATING TO THE PROTECTION, KEEPING, SHOWING AND USE OF PROTECTED ANIMAL SPECIES

In contrast with the points outlined in section 2, the legal base for this directive (*Magyar Közlöny*, 1998b) is provided by the 1996 act on the conservation of nature (*Magyar Közlöny*, 1996).

Activity connected with the various animal species and individual animals specified in this directive and which comes under the ruling of the directive may only be carried out by parties in possession of a *licence issued by the authorities*.

Licences are granted primarily to bodies involved in defined activity in the public interest, private individuals can obtain such a licence only under strictly defined conditions (relating to qualifications and practical experience).

Several appendices are attached to this directive; among these, the appendix stipulating the minimal conditions for the keeping of protected and highly protected animal species may lay claim to particular interest.

CONCLUSIONS

The main conclusions drawn by the authors and their recommendations are summarised below.

Firstly: The legislation of the 1990s in connection with livestock production and animal keeping features complex treatment of aspects relating to environmental conservation, animal health and hygiene and the protection of animals.

Secondly: The authors consider it an important objective that, alongside the various specialist subjects taught in higher education for agriculture, this body of knowledge relating to legislation should also increasingly be included in the teaching of law-related topics.

Thirdly: An expedient exercise would be to perform economic model calculations for the purpose of ascertaining what increase in costs would accompany compliance with the stipulations relating to environmental conservation and the protection of animals: that is, what long-term and short-term effects these specifications exert on profitability in livestock production. At the same time it would also be useful to perform calculations on the risks involved should Hungary fail to comply with the regulations in line with EU requirements.

Fourthly: Of the laws outlined in this study, a great deficiency is the lack of a manuring act of the type in force in Germany.

Fifthly: While in the field of animal health and the protection of animals the institutional authoritative system boasts an established tradition, the regional bodies concerned with agro-environmental conservation are still merely in the embryonic stage. The development and reinforcement of these is one of the most important conditions for the implementation of the Agro-Environmental Conservation Programme.

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Application of change management methods in the transition process of Hungarian agricultural enterprises

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ABSTRACT

The socio-economic transition in Hungary has made agricultural enterprises change their organisation pattern to enable them to incorporate themselves into the new context of the market economy, particularly when the idea of joining the EU becomes more a fact than simple speculation. Alterations in the inner and outer environment have forced such enterprises to change their organisational structure and behaviour patterns; however, the changes required do not occur spontaneously, so it is a prerequisite that organisational development methods and experts be involved. The system of changes induces a complex web of multilevel and multidirectional sets of modifications – all pushing the enterprises towards a turning point at which they can become real beneficiaries of the changes. Organisation development – a process and a method – may also present a possibility for the agricultural enterprises to turn their handling of actual changes into a process within which they can develop both their organisational and their human structure in a manner as desired.

(Keywords: organisation development (OD), organisational behaviour)

ZUSAMMENFASSUNG

Anwendungen von Veränderungs-Management-Methoden bei sich in Umgestaltung befindlichen Agrarunternehmen

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Durch die gesellschaftlichen-wirtschaftlichen Umgestaltungen in Ungarn sind auch die Agrarunternehmen gezwungen, sich organisatorisch zu verändern, um den Anforderungen der Marktwirtschaft gerecht zu werden, besonders dann, wenn der EU-Beitritt auf der Tagesordnung stehen wird. Aufgrund der Veränderungen im inneren und äußeren Umfeld sind auch Veränderungen in ihre Organisationsstruktur und ihren Verhaltensformen vorzunehmen. Diese Veränderungen treten jedoch nicht spontan ein, so daß es notwendig ist, die Methoden des Veränderungs-Managements anzuwenden. Organisatorische Veränderungen bedeuten Veränderungen eines Komplexes vielseitiger Prozesse, durch die die Organisation befähigt wird, auch Nutzen aus diesen Veränderungen zu ziehen. Organisationsentwicklung kann – als Prozeß und auch als Methode – im Falle der Agrarunternehmen ein wirksames Mittel sein, ein Mittel, das

durch Umwandlung der Veränderungen in Prozesse eine große Hilfe bei der Verbesserung der organisatorischen und humanen Struktur der Unternehmen bedeutet.
(Schlüsselwörter: Organisationsentwicklung (OD), Organisationsbetragen)

INTRODUCTION

The socio-economic transition of the early 90s in Hungary has induced radical changes in both the sociological and the economic context.

Political changes, alterations in the pattern of property ownership, the restructuring of the economy to a market-oriented one, and substantial modifications in the structure of society have all forced organisations involved in agricultural production to reshape their organisational structures to fit the modified socio-economic conditions. Matching the requirements of the new conditions brought by the transition assumes a new approach, more effective attitude patterns and the modification of strategies.

Agricultural organisations are closely connected to the rural areas of the country, to the local and regional communities and also to the local economy. As the European integration of the country is becoming more a fact than simple speculation the problems related to rural development are becoming increasingly emphasised: these include the regional development programmes as well as the agricultural organisations and institutions themselves taking an active role in such programmes.

Agricultural organisations, however, need to be restructured in order to take an active part in improving their economic efficiency and consequently in improving the life quality of inhabitants and in strengthening the population-keeping ability of the given region.

The study briefly outlines the necessity and the characteristics of applying the organisational development approach in the case of agricultural enterprises.

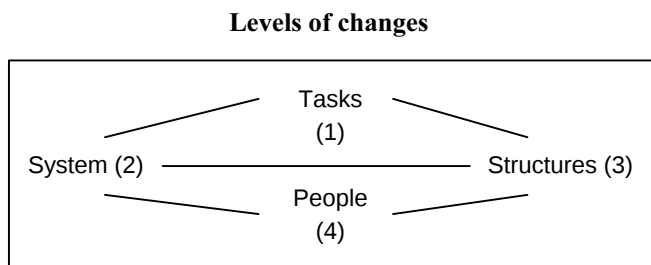
Necessity of applying change management methods in agricultural enterprises

Permanent changes in the outer, mainly economic environment of an enterprise raise the continuous requirement of acclimatisation through the solving of the problems connected with organisational changes. In certain cases these changes are unavoidable; they occur as a direct result of external effects, so they cannot be influenced or planned. However, more attention should be paid by experts and managers to desired, conscious and planned changes that can give relevant answers to both externally and internally generated challenges (*Farkas et al.*, 1994).

Planned changes represent the will of the enterprise management and staff to develop the flexibility of the enterprise and to modify the individual behaviour patterns in the desired direction. The two aspects, i.e. the organisational and the individual aspect, at the same time represent the basic fields of impact (levels) of any change. The organisational level can, of course, be divided into several parts, as shown in *Fig. 1*.

Planned changes therefore constitute a sequence of actions, a well designed process, where changes affect the individuals, the groups, the organisational structure and the tasks involved. Transition, as a result, is a process covering a space between the initial and the final states.

Fig. 1



1. Abbildung: Veränderungsebenen

Aufgaben(1), Systeme(2), Strukturen(3), Menschen(4)

Changing the culture

When discussing organisational changes one aspect must be always borne in mind: that is, an organisation always consists of people with their own values, beliefs, attitudes and expectations, together forming a certain organisational culture. Behavioural rules, the way language is used and situations are handled, the effective norms, dominant values, the philosophy of the organisation, the 'rules of the play' (if accepted then you are a member) and feelings 'broadcast' towards the external environment can all influence the operation of the enterprise (Schuller, 1992). Basically, every kind of organisational culture can give an answer to the following questions: 1. how the organisation react to external changes, and 2. how it organises internal integration.

Organisational changes are always accompanied by cultural changes. The more drastic the former, the more radical the latter. In the countries of central Europe, including Hungary, it is possible to trace clearly where political changes have been (and are) followed by significant changes in the economy. Changes in the pattern of property ownership, privatisation, the appearance of multinational companies and the future EU integration put Hungarian managers under unprecedented stress which forces them towards changes. In sectors where profit capacities are lower cultural changes raise even more serious problems. This is particularly true of Hungarian agriculture, which, due to its unclarified situation can hardly meet the requirements for urgent changes (Nógrádi, 1997).

Resistance to changes

The introduction and/or conducting of changes is an operation full of risks. The organisation, due to the necessary inflexibility of its members, will face a certain degree of resistance. Therefore one of the most important tasks of the staff managing the changes is to measure the extent of this resistance and to find appropriate ways and means to overcome the problem.

According to previous experience the reactions to any change follow a well defined route which can be divided into the following 7 steps: 1. paralysis, 2. negation, 3. depression, 4. acceptance, 5. trial, 6. consciousness and 7. fixation.

Due to organisational changes the power status of individuals and the structure of the organisation (jobs, information flow etc.) are 'endangered', so there is a reaction against the changes. Competition for limited resources among the organisational units,

previous investments, and formal and informal agreements within the organisation all enhance the inflexibility of the organisation; hence, the changes are blocked even from the side of the organisation itself.

For the purpose gaining the capacity to overcome resistance a series of tools and strategies are available to management staff. The proper application of these depends on correct assessment of the nature and importance of the given resistance factors.

Framework of change management

The present situation of an organisation can be taken as a resulting vector of forces pointing toward and against the given changes. Changes begin when the equilibrium between the forces is distorted, i.e. progressive forces strengthen or regressive forces weaken. The process itself takes place within a steady framework containing the following steps: 1. realising the necessity for changes, 2. setting aims, 3. analysing the relevant alternatives, 4. the taking of a decision on appropriate strategy, 5. planning the change process, 6. practical implementation and 7. monitoring, evaluation and follow up.

In its traditional sense change management requires a systematic approach, a scientifically based series of actions. According to a quite recent approach change management is a new-born kind of art which endeavours to find pathways in the unmappable set of organisational (structural, information and individual) fields by giving prompt answers to problems as they arise.

The planning and conducting of changes will unavoidably lead to conflicts. In the case of an organisation the conflicts emerge between individuals but can spread to groups or even to the whole organisation when another organisation enters the power field.

Organisation development model

If it is necessary to define what is meant by organisational development as a concept, it can be described as an approach of change management that covers the entire organisation through a top-to-down controlled, planned process of complex interventions focusing on intra-organisational interactions to enhance overall efficiency (Szedlár, 1998).

The aim of the concept is the harmonisation of individual and community aims and interests and the summarising or integration of these into a complex system to ensure the operation of the organisation in a 'healthy' way as well as improving the satisfaction level of individuals.

Process and intervention methods of organisation development

The most effective participation of management consulting in organisational development can be ensured by certain interventions carried out through the creation and operation of training groups (Lewin, 1951).

During so-termed process-consulting, and due to its supportive approach, previously unexploited or not properly exploited reserves can be opened and organised and then turned into real capacities. The application of training groups means that the staff involved transfer the knowledge required for OD via the active involvement of the participants. Group training focuses on individuals and also on the entire group. It constitutes simultaneous knowledge transfer and the improvement of skills and abilities. Such knowledge, having been transferred during the training sessions, is to build up skills and to be included in the development process of organisational culture.

Change management in agriculture

A special form of intervention is so-termed 'task-based development' training sessions, supporting team building at the same time as fulfilling the actual task in order to strengthen the quality of co-operation among the participants.

A type of task-based training is 'action-defining or target-defining' training. This is used widely within the framework of rapid response projects aimed at the improvement of regional development. The general concept of this type of training is, in addition to business development, to push into motion the human and material infrastructure available in the given region in all its complexity. This intervention is process-based, so besides maintaining existing enterprises it also supports the formation of new business units along with the improvement of the related social and economic institutional system in order to create a local 'brain reserve' which could elevate participants to a position from which they would be able to execute progressive activities. Among potential participants in regional development projects are the local agricultural enterprises. These enterprises also previously played a dominant role in the maintaining of the population keeping ability of the regions, partly through presenting sources of income for the local communities.

The development of agricultural organisations requires a multidirectional and multilevel process. Such a process can reach its maximum efficiency when it is integrated into a regional development project.

A good example of such a project is the USDOL Rapid Response method, particularly fine-tuned for agricultural and/or rural regions. Its basic aim is to maintain existing enterprises, to urge new ones to be established, to create a mental base for development and to encourage participants to develop themselves on their own initiative. In particular, it uses the existing material and human resources for development, and can therefore strengthen the endogenous aspect of development.

CONCLUSIONS

Accelerating modification tendencies in the external and internal environment, as well as in the expectations, values and knowledge of the personnel, create special development conditions for enterprises. This is particularly true of Hungary, where social and economic transition is still in progress.

To overcome the problems raised by the transitional period and to clarify and handle appropriately the forces acting against the changes is a task representing quite a challenge for managers, regardless of the management level at which they actually work. Awareness of the features of the changing processes and the application of the aspects of change management and organisation development described above can be useful tools for the handling of the necessary steps towards the alterations desired at individual and organisation level.

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Work organisation in the production of slaughter pigs on Hungarian and Japanese pig farms

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ABSTRACT

The production of slaughter pigs is a particularly important branch of Hungarian agriculture. Indication of this can be observed in the fact that pig meat accounts for 20-22% of all agricultural exports from the country. In the past 25 years particularly specific changes have taken place in the production of slaughter pigs in Hungary; these manifest themselves extensively in the respective variations of keeping technology, mainly in procedures related to animal feeding and nutrition. The authors provide a detailed account of the investigations performed on various farms for the purpose of exploring solutions and variations for work organisation to be considered optimal from the economic aspect. In the course of these investigations the role of the various factors influencing quality was applied as an important aspect, as was the unearthing of experience and observations related to the introduction into use in Hungary of the EUROP meat classification system. Japanese pig farming was also studied from the aspect of work organisation. Special emphasis was laid on the production of slaughter pigs and work organisation solutions. A comparison was made between Japanese and Hungarian pig farms with a case study on four Hungarian, one American and four Japanese farms.

(Keywords: pig production, work organisation, work efficiency, Hungary, Japan)

ZUSAMMENFASSUNG

Die Arbeitsorganisation in der Schlachtschweineproduktion in ungarischen und japanischen Betrieben

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Die Schlachtschweinproduktion ist ein ausgesprochen wichtiger Zweig der ungarischen Landwirtschaft. Dies wird dadurch bestätigt, daß das Schweinefleisch einen 20-22%-igen Anteil am gesamten landwirtschaftlichen Export hat. In den vergangenen 25 Jahren kam es zu spezifischen Veränderungen in der ungarischen Schlachtschwein-Produktion, hauptsächlich bei der Haltungstechnologie und den Zuchtmethoden. Die Verfasser berichten ausführlich über die Untersuchungen, die in verschiedenen Betrieben durchgeführt wurden, um optimale arbeitsorganisatorische Lösungen zu finden. Im Rahmen der Analyse wurden die Kriterien der am meisten verbreiteten Masttechnologien (Fütterungsmethoden) aufgearbeitet, die auch mit Hilfe einer

ausführlichen Arbeitstagsaufnahme bewertet wurden. Während der Untersuchungen wurden besonders die qualitätsbeeinflussenden Faktoren und die Erfahrungen bei der Einführung der EUROP-Handelsklassen berücksichtigt. Auch die japanische Schweineproduktion wurde aus der Sicht der Arbeitsorganisation in einem Großbetrieb untersucht. Besondere Aufmerksamkeit galt den arbeitsorganisatorischen Lösungen in der Schlachtschweinproduktion. In einer Fallstudie wurden 4 japanische und 4 ungarische Schweinefarmen sowie eine amerikanische untersucht.

(Schlüsselwörter: Schweineproduktion, Arbeitsorganisation, Arbeitsproduktivität, Ungarn, Japan)

INTRODUCTION

In Hungary slaughter pig production accounts for 54-60% of all slaughter livestock production. In the past ten years the proportion occupied by pig production has declined substantially. The pig population's density is considerably lower (5 sows per 100 ha) than the average for the member countries of the European Union. This tendency is also to be regarded as unfavourable due to the fact that, on the one hand, the agro-ecological conditions in Hungary are favourable for the production of feed concentrates. On the other hand the processing capacity of the meat industry was established on the basis of 10 million pigs. The now smaller domestic pig population has led to lower efficiency in the exploitation of the capacities available, which in turn exerts an unfavourable effect on overheads and fixed costs, and therefore on the economic efficiency of processing on the whole (Széles, 1998).

In many cases the pig production sites of the agricultural associations and cooperatives were built in the 1970s; their keeping technology systems have therefore now become outdated, and they are in dire need of modernisation and reconstruction. An indication of this is that the practice of feeding from the floor is still in use, which entails high levels of feed loss, and risk to animal health remains high; this also raises the priority of the earliest possible modernisation. In the course of the modernisation of feeding technology pig feeding methods based on the Big Dutchman system have come into increasingly widespread use.

On comparison of Hungarian and Japanese agriculture and pig farming it can be seen that there are great differences. The total area of agricultural land in Hungary is 20 per cent larger than that of Japan, but this land occupies less than 14 per cent of the total land area of Japan while in Hungary it accounts for more than 65 per cent. In the case of the number of people per 1 ha of agricultural land the difference is striking. Japan has nearly 15 times more people on 1 ha of agricultural land than Hungary. In Japan the most important branch of farming is rice production with a share of over 55 per cent, while the share of livestock farming share is only 2.9 per cent (*Japanese Ministry of Agriculture*, 1995). Agricultural production has centred around harvesting rice. This has given a number of characteristics to Japanese agriculture. Domestic livestock have never been very important in Japan.

The most notable characteristic of the livestock industry is that the number of farming households has been decreasing annually. Farm closures have been especially prevalent among small operators, and were brought by on the increasing age of those working on them, lack of successors, and the worsening environment for livestock breeding. In contrast, the number of large-scale livestock farms has increased, and the output per farm has been rising (*Nippon*, 1994).

MATERIALS AND METHODS

Work organisation systems applied in slaughter pig production were analysed on the basis of investigations performed at four Hungarian and four Japanese agricultural enterprises. In the process of collecting the data the endeavour was to create a database suitable to serve, with the application of a computer-installed facility, as the base for the formulation of a wide range of indicators relating to livestock breeding and also other economic indicators. Linked to this, a method involving the detailed recording of data for individual working days was used for the analysis of the structure of working time in each of the respective areas of work activity, which also involved the application of a computer-based procedure.

RESULTS AND DISCUSSION

Table 1 shows the number of employees, the number of sows and litter size on the selected farms.

Table 1

Number of employees, number of sows and litter size on various farms, 1992-97

Figures of	Csákvár farm	Barcs pig farm	Somogy-szil	Rácegres farm	Suzuki pig farm	Sato pig farm	Koyama farm	Morita pig farm
Number of employed workers (1)	41	28	18	8	23	30	2	5
Mean stock of sows (2)	1353	730	252	112	2100	2000	76	466
Litter size, piglets per sow (3)	9.48	9.10	9.44	9.45	10.99	10.22	9.50	9.82

1. Tabelle: Anzahl der Mitarbeiter, Anzahl der Sauen und Wurfgröße in verschiedenen Betrieben 1992-97

Anzahl der Mitarbeiter(1), Anzahl der Sauen(2), Wurfgröße pro Sau(3)

In regard to the main technological features of the keeping of animals on the farms examined the following differences were found. Of all the farms observed only two of the Hungarian farms - the small and the medium-sized one - used straw bedding. All the other farms had a liquid manure slurry system, which is more favourable as it requires less manpower, but on the other hand it is more hazardous to the environment. The American farm uses the largest amount of water among the farms due to the water flushings. With natural ventilation and lighting a considerable amount of electricity can be saved, but in order to achieve this not only a milder climate but also a specific building design is necessary. Winters are harsher on Sato farm in Iwate prefecture and also in Csakvar farm in Hungary, so ventilation and lighting are mainly ensured artificially. On two Japanese farms - the Suzuki and the Morita farm - both ventilation and lightning are supplied naturally, as on the smallest Hungarian farm, Racegres (*Fejes-Schweigert*, 1992). Mating methods vary from farm to farm, but natural mating is preferred on two Japanese and on two Hungarian farms. One Japanese farm, the Suzuki

farm, one Hungarian farm, Csakvar, and the American farm use only artificial insemination, which is the preferred method among the largest farms examined.

On comparison of the main breeding indicators for the pig production units of the farms studied it can be seen that there are better overall results on the four Japanese farms. This is shown in Table 2.

Table 2

The indicators of pig production for the farms studied 1995-1997

	Csákvár Hun	Barcs Farm Hun	Somogy zil Hun	Rácegres Hun	Suzuki farm Japan	Sato farm Japan	Koyama farm Japan	Morita *farm Japan
Piglet no. at weaning (1)	7.91	8.55	8.50	8.30	9.91	9.43	8.50	9.09
Sow rotation (2)	2.05	1.93	2.14	1.82	2.09	2.20	2.14	2.32
Rate of selection for sows (%) (3)	31.00	50.00	30.00	30.00	42.00	40.00	40.00	89.35
Success rate of mating (%) (4)	60.20	51.00	85.00	48.00	90.00	82.00	89.5	91.04
Piglet mortality (%) (5)	16.63	6.15	10.00	12.20	9.90	7.70	10.53	7.44
Fattening pig mortality (%) (6)	3.72	10.50	2.50	2.90	3.10	1.40	1.37	5.40

* The 89.35% selection rate is high, the reason for this being that last year 110 new gilts were introduced. (*Die Selektionsrate von 89,35% ist so hoch, weil im vorjahr 110 Jungsauen eingestallt wurden.*) This was on top of the selection of old sows. (*Dieser Wert lag noch über dem Selektionswert der Altsauen.*) The many new gilts introduced also increased the sow rotation figure. (*Die hohe Zahl der Jungsauen erhöhte auch die Sauenrotation.*)

2. Tabelle: Indexzahl der Schweinerzeugung in den untersuchten Betrieben 1995-1997

Zahl der Absatzferkel(1), Sauenrotations(2), Sauenselektion(3), Trächtigkeitsanteil(4), Ferkelverluste(5), Mastverluste(6)

These data draw attention to the fact that the greatest variation between the farms is in piglet mortality, percentages for this varying between 6.15 and 16.63%. An undesirable observation is that this indicator was found to be above 12% on two Hungarian farms, this being higher than the national average, while the Japanese results are considerably better.

Feed conversion is of particular significance in the assessment of the economic efficiency of slaughter pig production; this was examined on the basis of the quantity of diet required for the production of 1 kg live weight. Feed conversion values varied between 3.26 and 4.22 on the selected Hungarian farms, while at 3.03 to 3.60 kg the Japanese results are better again. This is also particularly worthy of consideration in the light of the view of Kalm (1994). He expresses the opinion that in the countries of the European Union, in relation to the development of slaughter pig production, 2.8 kg per kg feed conversion and 750 g live weight gain per day should be the objective to be attained in the future. The present studies indicate that on the farms included in the

evaluation daily weight gain was between 443 and 610 g on the Hungarian farms, the values of 646 and 750 g on the Japanese farms representing much better results.

The methods of feeding used in the fattening houses on the farms examined can be seen in *Table 3*. The Big Dutchman type of feeder is the most popular on the Japanese farms, and Hungarian farms also tend to use this type of feeder due to the advantages it offers.

On most Japanese farms feeding is fully automatic, while on the Hungarian farms examined great manpower is required on account of the procedure of filling the feeders.

Coarse meal (either dry or wet) is fed on all the Japanese and Hungarian farms studied.

Table 3

Feeding in the fattening houses

Name of farm (1)	Short description of the method of feeding (2)
Csákvár Pig farm Hungary	Liquid feed is poured into a concrete trough from a metal pipeline system
Barcs Pig farm	Various methods: Big Dutchman self-feeders, concrete troughs and feeding on the concrete floors are all in use on the farm. First, hand wagons are filled with dry feed from the feed-storage-towers, then the employee fills up the feeders with a shovel.
Somogyszil Pig farm	Various methods: Big Dutchman self-feeders and metal self-feeder troughs. Filling procedure: from sacks to a hand wagon, and from there to the trough with a bucket.
Rácegres Pig farm	Various methods (as in Somogyszil): Big Dutchman self-feeders and metal self-feeder troughs. Filling procedure: from sacks to a hand wagon, and from there to the trough with a bucket.
Suzuki Pig Farm, Japan	Various methods: metal self-feeder troughs and feeding from the floor. Filling: automatic pipeline system. Dry coarse meal.
Sato Pig farm	Big Dutchman type self-feeders. Filling is via a fully automatic pipeline system.
Koyama Pig farm	Metal self-feeder troughs and a semi-automatic pipeline system.
Morita Pig farm	Big Dutchman type self-feeders and new round BD type self-feeders. Filling is via a fully automatic pipeline system.
PIC Ltd. Farm USA	An automated pipeline system fills up the feeding boxes with dry feed. From there it is just scraped out with a bucket and tipped onto the concrete floor.

3. Tabelle: Fütterungssysteme im Mastbetrieb

Der Name des Betriebes(1), Kurze Beschreibung des Fütterungssystems(2)

Job structure on the selected pig farms

There are various jobs on the farms examined. As farm size is increases specialisation in certain work fields is also on the increase. This is particularly true on the Hungarian farms. On average, Japanese farms employ fewer working staff than Hungarian farms. There are many reasons for this, as outlined below.

- The structure of buildings is better. On the Japanese farms the buildings were designed especially and originally for pigs, while this was not always the case concerning some buildings on the Hungarian farms.

- Differences exist in ownership structure. Although by now almost all Hungarian farms have been privatised, the attitudes of the owners are not as advanced as on Japanese farms.
- Because of the different historical backgrounds, social rules and regulations are also different.
- The degree of bureaucracy is lower on Japanese farms, but still higher than on the western competitor farms.
- The previous full employment policy in the socialist countries still has its effects, and even now more workers are employed on farms.
- More machinery is used on Japanese pig farms, and this equipment is of higher quality and a higher level of sophistication.
- In Hungary employees tend to be specialised in particular farm jobs. For example, there are machine operators or specialised persons who work only on their own field. On the other hand, Japanese employees are more universal, like American or other western employees. On western and Japanese farms family members (wife and grown up children) do the bookkeeping and administration. The vet only comes at the request of the village or otherwise once a month. In Japan pig men do the maintenance and repair jobs around the farm.
- In Japan there is enough capital for the renewal of farm equipment and machinery.
- Capital is also needed to keep up with the latest developments in various areas of pig farming, including work organisation. Japan has not only the capital but also the connections, as the USA is actually a neighbour country from which it is relatively easy to obtain new information, which is of bilateral interest, as the USA is the most important agricultural trading partner of Japan.
- Fewer workers are needed in Japan due to the very short vacations and holidays there.
- Safety rules are different, for example in the mating process. Sometimes this requires the presence of an extra person, since in Hungary only men can work with boars in the interest of avoiding accidents.
- In Japan farmers live next to the farm, so there is no need for night guards.

On Sato farm, for example, there are no night guards. After work the farm is closed and opened only in the morning. It has been calculated that the wage for the night guard would be higher than what could be saved with night work, particularly in the farrowing house. Also, there is no danger of theft in Japan.

Evaluations relating to work organisation should include consideration of variations in the length of the working day, and also of the relation between the number of staff and the number of animals. *Table 4* provides an overview of this. Concerning work efficiency in fattening houses, the Japanese Suzuki farm (which is the largest Japanese farm examined) showed the best results (almost 3900 fattening pigs per day per attendant), followed by the Morita farm, third place being occupied by Csakvar Ltd. in Hungary, which is the largest Hungarian farm examined. As farm size diminishes the results weaken. This is especially obvious with the smallest Hungarian farm examined, Rácegres. Daily working time is officially eight hours on all of the farms. However, in practice this is shorter in some places, for example at Rácegres, or else longer, as on the Suzuki farm. At the Morita farm all employees work 8 hours a day: no more and no less. This is quite an outstanding achievement the organisation of the daily work on the farm. On this farm only the owner works on Sundays. He works 2.5 hours in the morning and

1.5 hours in the afternoon, while his staff have the day off; this is also outstanding on consideration of the fact that the farm has 466 sows.

Table 4

Number of fattening pigs per attendant and daily working time on the farms examined, at the time of the study

Farm (1)	Daily number of fattening pigs per attendant (2)	Daily working hours (3)
Csákvár Ltd., farm, Hungary	2100	05.30 - 16.00
Barcs, Coop. Farm, Hungary	1060	06.00 - 15.00
Somogyszil, Coop., Hungary	450	06.00 - 11.30 14.00 - 16.45
Rácegres, Pig farm, Hungary	421*	05.00 - 10.30 15.00 - 17.30
Suzuki Pig farm, Japan	3875	6.00 - 12.00 14.00 - 16.00
Sato, farm Morioka, Japan	2083	8.00 - 12.00 13.00 - 17.00
Koyama farm, Japan	350*	9.00 - 11.30 13.00 - 17.00
Morita farm, Japan	2236	8.00 - 12.00 13.00 - 17.00

* Total number of fattening pigs on the farm (*Anzahl der Schweine im Betrieb.*)

4. Tabelle: Anzahl der Mastschweine /Mitarbeiter/ Tag und die Tagesarbeitszeit

Benennung(1), Anzahl der Mastschweine/Mitarbeiter/Tag(2), Tagesarbeitszeit(3)

Concerning some of the work efficiency figures at the following farms it can be stated that the Morita pig farm yielded the best results in terms of annual working hours per sow (23 hours) and working hours to produce 100 kg of slaughter pig (2.1 hours). This is a well managed farm with shorter working hours, there being buildings and road structures aimed at saving working time and manpower on the farm. The results from the other three Japanese farms are also very good. Among these the relatively small family farm, the Koyama farm, gave the weakest results, mainly due to the fact that it is smaller in size. It is not possible to exploit work organisation solutions as deeply on the smaller farms as on the larger farms.

In slaughter pig production an important aspect of efficiency studies is that analyses related to the utilisation of human labour should be performed. The results of these analyses are summarised in *Table 5*, in which the major work productivity indicators are outlined. It is no surprise that the large American farm with only ten workers, well designed buildings and with the excellent PIC hybrids yielded the best result; 115 sows per employee and less than 2 hours of labour to produce 100 kg of slaughter pig. The result for the Morita farm is also excellent (93 sows and 2.1 hours), together with those for the two other larger Japanese farms. The largest Hungarian farm also gave good results.

Table 5

Work efficiency figures in pig production on the selected farms in the years 1993-97

Farm	Sows per employee (1)	Working hours to produce 100 kg of slaughter pig (2)
Csákvár Ltd. Pig farm, Hungary	33	3.5
Barcs, Cooperative farm, Hungary	26	4.6
Somogyszil, Cooperative farm, Hungary	14	10.7
Rácegres Pig farm, Hungary	14	10.4
Suzuki Pig farm, Japan	91	2.3
Sato, Pig farm Morioka, Japan	67	2.2
Isamu Koyama Pig farm, Japan	38	4.3
Morita Pig-farm, Japan	93	2.1
PIC Ltd., Kansas, USA	115	1.5

5. Tabelle: Arbeitsproduktivitäts Indexe in den untersuchten Betrieben in den Jahren 1993-97

Anzahl der Sauen/Mitarbeiter(1), Anzahl der notwendigen Arbeitsstunden für die Erstellung von 100 kg Schlachtschwein(2)

The data presented in this table indicate that great differences exist between the farms both with respect to the number of sows per member of staff and regarding the number of man-hours required for the production of a 100 kg slaughter pig.

The economic efficiency and success of slaughter pig production are fundamentally determined by changes in the prevailing sales returns conditions, which are inextricably linked to quality. 1995 saw the introduction into Hungary of the EUROP meat quality classification system, which is in general use in the countries of the European Union. These data verify an improvement in quality, although modest: the ratios of the grades denoting the highest quality (S, E, U and R) increased, reaching values of 76% in 1995, 81% in 1996, and 85% in 1997. In Hungary the cause for concern lies in the fact that, despite a decreasing tendency, the proportion of meat classified into groups O and P is still high.

Concerning carcass quality measurement, the EUROP system is not used in Japan, but the following system is in operation, with the example of Iwate prefecture, where the average prices for three qualities of pork were the following in August 1998:

Back fat measurements are taken at three points: the shoulder, back and hip.

Good quality Back fat thinner than 18 mm: 420-440 yen/kg.

Medium quality Back fat between 18 and 20 mm: 380 yen/kg.

Low quality Back fat thicker than 20 mm: 300-320 yen/kg.

The slaughterhouse pays this price, which does not include the 5% VAT. For the by-products the price is 1000 yen/pig. (3-5 yen/kg)

The daily average price for a good quality carcass is calculated on the average of prices at three main pig markets; for example, on Monday 8th February 1999 the price was 437 yen in Tokyo, 419 yen in Oomiya, 413 yen in Yokohama=423 yen/kg. (*Local farmers newspaper*, 1999). For example, on that day the owner of Morita farm received 388 yen/kg, representing 3.5 grade level out five.

CONCLUSIONS

The studies performed verify that in Hungary more efficient work organisation will enable the economic position in the production of slaughter pigs to be improved. It has been ascertained that the structure of working time in pig breeding is not particularly favourable, and the use in fattening units of feeding systems of types which entail wastage and losses is still characteristic of a high proportion of farms, specific feed utilisation levels remaining high. With respect to the pig meat classification system used in the countries of the European Union, on the basis of the experience of the past three years it can be ascertained that quality has improved.

In Japan feed is imported, and the manure produced causes problems, since there is no appropriate way to deal with and to utilise it completely. There is not enough agricultural land for its utilisation, especially in heavily populated areas. At present it is cheaper to buy feed than to grow it.

Concerning the organisation of daily work there are considerable differences between the Japanese and the Hungarian pig farms. It is true for pig farms in both countries that as the size of the farm increases specialisation in certain fields of work also increases. However, Japanese farms employ fewer workers, the main reasons behind this being that the structure of buildings is better, and the buildings were designed especially and originally for pigs. Differences in ownership structure, historical background, and social rules and regulations are also different. The degree of bureaucracy is also lower on Japanese farms. More and better machinery is used on Japanese pig farms. On most farms in Hungary employees tend to be specialised in various jobs, while Japanese employees are more generalised. It is also an important aspect that there is enough capital in Japan for the renewal of farm equipment and machinery. Fewer workers are needed due to the very short vacations and holidays in Japan. Furthermore, one other important difference is that Japanese farmers live next to their farm.

The Japanese are doing very well in work organisation and other areas of pig farming, while environmental protection is at a higher level in the countries of the EU. As Hungary wishes to join the EU in the near future, all the strict rules and regulations of the Union must also be implemented on Hungarian farms. Japan and the USA, on the other hand, are not bound by these and have higher levels of pollution.

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The transformation of Hungarian meat sector -lessons and experiences

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ABSTRACT

The linkages between the privatisation of agricultural cooperatives, state- owned enterprises, their restructuring and the participation of foreign capital in both processes are the focus of this paper. In a broad sense, restructuring includes all policy measures and economic processes which increase the efficiency on an economy or of a company. The paper analyses the processes of privatisation and their effect on structure, conduct and strategy of various economic entities in the meat sector. The experience of last ten years puts us in a much stronger analytical position than at the start of the transition. In general it can be stated, that the privatisation of agriculture and food industry was a necessary precondition for improvement of economic competitiveness of meat sector, but did not solve numerous problems, and generated some important contradictions.

(Keywords: privatisation, economic policy, strategic planning, vertical integration)

ZUSAMMENFASSUNG

Umgestaltungen in der ungarischen Fleischwirtschaft - Erfahrungen und Versuche

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Ab Ende der 60-er bis Ende der 70-er Jahre war Ungarn in der Liberalisierung seiner Agrarpolitik weit über die in den übrigen sozialistischen Ländern gültigen Rahmenbedingungen hinausgegangen. Die ungarische Landwirtschaft war innerhalb des sozialistischen Lagers ein Vorzeigeeobjekt und mit Abstand am leistungsfähigsten. Basis für diese Entwicklung war eine Zusammenarbeit zwischen den Großbetrieben und den Hauswirtschaften, die sogenannten Produktionssysteme. Diese Produktionsform war auf die konkreten ökonomischen und ökologischen Bedingungen abgestimmt und verfügte über einen sicheren Absatzmarkt. Durch das Privatisieren der Landwirtschaft wurden diese verschiedenen Formen der horizontalen und vertikalen Kooperation zerstört. Zeitlich dauerte jedoch der Strukturwandel länger als erwartet. Kapitalmangel und Unsicherheit führten bisher nicht zum erwarteten dauerhaften Aufschwung. Bei der Stabilisierung der Fleischwirtschaft spielten ausländische Direktinvestitionen eine wichtige Rolle. Die landwirtschaftlichen Kleinbetriebe werden jedoch auch in Zukunft weiterbestehen, da über 20% der Bevölkerung statistisch unterhalb des Existenzniveaus

lebt. Außerdem ermöglichen diese Betriebe als Nebenerwerb auf familiärer Basis die Fortführung der ungarischen Traditionen und des ungarischen Modells. Die wichtigsten Aufgaben in naher Zukunft sind: Verstärken der horizontalen Integration der Kleinbetriebe, Förderung der Konzentration und Verstärken der vertikalen Integration der Fleischverarbeitungsindustrie.

(Schlüsselwörter: Privatisierung, Betriebsformen, horizontale und vertikale Integration)

OWNERSHIP AND STRUCTURAL CHANGES IN HUNGARIAN MEAT SECTOR BEFORE THE PRIVATISATION

Historical background

The recent development of Hungarian meat industry is hard to understand without a brief overview of recent development in Hungarian economy and society.

While collectivisation began in 1949, it was the military repression of the 1956 Hungarian revolution against the Soviet-style regime which prompted a quickening of agricultural collectivisation, completed by 1968, and tighter ties through COMECON. The theoretical aim of COMECON was the efficient division of production between socialist countries. In practice food and industrial products were transferred to the USSR in exchange for natural resources and technological inputs; the latter often out-dated technologies. The use of artificial exchange rates between the local currency (Hungarian Forint) and the Rouble resulted in low prices for Hungarian meat products which were supplemented with state subsidies and lead to poor product quality.

In the early 1970's problems of a growing foreign trade gap resulted in increased political emphasis on promoting exporting industries. By the mid-1980's a degree of economic liberalisation was already occurring with the introduction of a commercial banking system, tax reform and the abolition of consumer food price support. In 1989 the Hungarian Socialist Workers Party was removed from power in both the political arena and the work place, and privatisation and liberalisation began in earnest. The first free elections in Hungary for more than 40 years took place in 1990 and in 1991 COMECON itself collapsed. In agriculture privatisation of state farms began and price liberalisation was almost complete.

The process of transition to a market economy is not without its problems as demonstrated by the macro-economic indicators for Hungary during this period. In early 90s the GDP has fallen and the inflation rate reached 30%. High inflation followed the initial price liberalisation, and failure of the Government's attempts to stimulate the private sector through ill-conceived credit schemes lead to declining GDP. The budgetary controls introduced in 1995 - 9 per cent devaluation, import surcharges and control of energy prices - stabilised GDP but were initially inflationary. There now appears to be more stability with inflation in 1997 estimated at about 18 per cent and GDP annual growth at about 2 per cent.

The development of Hungarian agriculture and meat industry from collectivisation to privatisation

After World War II Hungarian agriculture contributed some 38 per cent to GDP but had a highly fragmented structure in which more than 90 per cent of the farms were less than 12 hectares and a few large estates, which represented less than one per cent of farmers, held almost half of the land. This inequality was the target of land reform which after the Soviet-backed Communist Party gained power led to expropriation. Those estates of the so-called "gentry" between 58 and 580 hectares and those of

peasants above 145 hectares were redistributed and organised into co-operatives. Estates above 580 hectares were expropriated and turned into state farms. The latter were often badly organised but the income generated was diverted into industry by the state. The co-operatives also performed poorly and were dissolved after the 1956 revolution to be reorganised after 1957 in a second wave of collectivisation. In this programme state subsidies were used to encourage investment by the co-operatives and the development of joint marketing arrangements with the food processing sector. This was aided by the introduction of formal contracts for the sale of products with quality premiums and advance payments.

The land in the co-operatives remained in private ownership with about one-third of all land in actual state ownership. However in 1957 a law was passed under which ownership of that land held in the co-operatives by non-members was passed to the co-operative on payment of a sum equivalent to about 5-year's rent. As a consequence, by the end of the 1970's the private ownership of co-operative members had fallen to about 50 per cent. The comprehensive work of *Csizmadia* and *Székely* (1986) analyses the development of Hungarian agriculture and food industry before the reform-wave in end of 1980s`.

In the meat processing industry a large, centrally planned, state-owned company (trust) was established with no elements of a market economy, and farmers were obliged to hand over their produce to these state agencies, generally for prices below the costs of production. In the late fifties this system was replaced by formal legal contracts which protected the rights of the producers for a secure outlet but at a fair price, making the system in Hungary quite different in this respect from that in the other planned economies. The meat processing organisations also often assisted producer co-operatives in the purchase of machinery, and provided advice on production technology and product quality.

However after the partial economic reforms of 1968 the structure and organisation of the Hungarian meat industry gradually changed. The nation-wide state company was replaced with independent meat- industrial enterprises, more local factories, sometimes producer-owned. Central planning declined with more freedom given to processors in sourcing their raw material. This led to changes in the relative bargaining power of producers and processors depending on whether shortages or surpluses resulted from fluctuating annual yields. By the late 1980's it had become clear that the only real possibility for improvement was the adoption of a fully-fledged market economy system. Similarly in the retail sector, centralised organisation and severe diversion of income by the state into other industrial sectors had crippled the system.

Western commentators often use the term "command economy" to refer to the state organised agri-food industries in Central and Eastern European countries at this time. This is however an over simplification of a system in which, perhaps surprisingly, small private producers contributed significantly to meat production and were integrated with the large co-operatives. For example in 1980 more than half of pig production came from these small farms. Also the livestock feed was often produced on the co-operative and could be taken in lieu of wages by members who would then sell their livestock through the co-operative. There was also horizontal integration across the co-operatives which shared technical expertise and collaborated in marketing (*Szabó*, 1998).

TRANSITION TO PRIVATE OWNERSHIP

Agricultural transition

At the end of the 1980's it was clear that agricultural reform would be a major component of the transition to a market economy although different political parties had different views on how the land reform should be conducted. The elections of September 1990 saw the formation of a centre-right government which favoured the formation of a mixed agricultural structure based on family farms. To achieve this, account would be taken of the land ownership in 1947 before collectivisation, and compensation made where appropriate. People who were able to prove a legitimate claim were given a voucher which represented full compensation up to a value of about 2500 USD and a sliding scale of compensation thereafter. These vouchers could be used to purchase physical assets, which could include land (but only by the first recipient of the voucher), property, and also annuities. The purchase of the land could take place at auctions where the land price in 1991 averaged about 250 USD per hectare.

There were problems in this process of land restitution mainly arising from the separation of the land ownership and its use, due to the urbanisation of the population since the first half of the century. Although it is illegal for foreigners to buy land, farms in the north west of the country were acquired by Austrian farmers through local intermediaries. It is suggested that these Austrian farmers were subsequently setting aside land in Austria, producing in Hungary and "smuggling" the produce back across the border. The process of restitution was slow because of the lack of sophisticated information systems and this led to land actually falling into disuse.

Also, the division of large co-operatives and state farms often meant the separation of land from the associated farm buildings. This was the case in animal production. *The fodder basis of production were in separate ownership, than the pigstyes and cow-houses* (Széles, 1993). During this period the percentage of workers engaged in agriculture fell from 17 per cent in 1990 to 8.5 per cent in 1995 (Kocsondi, 1999).

Legislation was introduced to control the privatisation of co-operatives and allow members to leave with some assets. Some state farms remained in public ownership and others were privatised under the voucher system. The resulting changes in land ownership and holding structure are shown in *Tables 1* and 2.

Table 1

Land ownership in Hungary 1990 – 1998

Ownership(1)	1990	1991	1992	1993	1994	1998
			per cent			
State (2)	27	27	24	23	19	9
Co-op. (3)	64	62	57	42	38	30
Private (4)	7	11	19	35	43	61

Source: Central Hungarian Statistical Office. (*Quelle: Ungarisches Zentralamt für Statistik.*)

Tabelle: 1. Tabelle: Struktur des Landbesitzes in Ungarn 1990 - 1998

Eigentümer(1), Staat(2), Genossenschaften(3), Privateigentum(4)

Table 2**Farm size structure in Hungary 1989, 1993 and 1994**

Size of holding ha (1)	1989	1993 No. Holdings (2) 000's	1994
< 500	46	634	972
501 - 3000	426	1153	1256
3001 - 10,000	934	567	29
Total (3)	1,499	2,395	2,572

Source: Central Hungarian Statistical Office (*Quelle: Zentrale Ungarische Statistische Amt*)

*2. Tabelle: Struktur der ungarischen Agrarbetriebe nach Größenklassen**Betriebgröße(1), Anzahl der Betriebe(2), Gesamt(3)*

These changes in the structure of production meant that produce was now being sold from a much larger number of small production units.

Many of the producers were former co-operative or state farm employees suddenly faced with new decisions about production and marketing. They often lacked the necessary technical and business skills as well as working capital. This latter situation has led to a reduction in the use of certain inputs such as fertilisers as well as a lack of investment and early sale of products in order to generate cash as interest rates rose.

The balance of power shifted in favour of the large meat processing organisations which were also able to source their raw material from abroad as imports were liberalised. Farm prices fell and consequently farm incomes did also.

Hungarian meat processing industry in transition

Until the end of the so-called socialist system the economic environment of firms did not promote the efficient work of meat processing enterprises. The enterprises had to adjust to distorted prices. This was an extraordinary important problem in export-oriented industries, because these industries exported mainly in COMECON countries, and the prices of their products were determined politically. This system gave a wide freedom for Hungarian governmental organs to "compensate" these distortions by subsidies. Under these conditions the incentive to innovate in terms of new products and product quality was extensively weak. Thus the Hungarian firms followed a mixed strategy, according to various conditions of different market segments. The Hungarian meat industry produced for former Soviet member states low -quality mass- products with low value-added content, for markets of developed states high - quality products, and for domestic market middle quality products. The goal in forms socialists market was to achieve a high quantity, in markets of developed countries to maximise the gross income and in domestic market to maximise the net income.

The Hungarian meat industry exported extensively into EU - member states, and co-operated with leading European firms, so in this industry the demand-side incentives to improvement of production have been more expressed.

The collapse of COMECON and the privatisation of the predominantly state-owned firms caused a drastical change in firms` structure and strategy.

The main objective when privatising firms is to increase their productivity. There is an intense debate about the appropriate mechanism for privatisation, and the consequences of alternative approaches for economic performance. Many different mechanisms are under discussion. The standard approach used in past privatisations elsewhere in the world has been to sell shares of firms to the public (foreigners may or may not have been allowed to participate). This approach is inevitably very slow. The existing financial assets of domestic residents are tiny relative to the value of the firms to be privatised, based on rates of return in Western financial markets.

The increasing loss of balance of the budget and the severe management, marketing and financial problems of meat industrial enterprises underlined the importance of role of foreign capital in Hungarian privatisation. Contrary to the previous expectations, the foreign investors showed interest in the first place for industries

- with safe home market(e.g. tobacco ind.)
- single product lines (e.g. sugar ind.)
- standard technology (e.g. starch ind.)and
- mono- or oligopolistic position (e.g. brewery ind.).

The meat processing industry can be characterised by neither of statements above, that's why the foreign direct investments in this branch begun rather late.

The collapse of COMECON three main strategy types could be determined in the Hungarian meat processing sphere.

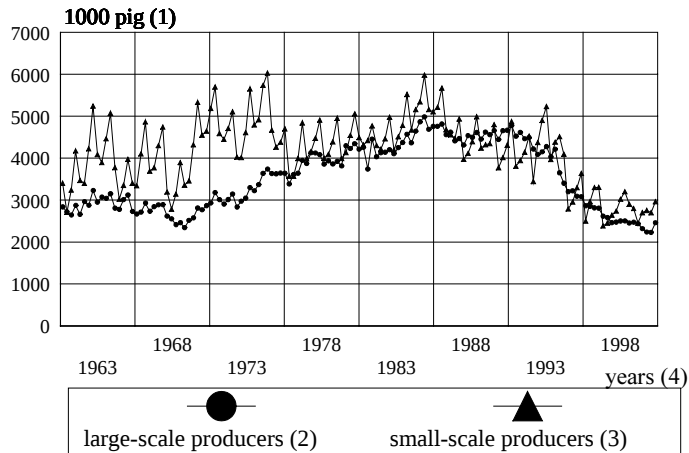
- the management does practically nothing, waits for possible ownership or market changes. In this case bankruptcy is practically unavoidable. In some enterprises the passivity of management resulted in a "melting away" of the material resources of the firm.
- the firm focuses on the home market, often with intensive product and/or process innovation . This strategy could be only a short-term solution , because the home market is approaching the saturation level.
- the management tries to take an active part in privatisation and -using existing connections with possible investors-does everything to stabilise the market positions of the firm.

After the long process of privatisation the Hungarian meat industry can be characterised by mixed ownership structure. The importance of foreign direct investment is increasing. This is of particular importance, because by this way is a possibility to involve capital for industrial modernisation and financing of revolving capital demand.

The change in farm structure, with the large increase in the number of small producers, has highlighted the concentration of the meat processing sector and led to calls from farmers' representatives for some desegregation of this sector with the aim of increasing competition. However, the meat processing sectors of EU countries show a degree of concentration very similar to that of Hungary. Although the causes of concentration differ (market forces in EU as against COMECON organisation in Hungary) the result is an industry which benefits from the available economies of scale, is well structured to support research, development and innovation, and can market produce efficiently. It can be argued that a policy aimed at reducing concentration in this sector may reduce efficiency as has happened in the meat processing sector. There, more than 500 small-scale plants have been established in the last 4 years, often with obsolete technology and poor hygiene standards, while at the same time the existing large plants are operating at only about 20 to 30 per cent capacity.

Fig. 1

The fluctuation of pig- number in small- and large scale production



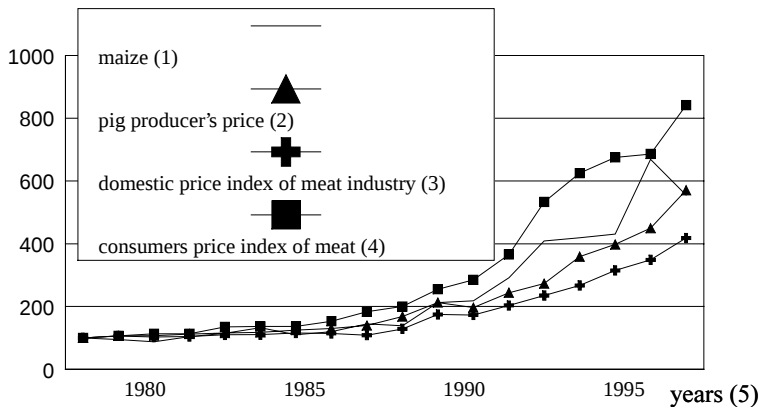
Source: Hungarian Statistical Yearbooks, own calculations. (*Quelle: Verschiedene statistische Jahrbücher sowie eigene Berechnungen.*)

1. Abbildung: Entwicklung der Schweinproduktion in Klein- und Großbetrieben

Stück(1), Großbetriebe(2), Kleinbetriebe(3), Jahre(4)

Fig. 2

The price indices in meat sector (1980=100%)



Source: Hungarian Statistical Yearbooks, own calculations. (*Quelle: Verschiedene statistische Jahrbücher sowie eigene Berechnungen.*)

2. Abbildung: Entwicklung der Preise in der Fleischwirtschaft

Mais(1), Erzeugerpreise für Schweinefleisch(2), Preisindex der Fleischindustrie(3), Verbraucherpreise bei Fleisch(4), Jahre(5)

The current fragmented farm structure also poses a major problem for the meat processing sector which prior to transition dealt with large scale co-operatives which ensured reasonably stable levels of supply of fairly uniform quality. Small producers are more volatile in their behaviour with wide and rapid swings in production in response to changing, often short term, prices (*Fig. 1*).

There is an increasing difference between in-and output prices of meat sector. By this way the income is pumped out of the sphere of production (*Fig. 2*).

One means of increasing the bargaining power of producers in the face of processor concentration might be for animal breeders to take a share in the ownership of processing facilities. In practice they have not had sufficient capital to do this and their political power is fragmented and has not led to policies which would enable this process. The only sustainable way of improving the balance in power between breeders and processors would be through the proper enforcement of effective competition law and reorganisation of the agricultural support system which currently channels the majority of support through processors or exporters rather than primary producers.

DISCUSSION

The privatisation of Hungarian animal breeding and meat processing sector after more than 40 years of collectivisation has inevitably resulted in an industry of fragmented structure run by “new” entrepreneurs some of whom lack business skills and many of whom lack capital. As a result they are often working with outdated technology and in an environment where market information systems are still developing. The existing support policies are largely focused at the processor-exporter and of limited benefit to the producer. The producer sector has little market power being faced by a relatively concentrated processing sector which is flexible in its sourcing of raw materials and already includes significant inward investment.

The prospect of EU membership brings both opportunities and threats to the Hungarian animal breeding and meat industry. Improved market access for Hungarian quality meat to existing EU states and to the other new members will clearly benefit the sector. Although it is difficult to predict in detail the form of the EU support policy, it is likely that elements of it will still be farm based which would help the Hungarian producers. However, the capitalisation of this support into land values and any increased labour mobility will drive up overhead costs with a consequent loss of competitiveness.

Domestic policies should be aimed at improving agricultural productivity and increasing competitiveness in the meat processing sector. Animal breeding productivity improvements require training and extension programmes and better access to finance. Structural change needs the lubrication of an efficient land market and growth in the general economy to encourage labour mobility. Implementation of farm-based support and a stable system of intervention will ease the next transition - that of EU membership.

Improved productivity and farm structure, will go part way to addressing the problem of weak producer marketing power. The encouragement of producer involvement in the processing sector through co-operation and other new entrants, either domestic or foreign, would also improve competition. Finally, the proper enforcement of competition legislation would provide a suitable environment for these developments.

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SECTION 6

ANIMAL NUTRITION AND OTHER TOPICS



Influence of Salinomycin-Na on business results in pig production

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ABSTRACT

The investigation was conducted on 150 swine divided into three groups. The first group was given a control treatment (without antibiotic), while the second and third groups were given ratios of 30/15 ppm and 50/25 ppm Salinomycin-Na respectively. All groups received rations with 16.5% crude protein and 13.42 MJ/kg ME from live weight 28 kg up to live weight 60 kg. After they reached a weight of 61 kg up to the end of production the ration was balanced at a level of 14.2% crude protein and 13.27 MJ/kg ME. The objective of this investigation was to determine the influence of Salinomycin-Na on farm revenues. Salinomycin-Na applied in higher concentration (50/25 ppm) changed the distribution of commercial classes in comparison to the control group. The number of animals in classes E and U increased and the number of animals in class R decreased. Changes in the group with lower concentration (30/15 ppm) were marginal. The application of Salinomycin-Na did increase farm revenues by 2.89% for lower and 8.90% for higher concentration. This was due to changes in two factors: higher final weight and greater leanness of the carcasses. In addition, marginal increase in the unit price of fodder for experimental treatments and better conversion resulted in an increase in fodder costs of 1.41% for the lower concentration and 3.32% for the higher concentration. The use of Salinomycin-Na in the form of Grosal at a concentration of 50/25 ppm proved economically viable. It is possible to achieve an increase in gross margin after feed costs of 5%. An even lower ratio of Salinomycin-Na (30/15 ppm) increased the gross margin after feed costs, but only by 1.5%.

(Keywords: pig production, economics, Salinomycin-Na, Croatia)

ZUSAMMENFASSUNG

Einfluß von Salinomycin-Na auf die Wirtschaftlichkeit der Mast von kastrierten Jungebern

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Die Forschung umfaßte insgesamt 150 Schweine, die in 3 Gruppen aufgeteilt wurden. Die erste Gruppe war Kontrollgruppe (ohne Antibiotika). Die zweite und die dritte Gruppe bekamen eine Salinomycin-Na-Ration von 30/15 ppm, bzw. 50/25 ppm. Alle Gruppen erhielten von 28-60 kg Lebendgewicht Rohproteinrationen von 16,5% und 13,42% MJ/kg ME. Nachdem ein Gewicht von 61 kg erreicht war, wurden 14,2% und 13,27% MJ/kg ME Rohprotein bis zum Ende der Mast gegeben. Ziel dieser Forschung

war die Bestimmung des Einflusses von Salinomycin-Na auf die Einnahmen der landwirtschaftlichen Betriebe. Die Verwendung von Salinomycin-Na in höherer Konzentration (50/25 ppm) veränderte die Einteilung in die Handelsklassen gegenüber der Kontrollgruppe. Die Anzahl der Tiere in den Klassen E und U erhöhte sich, in der R Klasse verringerte sie sich. Die Änderungen in der Gruppe mit niedrigerer Konzentration (30/15 ppm) waren unbedeutend. Die Verwendung von Salinomycin-Na in niedriger Konzentration erhöhte die Einnahmen um 2,89%, bei höherer Konzentration um 8,90%. Dies ist 2 Faktoren – einem höheren Endgewicht und damit einem höherem Fleischanteil zu verdanken. Eine unbedeutende Einzelpreiseerhöhung für das Versuchsfutter und bessere Konversion verursachten bei niedriger Konzentration eine Erhöhung der Futterkosten um 1,41%, bei höherer Konzentration eine Erhöhung um 3,32%. Die Anwendung von Salinomycin-Na in Form von Grosal und die Konzentration von 50/25PP ppm erwies sich als ökonomisch berechtigt. Es ist möglich, eine Erhöhung des Deckungsbeitrags für Futterkosten um 5% zu erreichen. Sogar eine niedrigere Salinomycin-Na-Dosis (30/15 ppm) erhöhte den Deckungsbeitrag für Futterkosten, jedoch nur um 1,5%.

(Schlüsselwörter: Schweinemast, Ökonomie, Salinomycin-Na, Kroatien)

INTRODUCTION

Salinomycin-Na is used as a nutritive antibiotic in swine nutrition. As a supplement it prevents the development of pathogenic gut microflora, reduces the quantity of fodder consumed, protects symbiotic microorganisms and makes their growth and reproduction possible. Furthermore it stimulates digestion, and accelerates the adsorption and distribution of nutrients and energy. The level of stimulating effect attained in its use depends on several factors. Age is recognised as an important factor and applied in younger animals nutrition antibiotic has higher efficiency. Thaler and Wheaves (1993) reported a 15% increase in piglet gain for 2.4% better conversion. Moreover, environmental hygiene and the general health condition of animals are also important.

The positive influence of Salinomycin-Na in swine feeding was confirmed by Scheurmann (1992) and Salobir et al. (1994, 1996). Investigations by DeWilde (1991) and Kralik et al. (1998) showed improved growth, but also a tendency for lower fat deposition associated with greater leanness of carcasses at concentrations from 15/30 ppm to 60/30 ppm Salinomycin-Na.

The objective of this investigation was to determine the influence of Salinomycin-Na on farm revenues. The market values of swine carcasses were estimated according to the (S)EUROP system (Pravilnik N.N. 79/95).

MATERIALS AND METHODS

The investigation was conducted on 150 swine divided into three groups. The first group was given a control treatment (without antibiotic). The treatment for the second group had a ratio of 30/15 ppm Salinomycin-Na and that for the third group 50/25 ppm Salinomycin-Na. All groups received ration ST-1 (16.5 % crude protein and 13.42 MJ/kg ME) from live weight 28 kg up to live weight 60 kg. From the weight of 61 kg up to the end of production ration ST-2, balanced at a level of 14.2% crude protein and 13.27 MJ/kg ME, was used.

The fattening period lasted 91 days for all groups. On the slaughter line the weights of the warm carcasses, together with back fat thickness with skin in mm, were measured

at the point where *Musculus gluteus medius* entered the back fat at the most (point S). Measurements also included loin muscle depth in mm and the shortest connection of *Musculus gluteus medius* with the dorsal spinal edge (point M).

Estimation of the quantity of muscle tissue was calculated according to the following mathematical expression:

$$y(\%) = 13.4592 + 50.944 \frac{S}{M} + 7.17767\sqrt{M} + 45.1467 \log_{10} S - 20.682\sqrt{S}$$

The carcasses were classified into (S)EUROP classes according to estimated proportion of muscle tissue. After classification into commercial classes the efficiency of Salinomycin-Na in pig production was determined by comparing the results for the experimental groups with those for the control group.

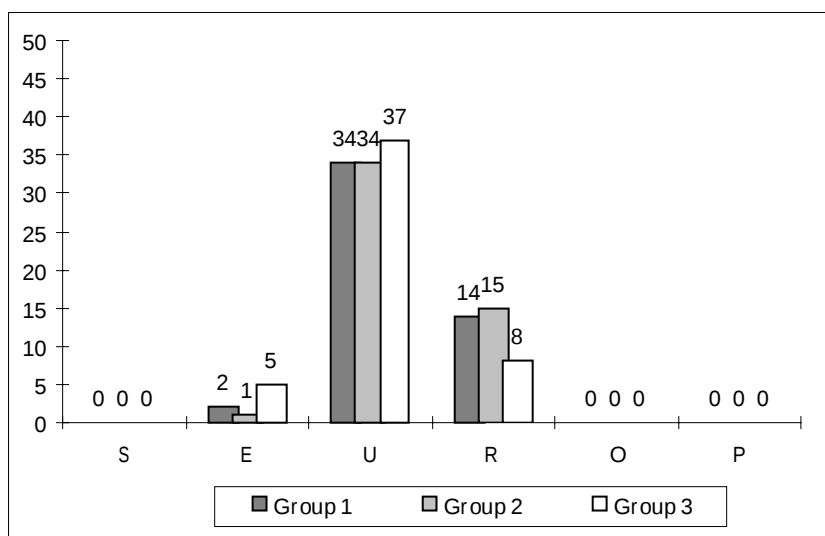
All prices are in Croatian kuna (kn), the current exchange rate being 1 EUR=7.5921 kn (July 7, 1999). Statistical procedures were performed using SPSS for Windows 6.1.

RESULTS AND DISCUSSION

Salinomycin-Na applied in higher concentration (50/25 ppm) changed the distribution of commercial classes in comparison to the control group. The number of animals in classes E and U increased and the number of animals in class R decreased. Changes in the group with lower concentration (30/15 ppm) were marginal: only one animal fewer in class E and one animal more in class R, with the same number of animals in class U (*Figure 1*).

Figure 1

Distribution of commercial classes in the various groups



1. Abbildung: Einteilung in die verschiedenen Handelsklassen

The application of Salinomycin-Na increased farm revenue by 2.77 and 8.56 EUR for each fattened animal in groups two and three respectively. This increase of 2.89% for the

lower and 8.90% for the higher concentration was due to changes in two factors: higher final weight and greater leanness of the carcasses in both experimental groups (Table 1).

The equation for multiple regression was

$$R[kn] = -762.709573 + 8.036390 Fw + 14.611258 y,$$

R square being 0.99889.

Table 1

Results of ANOVA procedure for selected production results *

	Group 1 (Control)	Group 2 (30/15 ppm)	Group 3 (50/25 ppm)
Fw–final weight [kg](1)	93.02±4.51 a	95.41±5.24 b	98.28±6.94 c
Cw–carcass weight [kg] (2)	73.52±4.10 a	75.67±4.44 b	78.06±6.20 c
y–quantity of muscle tissue [%] (3)	50.99±2.35 a	51.19±2.41 a	52.55±2.22 b
R–market value of slaughtered animal [EUR](4)	96.18±6.52 a	98.96±6.04 a	104.74±8.78 b

* Average values are always shown with std. deviation. Means with the same letter are not statistically different according to Fisher's protected LSD test ($P \leq 0.05$). (Der Durchschnittswert zeigt immer Standardabweichungen. (Gleichen Buchstaben bedeuten, dass keine Signifikanz vorhanden ist zu dem LSD-Test von Fisher.)

1. Tabelle: Ergebnisse der ANOVA-Behandlung auf einzelne Produktionsparameter

Mastendgewicht(1), Gewicht Schlachthälfte(2), Menge der Muskulatur(3), Marktwert der Schlachttiere(4)

Taking into consideration the price of Grosal (containing 12% Salinomycin-Na), at 43 kn per kg, increase in the unit price of fodder for the experimental treatments was marginal, from 0.25% for the lowest concentration up to 0.79% for the highest concentration (Table 2).

Table 2

Unit prices for fodder in the various groups [EUR per kg]

	Group 1 (Control)	Group 2 (30/15 ppm)	Group 3 (50/25 ppm)
ST 1 ratio (1)	0.30	+0.48%	+0.79%
ST 2 ratio	0.28	+0.25%	+0.42%

2. Tabelle: Futterpreise in den verschiedenen Gruppen (EUR/kg)

Verhältniszahl(1)

The total cost of the fodder consumed for the first and the second phase of fattening and for the whole fattening period is shown in Table 3. The moderate increase in the unit price of fodder for both experimental groups, combined with better conversion, resulted in increases in fodder costs of only 1.41 % for group 2 and 3.32 % for group 3.

Table 3**Cost of fodder consumed in the various groups [EUR]***

	Group 1 (Control)	Group 2 (30/15 ppm)	Group 3 (50/25 ppm)
Ration ST 1 (1)	30.07 (100)	30.58 (101.72)	30.23 (98.84)
Ration ST 2	32.26 (100)	32.63 (101.12)	35.08 (107.51)
Total	62.33 (100)	63.21 (101.41)	65.31 (103.32)

* Control group=100

*3. Tabelle: Kosten für verbrauchtes Futter in den verschiedenen Gruppen (EUR)**Verhältniszahl(1)*

The use of Salinomycin-Na in the form of Grosal at a concentration of 50/25 ppm proved economically viable. It is possible to achieve an increase in gross margin after feed costs of 5 %. An even lower ratio of Salinomycin-Na (30/15 ppm) increased the gross margin after feed costs, but only by 1.5%.

CONCLUSIONS

Salinomycin-Na applied in higher concentration (50/25 ppm) changed the distribution of commercial classes in comparison to the control group. The number of animals in classes E and U increased and the number of animals in class R decreased. Changes in the group with lower concentration (30/15 ppm) were marginal.

The application of Salinomycin-Na increased farm revenue by 2.89% for the lower and 8.90% for the higher concentration. This was due to changes in two factors: higher final weight and greater leanness of the carcasses. In addition, the increase in the unit price of fodder for the experimental treatments was marginal, from 0.25% for the lowest concentration up to 0.79% for the highest concentration.

The use of Salinomycin-Na in the form of Grosal at a concentration of 50/25 ppm proved economically viable. It is possible to achieve an increase in gross margin after feed costs of 5%. An even lower ratio of Salinomycin-Na (30/15 ppm) increased the gross margin after feed costs, but only by 1.5%.

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Improvement of dietary grain protein utilization in order to reduce environmental impact from pollution

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ABSTRACT

Proteins varie in its amino acid composition and this one is never ideal or sufficient for the animal. That's why the diets are, very often, supplemented by some synthetic amino acids. Two different cereals produced in Slovenia are tested here (wheat Rezka and barley Gotic) supplemented or not by one (Lys) or two (Lys+Met) amino acids to obtain a better utilisation in the view of a weight gain superior, and the decrease of the nitrogen excreted. The results obtained by nitrogen balance studies with laboratory rats, show that these two cereals have a CP, TD and BV inferior to in literature cited. The PER gives some very good values for the weight gain in the presence of synthetic amino acids (2,23 g/1g protein for wheat and 2,4 g/1g protein for barley against 1,75g and 1,7 g without supplementation). Moreover the excretion of nitrogen shows a real decrease (34,4% for wheat and 35,4% for barley) for both third groups in comparison with the control group.

Keywords: animal nutrition, protein, aminoacids, nitrogen balance, cereals, wheat, barley, rat

ZUSAMMENFASSUNG

Bessere Anwendung der Proteine im Futtergetreide im Interesse einer verminderten Umweltverschmutzung

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Die Proteine unterscheiden sich aufgrund ihrer Aminosäuren-Zusammensetzung voneinander. Sie sind für die Tiere weder ideal noch ausreichend. Deshalb wird das Futter mit synthetischen Aminosäuren ergänzt. In diesem Versuch wurden in Slowenien zwei Getreidesorten getestet (Weizen Recka und Roggen Gotic). Diese wurden mit ein (Lysin) bzw. zwei (Lysin und Methionin) Aminosäuren ergänzt mit dem Ziel, eine höhere Gewichtszunahme zu erreichen bzw. die N-Ausscheidung zu verbessern. Die erhaltenen Ergebnisse weisen darauf hin, dass in den beiden Getreidesorten die Werte für CP, TD und BV niedriger sind als in der Fachliteratur angegeben. In Anwesenheit von synthetischen Aminosäuren brachte PER ein gutes Ergebnis hinsichtlich der Gewichtszunahme (beim Weizen wurden pro Gramm Protein 2,23 g, beim Roggen 2,4 g Zunahme erreicht gegenüber den Gewichtszunahmen ohne Ergänzung von 1,75 bzw. 1,7). Weiterhin war eine reale Verringerung der Nitrogenausscheidung (bei Weizen

34,4%, bei Roggen 35,4%) in der zweiten und dritten Versuchsgruppe gegenüber der ersten (Kontrollgruppe) festzustellen.

(Schlüsselwörter: Tierfütterung, Proteine, Aminosäuren, N-Gleichgewicht, Getreide)

INTRODUCTION

From the economical point of view, modern animal production gives a special emphasis to the wellbeing of animals. In ration formula the objective is for use knowledge about nutrients, feedstuffs and animals in the development of nutritionally adequate rations that will be eaten in sufficient amounts to provide the level of production desired at a reasonable cost. Protein is a critical nutrient particularly for young rapidly growing animals. Optimal use of protein is a must in any practical feeding system, because protein supplements are usually much more expensive than energy feeds and wasteful usage increases the cost of production in almost all instances.

Synthetic amino acids are used in feed manufacture to improve protein quality. Improving the cereal protein utilisation by additional limiting essential amino acids feeding of animals, results also in possibilities to lower total crude protein level in the diet and enable lower excretion of remaining nitrogen with a prevention of environmental nitrogen load.

That is why it is very important to test different diets (based on cereals) and their influence on the nitrogen balance, protein utilisation and production when they are supplemented with some limiting components. In fact, in this case, the supplementation of the diets of animals (rats) with limiting amino acids could enhance the quality of the dietary protein.

Two different Slovenian grain samples (wheat Rezka and barley Gotic), with addition of one or two synthetic essential amino-acids will be tested. The influence of the supplementation of these diets on the nitrogen balance and on protein utilisation (positive effects expected) will be analysed.

Nitrogen balance studies in biological experiments with different animals (measuring amounts of ingested and by feces and urine excreted N) can give the answer what amounts of ingested or absorbed amino acids are utilized for a new protein synthesis in the body. The systems of ranking dietary proteins after this method are: Biological Value (BV), Net Protein Value (NPV) and Net Protein Utilisation (NPU). (McLaughlan and Campbell, 1969).

The literature can give, after numerous experiments, an ideal protein or an ideal menu for one animal, for example, the two different propositions for the ideal protein for the pig (Cole, 1978; Fuller et al., 1979).

The best solution to create imbalance is to use specially designed mixtures. These mixtures can be tested for the growing of animals (Pant, 1972). The test of some mixtures which contain 1 or 2 more limiting amino acids represent a real basis to study the influence of the supplementation on the growth or on the utilisation of the compounds of the diets by the rats and later on by the farm livestock.

It is important to study the food protein quality because a tremendous variety of feedstuffs is used for animal feeding throughout the world. The variety in a given location will depend, in fact, on the local products grown or harvested and the class and species of animal involved. 85-90% of the nitrogenous compounds in the seed is in form of proteins, but the proteins, their solubility and amino acids content vary from cereal to cereal.

Wheat and barley are two of the most important cereals used for feeding. A lot of differences exist between the both. Barley is known to be low in lysine and will normally show a positive response to a lysine supplement, but it is important to note that a considerable variation in protein quality from one barley lot to another is observed (Bengtsson and Eggum, 1969; Schiller, 1971). The TD of total N, lysine and methionine are, respectively, 80.2%, 78.3% and 86.4% in rats experiments with barley (Poppe, 1969). Finally with high lysine barley the BV, in rats experiments, is increased by 34.8% (Jorgensen *et al.*, 1997). Wheat protein quality is inferior to that in barley, due to a very low lysine and threonine contents, but the TD is higher than in barley. With rats Nerhing and Bock (1961) obtained a value of 69% for BV.

MATERIALS AND METHODS

The diets are prepared in the laboratory. A sample is chosen (wheat Rezka or barley Gotic) and represents the higher amount in the diet. Chemical analyses of the different cereal sample are realised, moreover the analyses of the amino acids composition of both was also realised. Some other components are added to the test diets in determined quantity:

- sample (87,52%; 2625,6g for 3 kg), cereal here.
- cellulose (3%; 90g)
- sunflower oil (4%; 120 g)
- premix (4%; 120g)
- CaCO₃ (1,35%; 40,5g)
- NaCl (0,13%; 3,9g)

The components were mixed and divided into 3 portions, the first for the control group of rats, and the two others for the two different test groups. In the two last diets one or two synthetic amino acids were added to test their influence on the nitrogen balance. For the experiment with wheat Rezka:

- 4,1g of Lys are added (diet 2)
- 4,1g Lys and 5,2g of Met are added (diet 3)

For the experiment with barley Gotic:

- 3,0g of Lys are added (diet 2)
- 3,0g of Lys and 5,3g of Met are added (diet 3)

The amino acids are added after the known amino acid composition of tested proteins to cover 75% of the optimal requirements of the animals (NRC, 1995).

The rats used are from the WISTAR (Novo Mesto) strain, at the start of the experiment they were 42 days old. 12 rats divided in three groups of four were used in each experiment.

The room during all the experience had to be practically at the same temperature (about 21°C) and with special moisture conditions (about 60%). The light was regulated by an automatic timeswitch during all the experiment to obtain the same conditions every day (12 hours light regime).

Twelve cages were used, one per a rat. These metabolic cages permit to collect the urine and the feces during all the experiment, normally without any contamination between the urine and feces. In these cages food and water were always available.

Nitrogen balance experiments were performed after the mode of work developed in the laboratory of Institute for Nutrition (Orešnik *et al.*, 1981,1982,1984).

Some tries for determination of crude protein and nitrogen concentration were also performed with wheat flour (BCR) to see if the results are in accordance with the certificate value of the reference materials.

Formulas

- Apparent digestibility (AD, %) = $(N \text{ intake} - N \text{ feces}) / N \text{ intake}$
- True digestibility (TD, %) = $(N \text{ intake} - (N \text{ feces} - N \text{ endogenous})) / N \text{ intake}$
- Endogenous N feces (MNF, mg) = $15,2 \times (\text{average body weight} / 0,075)$.
- Endogenous N urine (ENU, mg) = $0,081 \times (\text{average body weight}) + 3,01$
- Biological value (BV, %) = $[N \text{ intake} - (N \text{ feces} - \text{MNF}) - (N \text{ urine} - \text{ENU})] / (N \text{ intake} - (N \text{ feces} - \text{MNF}))$.
- Net protein utilisation (NPU, %) = $(BV \times TD) / 100$.
- Protein efficiency ratio (PER, g) = $\text{Gain in body weight (g)} / \text{Protein consumed (CP)}$.

Statistical studies

Data were analysed by the Analysis of Variance (ANOVA) procedure (SAS, 1990) from SAS® software (Realese 6.11), taking into consideration the grain (wheat or barley) and type of diet (control, lysin supplemented and lysin and metionin supplemented) as the main effect. Comparisons of different kinds of treatment were done by Tukey test. If not explained otherwise, then the least significant difference (5%) was used to separate treatment means.

RESULTS

It is important to note that the wheat has some superior values in the crude protein than the barley. The addition of Lys only increases the CP of the wheat diet but not really the value for barley. On the contrary the addition of Lys and Met increases the CP in both diets.

Table 1

Nitrogen (N) and crude protein (CP) contents in test diets

		N (mg/100g)	CP (g/100g)
Wheat (1)	1 (Control)	165	10,34
	2 (Con+Lys)	175	10,91
	3 (Con+Lys+Met)	177	11,07
Barley (2)	1 (Control)	138	8,65
	2 (Con+Lys)	139	8,68
	3 (Con+Lys+Met)	144	9,01

1. Tabelle: Gehalt von Nitrogen (N) und Rohprotein in Fütterungsversuchen

Weizen(1), Gerste(2)

Table 2**Average weight of rats, daily gain and consumed quantity of test diet**

GROUP (1)		AVERAGE WEIGHT start of experiment g (2)	AVERAGE WEIGHT end of experiment g (3)	AVERAGE DAILY GAIN g (4)	CONSUMED TEST DIET g/day (%) (5)
WHEAT (6)	1 (Control)	99,0	111,3	2,45	13,49
	2 (C+Lys)	112,9	128,0	3,00	15,62
	3 (C+Lys+Met)	116,5	136,2	3,93	15,96
BARLEY (7)	1 (Control)	113,5	126,8	2,66	17,75
	2 (C+Lys)	106,8	120,7	2,78	16,61
	3 (C+Lys+Met)	120,0	141,1	4,21	19,22

2. Tabelle: Durchschnittsgewicht, tägliche Zunahme und Futterverbrauch von Ratten

Gruppe(1), Durchschnittsgewicht zu Versuchsbeginn(2), Durchschnittsgewicht zu Versuchsende(3), durchschnittl. Tageszunahme(4), Futterverbrauch(5), Weizen(6), Gerste(7)

The average weight of animals after the five days adaptation period were already different due to the different form of diet proposed to the different groups. At the end of the experiment the weight of the rats was again really different and the differences between the weights are now more important between the three different groups of each experiment. For the weight gain the addition of the synthetic amino acid was favourable in both experiments. But in both experiments, and particularly in the barley experiment, the addition of Met and Lys to the diet seems to be more important and the difference in weight gain between the group 2 and 3 was very high. Finally the weight gain difference between the group 1 and 3 represents 60,4% in wheat and 58,3% in barley experiments. The amount of wheat diet consumed by the rats increased regularly but the difference between the group 2 and 3 is not really important compared to the difference in weight gain. Barley diet consumed group 1 more than the group 2 but its weight gain was inferior. A big difference in the consumption in the group 3 can be noted, for this group the difference in the weight gain follows the same sense as in wheat experiment.

The consumed amounts of nitrogen increased normally between the group 1 and the two others due to the increasing of the amount of N in the diet after addition of the synthetic amino acid and to higher diet consumption. The excreted amounts of nitrogen in urine increased, but irregularly, between the different groups. On the contrary and in general (exception for the wheat group 2) the amount of N excreted by the feces is lower in the groups 2 and 3 than in the group 1. Finally it can be noted that for wheat experiments higher amount of N was excreted with urine and on the contrary with the feces in barley groups.

Table 3

Average amounts of nitrogen and nitrogen excreted by feces and urine

GROUP (1)		CONSUMED NITROGEN mg/DAY (2)	EXCRETED N in FAECES mg/DAY (3)	EXCRETED in URINE mg/DAY (4)	N-BALANCE mg/DAY (5)
WHEAT (6)	1(Control)	224 ^a	46	72	107 ^a
	2 (C+Lys)	272 ^{ab}	49	90	134 ^b
	3 (C+Lys+Met)	282 ^b	42	82	154 ^c
BARLEY (7)	1(Control)	247	89	42	113
	2 (C+Lys)	231	73	44	114
	3 (C+Lys+Met)	277	80	54	144

Values with no equal superscripts in the same column differ significantly. (*Die Werte mit ungleichen Indexen in der gleichen Spalte sind unterschiedlich signifikant.*)

3. Tabelle: Durchschnittliche Nitrogenaufnahme sowie Nitrogenausscheidung in Kot und Urin

Gruppe(1), Nitrogenverbrauch mg/Tag(2), Ausscheidung im Kot mg/Tag(3), Ausscheidung im Urin(4), N-Bilanz (5), Weizen(6), Gerste(7)

Table 4

Apparent digestibility (AD), true digestibility (TD), biological value (BV), net protein utilisation (NPU) and protein efficiency ratio (PER) of test diets protein

GROUP (1)		AD %	TD %	BV %	NPU %	PER g gain/1g prot
WHEAT (2)	1 (Control)	80,1	81,1	63,5	51,4 ^a	1,75
	2 (C+Lys)	82,0	82,9	62,7	51,9 ^a	1,76
	3 (C+Lys+Met)	83,7	84,6	67,8	57,4 ^b	2,23
BARLEY (3)	1 (Control)	65,0 ^a	66,1 ^a	75,9	50,2	1,7
	2 (C+Lys)	67,8 ^{ab}	68,9 ^{ab}	75,5	52,0	1,9
	3 (C+Lys+Met)	71,2 ^b	72,2 ^b	75,7	54,6	2,4

Values with no equal superscripts in the same column differ significantly ($P \leq 0,05$). (*Die Werte mit ungleichen Indexen in der gleichen Spalte sind unterschiedlich signifikant.*)

4. Tabelle: Scheinbare Verdauung (AD), tatsächliche Verdauung (TD), biologischer Wert (BV), Netto-Proteinverbrauch (NPU) und Wirkungsgrad des verbrauchten Proteins im Versuchsfutter

Gruppe(1), Weizen(2), Gerste(3)

According to results presented in Table 4 wheat protein was much better digestible than barley protein. In contrary the BV of wheat protein was lower than the BV of barley protein. NPU values and PER values obtained in control groups were similar in wheat and barley.

Supplementation the diets with Lys lightly improved the digestibility of both proteins and has not significantly influenced the BV, NPU and PER. In the group 3 (C+Lys+Met) higher NPU value was observed in the wheat diet and increased AD and TD and somewhat higher NPU values in barley diet.

Table 5**Statistical correlation among specific parameters obtained in the experiment**

CORRELATION (1)				
FEED CONSUMPTION: (2)	N CONSUMPTION: (3)	FEED+N CONSUMPTION: (4)	NPU: PER	NPU: DAILY GAIN
DAILY GAIN (5)	DAILY GAIN	DAILY GAIN	PER	DAILY GAIN
0,57	0,85	0,58	0,64	0,86

5. Tabelle: Statistische Korrelation der spezifische Parameter im Versuch

Korrelation(1), Futtermittelverbrauch(2), Stickstoffverbrauch(3), Futter- und Stickstoffverbrauch Tageszunahme(4), Gewichtszunahme (5)

Calculated statistically significant correlation coefficients give an explanation of relationships between in nitrogen balance studies measured parameters and animal growth. Amount of nitrogen consumed and NPU have the highest correlation to daily gain.

Table 6**Excretion of nitrogen per g of daily gain.**

GROUP (1)		Excreted N in feces and urine, mg (2)	Daily gain g (3)	Excreted N per g of gain mg (4)	Difference mg (5)	%
WHEAT (6)	(Control)	118	2,45 ^a	48,2 ^a		
1						
2	(Con+Lys)	139	3,00 ^b	46,8 ^a	-1,9	3,9
3	(Con+Lys+Met)	124	3,93 ^c	33,4 ^b	-16,6	34,4
BARLEY (7)	(Control)	131	2,66 ^a	49,2		
1						
2	(Con+Lys)	117	2,78 ^{ab}	42,1	-7,1	14,4
3	(Con+Lys+Met)	134	4,21 ^b	31,8	-17,4	35,4

Values with no equal superscripts in the same column differ significantly ($P \leq 0.05$). (Die Werte mit ungleichen Indexen in der gleichen Spalte sind unterschiedlich signifikant.)

6. Tabelle: Stickstoffausscheidung pro g täglicher Zunahme

Gruppe(1), Stickstoffausscheidung in Kot und Urin(2), Tageszunahme(3), Stickstoffausscheidung pro g Tageszunahme(4), Differenz(5), Weizen (6), Gerste(7)

It can be noted that the amino acid supplementation of the test diets lowered the amount of excreted nitrogen per g of daily gain.

DISCUSSION

Lang and *Schoen* (1952) give a biological value for wheat protein at 67% *Nerhing* and *Bock* (1961) find 69%. These values are superior than those obtained in the experiment with the Slovenian cereal. In the meantime obtained value of BV is superior than the value obtained by *Nerhing* and *Bock* (1961) - 60%.

For the TD, again, the values are inferior to the literature values, from 88,8% to 93,4% (*Nerhing* and *Bock*, 1961) against 81,4 to 84,6% for Slovenian samples.

For the barley samples the values are really different for the TD. The Slovenian samples give some results between 66,1 and 72,2%, *Wunsche* and *Bock* (1965) find a TD at 89,3%. From the same reference the BV of the experiment cereal (around 75,7%) is comparable with our results (74,8%).

Out of the results obtained in our experiments we can observe and confirm a generally accepted regularity: barley proteins have a lower digestibility than the wheat proteins but also higher BV.

Moreover the results show that the supplementation of this samples with synthetic amino acids improve the digestibility of the protein. In the same time the NPU seems to be the same between the two cereals.

It is well known that the BV gives not the best answer of the positive effect of added amino acids and moreover only the group 3 of wheat gives in our research a real better BV. *Glem-Hansen* and *Eggum* (1972) show that the content of non essential amino acids might affect BV. That is why BV is not only dependant on the first limiting amino acids, but on whole aminogram. So here not only lysine and methionine are limiting amino acids and more experiments are needed to find final solution. In fact it is possible to put out that the addition of lysine alone in wheat group 2 doesn't influence the protein utilisation, two amino acids together are more effective.

The PER seems to be the best method to study, the influence of the addition of amino acids to the diets on protein utilisation. This one increases regularly and it is a proof of a better utilisation of the diet's components. This result is really important in the view of practical feeding conditions. After the results obtained in our experiments the supplementation of wheat and barley based diets with lysine and methionine improved the daily weight gains of rats in average for 60,4% (wheat group 3) and for 58,3% (barley group 3).

The correlation between PER and NPU was statistically significant. In nitrogen balance experiments NPU gives a good estimation of protein utilisation. NPU and daily gain are close correlated. Beside this N consumption gives better explanation for animal growth than feed consumption alone.

Important part of this experiment was the reduction of animals nitrogen excretion after diet amino acid supplementation. Good results were obtained with both cereals. The two third groups of rats reduced their excretions by 34,4% for wheat and 35,4% for barley. The two Lys groups reduced the N excretion in smaller amounts than the Lys+Met groups. Better protein utilisation is connected with reduction of N excretion. This fact is important not only for animal nutrition but also for prevention of environmental nitrogen load.

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Effect of probiotic Vebac on the growth of broilers

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ABSTRACT

Eighty Avian 24K broilers were randomly divided in 2 groups, 40 birds each. Each group had 4 subgroups of 10 birds. First group was control (without VEBAC in drinking water), while second was experimental (with addition of VEBAC - 3 g/100 l water). Average live weights of Avian 24K chicken in age of 42 days were for 10.8% higher in 2nd group (3 g/100 l VEBAC) compared to the 1st group without probiotic in drinking water (2.19 kg : 1.96 kg; $P < 0.01$). Growth curve showed that addition of VEBAC in drinking water enhances progressive stage of growth.

$$1^{st} \text{ group } y = \frac{4000}{(1 + 0.04695 \cdot e^{-31.12577 \cdot 0.01t})^{1/0.01}}; \quad 2^{nd} \text{ group } y = \frac{4000}{(1 + 0.04952 \cdot e^{-34.53264 \cdot 0.01t})^{1/0.01}}$$

Probiotic addition resulted in more efficient conversion of food into live weight gain of chicken for 6.44% in 2nd group of chicken compared to the 1st group. Addition of VEBAC in drinking water had positive effect on performances of broilers. Usage of VEBAC shortened fattening for 0,6 weeks.

(Keywords: broiler, probiotic, growth, feed conversion)

ZUSAMMENFASSUNG

Der Effekt von Probiotikum VEBAC auf das Wachstum von Broilern

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Achtzig Avian 24K Hühner wurden zufällig in 2 Gruppen mit jeweils 40 Hühnern aufgeteilt. In jeder Gruppe gab es 4 Untergruppen mit je 10 Hühnern. Die erste Hühnergruppe bildete die Kontrollgruppe (ohne VEBAC im Trinkwasser), die zweite Hühnergruppe war die Behandlungsgruppe (mit VEBAC Zusatz 3g/100 L Wasser). Das Durchschnittsgewicht der behandelten Avian 24K Broilern im Alter von 42 Tagen war 10,8% höher im Vergleich zur Kontrollgruppe. Die Wachstumskurve zeigt, daß man durch VEBAC Zusatz im Trinkwasser ein progressives Wachstum erreicht.

$$1. \text{ Gruppe } y = \frac{4000}{(1 + 0.04695 \cdot e^{-31.12577 \cdot 0.01t})^{1/0.01}}; \quad 2. \text{ Gruppe } y = \frac{4000}{(1 + 0.04952 \cdot e^{-34.53264 \cdot 0.01t})^{1/0.01}}$$

Das Ergebnis des Probiotikum-Zusatzes bei Hühnern ist eine bessere Futterumsetzung in Lebendgewicht, das dadurch 6,44% höher war als in der Kontrollgruppe. Dem Trinkwasser zugegebenes VEBAC hatte also einen positiven Effekt auf die Entwicklung der Broiler und verkürzte die Mastzeit um 0,6 Wochen.

(Schlüsselwörter: Broiler, Probiotik, Wachstum, Futterkonversion)

INTRODUCTION

In intensive conditions of poultry rearing, different additives are often used in feeding. Useful effect on productivity, health of animals and humans as well as their economical effect have to be considered before decision on their usage is made. The usage of additives in animal nutrition is primarily aimed on the elimination of pathogenic microbes such as *Salmonella*, *Clostridium*, *Campylobacter*, *Yersinia* and *Escherichia coli*; all present in digestive tract of animals. Researches of *Hinton et al.* (1991), *Nuoti et al.* (1992), *Corrier et al.* (1992), *Cox et al.* (1992) and *Schnitzel and Nuoti* (1992) proved that colonization of salmonella servor was significantly lowered by usage of different probiotic microflora. *Kumprecht et al.* (1983) investigated effect of probiotic *Streptococcus faecium* M-74 on gain, consumption of feed, content of lactic bacteria and *Escherichia coli* in intestine himus. After 49 days of fattening live weight of the chicken in experimental group was higher for 49 g or 3.05% than in control. Feed conversion for 1 kg of gain was 2.35 kg in control group while 2.38 kg in experimental. Authors stated that *Streptococcus faecium* M-74 significantly influenced increase in number of *Lactobacillus streptococcus* and decrease of *Escherichia coli* in content of intestines. By this fact was explained better gain of chicken in experimental group. On the basis of the research *Kumprecht et al.* (1984) found that addition of bacteria *Streptococcus faecium* M-74 in the diet for chicken cellulolytic enzymes were activated which resulted in higher gain and better utilization of food. Authors also found that content of lactic acid in intestinal himus of experimental group of chicken was for 34.8% higher than in control group fed diet without probiotic *Koudela* (1995) investigated influence of Ecovit preparation (which contains *Enterococcus faecium* M-74) in feeding diets for Japanese quail on gain, laying intensity, egg weight and content of hemoglobin in erythrocytes. Added preparation significantly influenced increase of gain for 17% and enhancement of feed conversion efficiency for 9% compared to control group. According to this author Japanese quail laid 10.69% heavier eggs, and laying intensity was 94% compared to control group. It is important to emphasize that addition of this probiotic in the diet reduced hemoglobin content in erythrocytes for 43.8% compared to control. *Kumprecht et al.* (1994b) researched influence of different probiotics on gain and feed conversion efficiency. Chicken from 1st group were fed diet with addition of yeast *Saccharomyces cerevisiae* var. *ovalis*, in 2nd experimental group in the diet was added *Streptococcus faecium* M-74, while chicken from 3rd group were given equal amount of *Saccharomyces cerevisiae* var. *ovalis* and *Streptococcus faecium* M-74. Authors found that chicken from experimental groups were 5% heavier at the end of the fattening while feed conversion efficiency was 7% better. *Koudela* (1995) investigated application of probiotic preparation Lactiferem (with *Streptococcus faecium* M-74) in production conditions on 127,043 laying hens and 155,538 broilers. Feed consumption per egg was lower for 12.60 g in groups with probiotic addition than in control group. Egg quality indicators in control groups showed higher total weight, heavier and firmer shell and heavier yolk and albumen. Comparing the results of the research in broilers author found that addition of probiotics yield in feed saving of 70.9 g per kg of gain.

MATERIALS AND METHODS

Eighty Avian 24K broilers were randomly divided in 2 groups, 40 birds each. Each group had 4 subgroups of 10 birds. First group was control (without VEBAC in drinking

water), while second was experimental (with addition of VEBAC - 3 g/100 l water). From the first until 21st day of the experiment chicken were fed ST₁ starter diet containing 22.18% crude proteins and 12.30 MJ/kg ME; and from 22nd until 42nd day the chicken were fed ST₂ diet containing 18.66% crude protein and 12.10 MJ/kg ME.

Each week chicken were individually weighted. Feed consumption and feed conversion into live weight are shown per weeks of fattening and for total fattening duration. Estimation of inflection point and separate growth stages were performed by asymmetric S-function (Kralik and Scitovski, 1993) using following formulas:

$$f(t) = \frac{A}{(1 + be^{-c\pi})^{1/\gamma}}, \quad A, \quad \gamma > 0$$

$$t_B = \frac{1}{c\gamma} \ln \frac{2b}{\gamma(\gamma+3) + \gamma\sqrt{(\gamma+1)(\gamma+5)}}$$

$$t_C = \frac{1}{c\gamma} \ln \frac{2b}{\gamma(\gamma+3) - \gamma\sqrt{(\gamma+1)(\gamma+5)}}$$

Asymmetric S-function with one inflection point is strictly increasing in the whole range of definition. Parameters of this function b and c are defined on the basis of experimental data by least squares method while biological maximum A and asymmetry coefficient are predetermined on the basis of experience. Point B is maximal point in region of intensive growth (convex region) while C is point of minimum in region of depressive growth (concave region). Interval $t \leq t_B$ is stage of forming the growth, interval $t_B \leq t \leq t_C$ is the stage of intensive growth and interval $t \geq t_C$ is the stage of growth retardation (Scitovski, 1993).

RESULTS

It is obvious from Table 1 that chicken with VEBAC added in drinking water had higher average live weights than chicken from 1st group, without probiotics in drinking water, during whole fattening period. Chicken from 2nd had 15 g, 44 g, 127 g, 163 g and 212 g higher average weight in period from 2nd to 6th week compared to chicken from 1st group. Differences in reached live weights between 1st and 2nd group of chicken were statistically highly significant ($P < 0.01$).

Live weights of chicken from 2nd group with probiotic in drinking water are in accordance with results found by Kumprecht *et al.* (1991, 1994a, b) and Kumprecht and Zoba~ (1992), which confirms that addition of probiotics during fattening enhances performances of broilers. While stated authors pointed out that it is possible to reach live weights higher for 3.4%-6.3% by usage of antibiotics in fattening, in our research enhancement of live weights at the end of 6th week was 10.8%.

Correlation between age and average live weights in chicken involved in the research are expressed as correlation and regression coefficients (Table 2). Results show that there is very high, positive and very significant ($P < 0.01$) correlation between examined fattening indicators.

Table 1
Average weights of chicken in fattening

Age (weeks)(1)	Statistical Parameters (2)	Groups of chicken(3)		Significance of differences(4) 1 st : 2 nd
		1 st	2 nd	
1 st day	$\bar{x}$ s	43 0.68	43 0.49	n.s.
1 st	$\bar{x}$ s	133 4.79	136 3.72	n.s.
2 nd	$\bar{x}$ s	344 3.60	359 5.19	**
3 rd	$\bar{x}$ s	642 16.01	686 12.79	**
4 th	$\bar{x}$ s	1042 29.92	1169 19.50	**
5 th	$\bar{x}$ s	1477 25.22	1640 30.06	**
6 th	$\bar{x}$ s	1956 15.03	2168 54.24	**

n.s. = No significancy. (Nicht significant.) $P > 0.05$, $**P < 0.01$

1. Tabelle: Durchschnittsgewicht von Broilerküken

Alter(1), Statistische Parameter(2), Kükengruppen(3), Signifikante Differenz(4)

Table 2
Indicators of correlation between age and average live weights of chicken

Group of chicken(1)	Coefficient (r)	Equation of regression(2)
1 st	0.999**	$y' = -44.678 + 133.273x + 33.657x^2$
2 nd	0.999**	$y' = -72.041 + 151.278x + 37.512x^2$

** $P < 0.01$

2. Tabelle: Korrelation zwischen Alter und durchschnittlichem Lebendgewicht der Küken

Kükengruppen(1), Regressionsgleichung(2)

Parameters of asymmetric S-function used in modeling of the growth of the chicken are presented on Table 3. Results show that addition of VEBAC preparation in drinking water enhances progressive stage of growth (2nd group 1.83-7.34 weeks, 1st group 1.86-8.07 weeks). Phase of intensifying came in some earlier period (1.83 weeks) in chicken which received water with VEBAC preparation than in control group (1.86 weeks). However, period of intensive growth lasted shorter in chicken given water with VEBAC. Hence, usage of VEBAC shortened fattening for 0.6 weeks. This conclusion is supported by different positions of inflection points

($t_i=4.633$ for chicken from 1st group and $t_i=4.968$ for chicken from 2nd group). Growth curves modeled by asymmetric S-function are shown on *Figures 1 and 2*.

$$1^{\text{st}} \text{ group } y = \frac{4000}{(1 + 0.04695 \cdot e^{-31.12577 \cdot 0.01x})^{1/0.01}} \quad 2^{\text{nd}} \text{ group } y = \frac{4000}{(1 + 0.04952 \cdot e^{-34.53264 \cdot 0.01x})^{1/0.01}}$$

Table 3

Parameters of functions - growth models of chicken

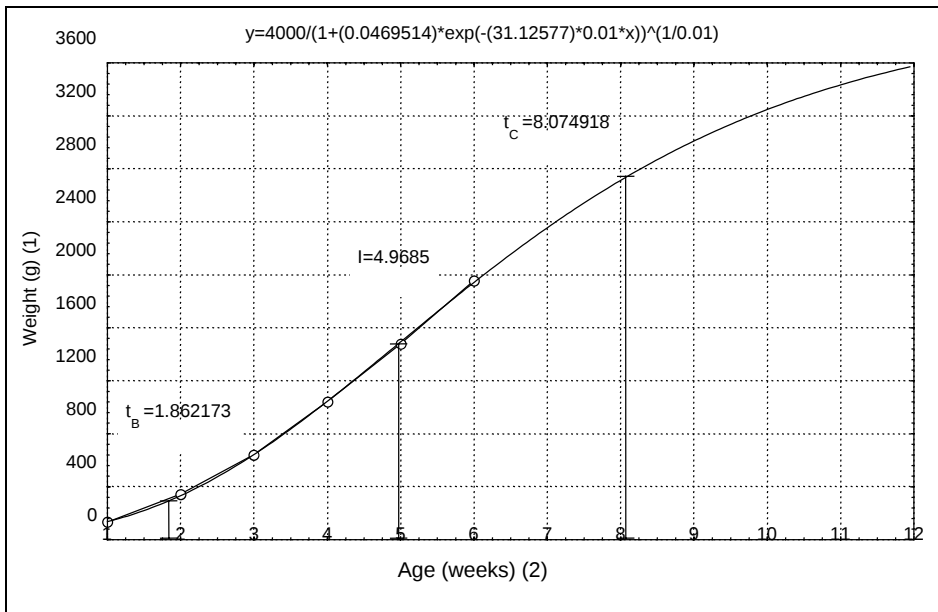
Parameter(1)	Group of chicken(2)	
	1 st	2 nd
b	0.04695	0.04952
c	31.12577	34.53264
γ	0.01	0.01
T_l	4.9685; 1478.78	4.632576; 1478.85
t_B	1.862173; 298.34	1.832668; 298.36
t_C	8.074918; 2736.66	7.432485; 2736.69

3. Tabelle: Parameter – Wachstumsmodell von Küken

Parameter(1), Kükengruppen(2)

Figure 1

Growth curve of 1st chicken group

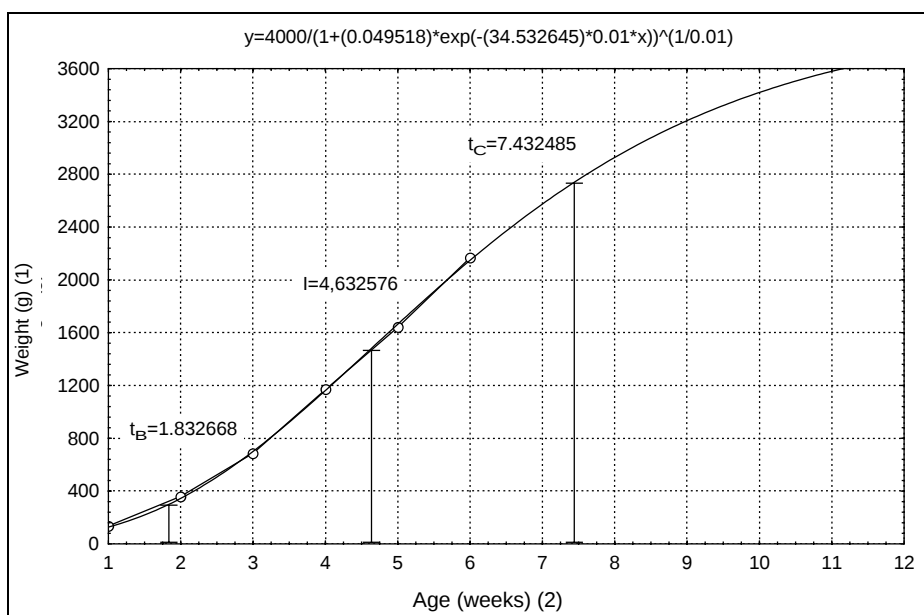


1. Abbildung: Wachstumskurve der ersten Kükengruppe

Gewicht(1), Alter (Wochen)(2)

Figure 2

Growth curve of 2nd chicken group



2. Abbildung: Wachstumskurve der zweiten Kükengruppe

Gewicht(1), Alter (Wochen)(2)

Cumulative indicators of feed consumption and conversion from 1st to 6th week of fattening are presented on Table 4. Chicken from 2nd group with VEBAC in drinking water took averagely 162 g or 3.93% more food than chicken from 1st group. It is also obvious that chicken from 2nd group had better conversion of food (2.02 g/g of gain) compared to chicken from 1st group (2.15 g/g of gain).

Table 4

Consumption and conversion of food per weeks

Week (1)	1 st group(2)			2 nd group		
	Consumation g(3)	Gain g(4)	Conversion g/g(5)	Consumation g	Gain g	Conversion g/g
1	116	90	1.29	123	93	1.32
2	375	212	1.77	358	223	1.60
3	550	298	1.84	561	326	1.72
4	810	399	2.03	892	483	1.85
5	1051	435	2.42	1091	471	2.32
6	1223	478	2.58	1262	528	2.39
Total	4125	1914		4287	2125	
$\bar{x}$			2.15			2.02

4. Tabelle: Futterverbrauch und Futterverwertung pro Woche

Woche(1), Gruppe(2), Futterverbrauch(3), Zunahme(4), Futterverwertung(5)

More efficient food conversion of chicken from 2nd group which were given VEBAC in drinking water for 6.05% is in accordance with results obtained by *Kumprecht et al.* (1994a) and *Kumprecht and Zobac* (1998b).

CONCLUSIONS

The research on influence of VEBAC probiotic addition in drinking water on the growth was performed on Avian 24K chicken. First group of chicken was given water without VEBAC probiotic throughout the whole fattening period (42 days), while 2nd group of chicken received VEBAC added in drinking water in amounts of 3g/100 liters. On the basis of the research, following conclusions can be formed:

- Average live weights of Avian 24K chicken in age of 42 days were for 10.8% higher in 2nd group (3 g/100 l VEBAC) compared to the 1st group without probiotic in drinking water (2.19 kg : 1.96 kg; $P < 0.01$).
- Growth curve showed that addition of VEBAC in drinking water enhances progressive stage of growth.
- Probiotic addition resulted in more efficient conversion of food into live weight gain of chicken for 6.44% in 2nd group of chicken compared to the 1st group (2.02 kg : 2.15 kg) Chicken from 2nd group consumed until 6th week averagely 3.93% more food than chicken from the 1st group.
- Addition of VEBAC in drinking water had positive effect on performances of broilers. Usage of VEBAC shortened fattening for 0,6 weeks.

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The effect of substituting corn with different levels of *Pistacia atlantica* seeds on laying hens performance in first phase of egg production

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ABSTRACT

Experiment was conducted over 12 weeks period with one hundred sixty 24 weeks old white-leghorn hens. Diets containing 0, 5, 10 and 15% Pistacia atlantica seeds were given to caged laying hens, In the first phase of egg production (weeks 24-36). Egg production rate, egg number, egg weight, egg mass, feed intake, feed conversion efficiency, mortality rate and body weight were not significantly affected by the experimental diets. It could be concluded from this study for the first time that Pistacia atlantica seeds could be used up to 15% in the ration of laying hens during the first phase of egg production (weeks 24-36) with no serious adverse effects on performance. (Keywords: Pistacia atlantica seeds, laying hens, performance, egg production, egg number)

ZUSAMMENFASSUNG

Einfluss von Pistacia atlantica als Maisersatz im Futter auf die Leistung von Legehennen in der ersten Legeperiode

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12 Wochen lang wurden Versuche mit 160 Legehennen der Rasse Weiße Leghorn im Alter von 24 Wochen durchgeführt. In der ersten Legeperiode (24-36. Lebenswoche) wurden 0%, 5%, 10% und 15% Pistazien (Pistacia atlantica) als Maisersatz in das Futter gemischt. Die Versuchsfütterung zeigte keinen signifikanten Einfluss auf die Produktionsparameter Legeleistung, Anzahl der Eier, Eigewicht, Futteraufnahme, Futterverwertung, Mortalität und Lebendgewicht. Die Versuche ergaben, dass bis zu 15% Pistazien anstatt Mais im Futter die Legeleistung der ersten Legeperiode nicht bedeutend beeinflusst. (Schlüsselwörter: Pistacia atlantica, Legehennen, Leistung, Eierproduktion, Eizahl)

INTRODUCTION

Feed is the major item of cost in the production of poultry meat and eggs, and energy sources are the most ratios, in poultry diets. The most energy sources for poultry

nutrition are cereal grains, which are in competition with human food. Finding new energy sources, which are not, or less in competition with human food is very important. *Pistacia atlantica* is one of the *Pistacia* species, which grow on Zagrossian region with *Quercus* species (Sabeti, 1994). *Pistacia atlantica* seeds that provide from forest are a new and unconventional energy source. It is not found any literature of *Pistacia atlantica* seeds in animal nutrition. The authors determined metabolisable energy content of *Pistacia atlantica* seeds according to Sibald (1989) and Vincze et al. (1994), and chemical composition of this feed according to the AOAC (1990) and the results were reported as following: AMEn 13.51 MJ/kg, crude protein 8.1%, ether extract 26.8%, crude fiber 32.4%, calcium 0.11%, phosphorus 0.16%, lysine 0.52%, methionine 0.05%, cystine 0.1%, and linoleic acid 5% of the feedstuff as dry matter basis, this result indicated that *Pistacia atlantica* could be used as an energy source in poultry diet. The aim of this study is to investigate the effect of different levels of *Pistacia atlantica* seeds on laying hens performance.

MATERIALS AND METHODS

Birds, housing and experimental design

One hundred and sixty 24 weeks old white leghorn hens were housed in cages located in two open-sided sheds, in double deck stair step cages. The dimensions of each cage were 40 cm length, 37 cm width and 44 cm height, and two birds were placed to each cage. The experiment was conducted in the experimental henhouse of Animal Science Research Station of Dezful in Khoozestan province in the Iran.

Twelve weeks old pullets all the same breeder flock from a commercial leghorn breeder stock was provided and raised on deep litter floor until 18 week old. The length of lightening during rearing of pullet was 10 hours with 14 hours dark pauses. At 18th week of age the pullets were transferred to cages and were fed with immature leghorn-type chicken's diet from 18 weeks old to first egg. The composition of pullet diet was formulated according the requirements of N.R.C 1994, and is shown in Table 1.

The 24 weeks old laying hen were weighed and assigned to cages according to a randomized complete block design with four treatments and four replication in four independent separate blocks. Forty birds were randomly assigned to each treatment, 10 laying hens were placed per replication or experimental, which include 5 cages and 2 hen were located in a cage. The experiment was carried out over 12 weeks period, between 24 and 36 weeks of laying hens age, during first phase of egg production. The hens had access to feed and water adlibitum, and provided 1hours lightening per day and 7 hours dark pauses. During the experimental period, the temperature of the henhouse was fluctuated between 16-20°C.

Diets

The composition of the experimental diets is shown in Table 2 and composition of premix is shown in Table 3. The control diet (To) without *Pistacia atlantica* seeds, was based on corn, soybean meal (44% protein) and fish meal (60% protein) as the principal sources of energy and protein, respectively.

In the all-experimental diets containing *Pistacia atlantica* seeds was substituted with corn. The experimental diet were formulated according leghorn - type chicken requirements was noted in Nutrient Requirements of Poultry (N.R.C, 1994). and all diets were isocaloric and isonitrogenic. The experimental diets are following:

T0 = Treatment-0: as control ton corn, extracted soybean meal, fish meal and other supplements (Basal diet).

T1 = Treatment-1:The ingredients used for the(T0)+5% Pistacia atlantica seeds.

T2 = Treatment-2:The ingredient used for the(T0)+10% Pistacia atlantica seeds.

T3 = Treatment-3:The ingredient used for the(T0)+15% Pistacia atlantica seeds.

Table 1

Composition of pullet diets in different ages

Ingredients & Composition (1)	12 – 18 week (2)	18 week to first egg (3)
Corn (4)	60	70
Soybean meal (5)	14	20
Fish meal (6)	3	4
Barley (7)	20	-
Oyster shell (8)	1.50	4.60
Dicalcium phosphate	0.65	0.55
Salt (9)	0.35	0.35
Premix *	0.50	0.50
Calculated composition (10)		
MEN (MJ/kg) (11)	12.27	12.15
Crude protein (12)	15.20	17.15
Ether extact (13)	3.03	3.2
Crude fiber (14)	3.2	2.97
Calcium	0.80	2
Phosphorus	0.30	0.33
Lysine	0.74	0.90
Methionine	0.28	0.31
Met + Cys	0.54	0.59
Linoleic acid (15)	1.55	1.63

*The composition of premix is shown in Table 3. (Zusammensetzung der Vitamin- und Mineralstoffmischung zeigt Tabelle 3.)

1. Tabelle: Futterzusammensetzung bei Junghennen verschiedener Altersgruppen

Zusammensetzung(1), 12-18. Woche(2), Von der 18. Woche bis zum ersten Ei(3), Mais(4), Sojaschrot(5), Fleischmehl(6), Gerste(7), Austernschalenmehl(8), Salz(9), Errechnete Zusammensetzung(10), MEN- Energie(11), Rohprotein(12), Rohfett(13), Rohfasern(14), Linolsäure(15)

The calculated nitrogen corrected apparent metabolisable energy (AMEn) Content of the diets was 11.75 MJ/kg and crude was 145 g/kg. The ratio of energy to protein was 193.33 and the other nutrients content of the diets were balanced by ratio. The experimental diets were ground and mixed weekly by a special miller and mixer in the Animal Science Research Station of Dezful. Feed intake and remaining in feeder of each

experimental unit were weighed weekly for determination feed consumption during week, every phases and finally whole period of the experiment.

Table 2

Composition of layer diets containing *Pistacia atlantica* seeds

Ingredients & Composition (1)	T0 Control diet	T1 P.at 5%	T2 P.at 10%	T3 P.at 15%
Corn (2)	72	67	62.30	57.44
Soybean meal (3)	12.40	12.47	12.50	12.56
Fish meal (4)	4	4	4	4
<i>Pistacia atlantica</i> (5)	-	5	10	15
Oyster shell (6)	6	6	6	6
Dicalcium phosphate	0.20	0.20	0.20	0.20
Limestone(7)	5	5	5	5
Methionine	0.06	0.08	0.09	0.11
Salt	0.25	0.25	0.25	0.25
Premix *	0.50	0.50	0.50	0.50
Calculated composition (8)				
MEN (MJ/kg) (9)	11.75	11.75	11.75	11.75
Crude protein (10)	14.50	14.50	14.50	14.50
Ether extract (11)	3.21	4.09	5.52	6.68
Crude fiber (12)	2.46	3.98	5.50	7.01
Calcium	3.16	3.16	3.16	3.16
Phosphorus)	0.24	0.24	0.24	0.25
Lysine	0.70	0.71	0.73	0.74
Methionine	0.32	0.33	0.34	0.35
Met + Cys	0.56	0.57	0.57	0.57
Linoleic acid (13)	1.60	1.77	1.92	2.10

*The composition of premix is shown in Table 3. (*Zusammensetzung der Vitamin- und Mineralstoffmischung zeigt Tabelle 3.*)

*2. Tabelle: Zusammensetzung des Legehennenfutters mit *Pistacia atlantica**

Zusammensetzung(1), Mais(2), Sojaschrot(3), Fleischmehl(4), Gerste(5), Austernschalenmehl(6), Kalkstein(7), Errechnete Zusammensetzung(8), MEN-Energie(9), Rohprotein(10), Rohfett(11), Rohfasern(12), Linolsäure(13)

Measurement and analyses

Egg production in each replicate group was recorded daily and the feed consumption was measured at 7 day intervals. All eggs were collected from each 16 replicate groups once a week intervals were weighed, and the average egg weight, weighted for the total number of eggs laid in each replicated groups during one week and summarized in a phase. Egg number was recorded daily for each replicate groups and summarized in a phases per hen. Individual body weights were recorded at the start and end of each phase and were summarized at the end of each phase per replication and treatments.

Table 3**Composition of vitamins and minerals premix***

Vitamins, Mineral (1)	Broiler Supplement (2)	Layer Supplement (3)	Breeder Supplement (4)
Vitamin A	11000000 IU	10000000 IU	12000000 IU
Vitamin D3	1800000 IU	2500000 IU	2200000 IU
Vitamin E	18000 IU	10000 IU	25000 IU
Vitamin K3	2500 mg	2200 mg	3000 mg
Vitamin B1	1500 mg	1000 mg	2000 mg
Vitamin B2	6000 mg	4000 mg	6000 mg
Niacin	30000 mg	20000 mg	30000 mg
Vitamin B3	12000 mg	8000 mg	14000 mg
Vitamin B6	1500 mg	2000 mg	2000 mg
Vitamin B9 Folic acid	1000 mg	560 mg	800 mg
Vitamin B12	16 mg	15 mg	14 mg
Biotin	100 mg	150 mg	100 mg
Choline chloride	550000 mg	400000 mg	500000 mg
Antioxidant	10000 mg	10000 mg	10000 mg
Iron (Fe)	5000 mg	50000 mg	40000 mg
Selenium (Se)	200 mg	100 mg	100 mg
Cobalt (Co)	100 mg	100 mg	100 mg
Copper (Cu)	5000 mg	5000 mg	5000 mg
Manganese (Mn)	100000 mg	80000 mg	100000 mg

*Each 5-kg of premix containing Vitamins and Minerals is shown in table and is used per 1 ton ration. (Zu 1 t Futter wurden 5 kg der in der Tabelle aufgeführten Vitamin- und Mineralstoff-Mischung gegeben.)

3. Tabelle: Zusammensetzung der Vitamin- und Mineralstoff-Mischung

Vitamine und Minerale(1), Futterergänzung für Broiler(2), Futterergänzung für Legehennen(3), Futterergänzung für Zuchttiere(4)

Feed consumption was recorded weekly for each replicate groups and summarized per hen per day. Egg production percentage or rate of laying was calculated by dividing sum of egg number to sum hen day. Egg mass per hen per day (g) was calculated by multiplying mean egg weight (g) and egg production rate. Feed efficiency was calculated by dividing feed intake per hen per day in kg or gram to egg mass per hen per day in kg or gram. Mortality rate was recorded daily of dead hen and summarized for first phase of egg production. For investigation the effects of experimental diets on egg quality characteristics, eggs were collected at 28-day intervals, in each replicated group, and 2 eggs which their weight were closed to the mean weight of group used for the measurement of : egg weight, shape index (maximum width/maximum length of egg), white weight, yolk weight, yolk colour, shell weight, shell thickness, shell weight per unit surface area (SWUSA), shell strength, albumen height and Haugh unit. A digital scale measured egg weight, white weight, yolk weight, width and length of eggs for determination index by a Venire caliper, shell strength, shell thickness and albumen

height by fine apparatuses in Molasani Agricultural College of Ahwaz University. Haugh unit was calculated by use of albumen height and egg weight according the mentioned formula, yolk colour by Roche fan. Shell weight per unit surface area (SWUSA) was calculated by dividing the shell weight (mg) by the egg surface area (cm²). Egg surface area was calculated according to Carter (1975) using the equation: $3.9782 \times \text{egg weight (g)}^{0.7056}$, and egg shell (plus adhering membranes) weight was determined after washing and drying at 105°C overnight and weighed. SWUSA was expressed in terms of mg/cm². All data for different parameters were recorded daily, weekly and summarized for first phase of egg production.

Statistical analysis

The data was subjected to analysis of variance (Steel and Torrie, 1980) and treatment means were compared by Duncan's multiple range test (Duncan, 1955). A statistical analysis of experimental results was made by the STATGRAPHIC (Statistical Graphics System), Version 5 and also Excel version 5 softwares.

Table 4

Effect of dietary levels of *Pistacia atlantica* seeds on the laying performance between 24 and 36 weeks

Treats (1)	Rations contain <i>Pistacia atlantica</i> (2)	Egg laying rate % (3)	Egg number 84 days $\pm$ SD (4)	Egg Weight (g) $\pm$ SD (5)	Egg mass g/h/d $\pm$ SD (6)	Feed intake g/h/d $\pm$ SD (7)	F.C.E (g)Feed (g)Egg $\pm$ SD (8)	Mortality rate% $\pm$ SD v (9)	Body weight week 36 $\pm$ SD (10)
T0	—	85.63	71.72	57.26	49.10	110.62	2.27	12.5	1.64
T1	5%	84.45	70.81	57.29	48.48	109.87	2.28	10	1.61
T2	10%	83.90	70.27	58.14	48.82	112.67	2.32	12.5	1.53
T3	15%	86	72.12	57.99	49.92	112.44	2.27	7.5	1.61
Mean(11) $\pm$ SD SL	—	84.99 $\pm$ 1.02 NS	71.23 $\pm$ 0.86 NS	57.67 $\pm$ 0.21 NS	49.08 $\pm$ 0.62 NS	111.40 $\pm$ 1.35 NS	2.28 $\pm$ 0.30 NS	10.63 $\pm$ 2.07 NS	1.60 $\pm$ 0.03 NS

FCE: Feed conversion efficiency (*Futterverwertungsvermögen*), T: Treatment (*Behandlung*); SD: Standard deviation (*Standardabweichung*); SL: Significant level (*Signifikanz*); NS: Not significant (*Nicht signifikant*)

4. Tabelle: Einfluss der Menge an *Pistacia atlantica* auf die Leistung der Legehennen in der 24.-36. Lebenswoche

Behandlungen(1), Menge an *Pistacia atlantica* (%) (2), Prozentuale Eierproduktion(3), Eizahl in 84 Tagen(4), Durchschnittliches Eigewicht (g)(5), Tagesleistung Eimasse (g/Huhn/Tag)(6), Futteraufnahme (g/Huhn/Tag)(7), Futterverwertung(8), Mortalität % (9), Körpergewicht in der 36. Lebenswoche(10), Mittelwerte(11)

RESULTS AND DISCUSSION

The performance data between 24 and 36 week of age (first phase of egg production) is presented in *Table 4*. Rate of egg production, number of eggs per hen in 84, mean egg weight, egg mass per hen per day (g), intake per hen per day (g), feed efficiency (feed intake g/mass g), the mortality rate and body weight were significantly ($P>0.05$) affected by the dietary treatments. In all parameters the data of all treatments are very closed to each other with a little standard deviation.

CONCLUSIONS

According to the results obtain in this study experimental diets containing different levels of *Pistacia khinjuk* seeds were not shown significant effects on performance of laying hens in first phase of egg production (weeks 24-36) up to 15% *Pistacia khinjuk* seeds of whole ration. It could be concluded from this study for the first time that *Pistacia atlantica* seeds could be used up to 15% in the ration of laying hens during the first phase of egg production (weeks 24-36) without any problem or limitation.

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The effect of different levels of Acorn seeds on laying hens performance in first phase of egg production

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ABSTRACT

The experiment was conducted over 12 weeks period with one hundred and sixty 24 weeks old white leghorn hens. Diets containing 0, 10, 20 and 30% acorn seeds of Quercus branti were given to caged laying hens in first phase of egg production (weeks 24-36). Egg weight, feed intake, mortality rate and body weight were not significantly affected by the treatments, but egg production rate, egg number, egg mass by $P < 0.01$ and feed efficiency with $P < 0.05$ were affected by the experimental diets. It could be concluded that treatment containing 30% acorn seeds significantly reduced egg production rate, egg number, egg mass, and feed efficiency in first phase of egg production (weeks 24-36). But acorn seeds could be used in the diet of laying hens in place of corn up to 20% with no serious adverse effects on performance.

(Keywords: laying hens, acorn seeds, feed intake, egg production rate, egg number)

ZUSAMMENFASSUNG

Einfluss von Eicheln als Maisersatz im Futter auf die Legeleistung von Legehennen in der ersten Legeperiode

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12 Wochen lang wurden Versuche mit 160 Legehennen der Rasse Weiße Leghorn im Alter von 24 Wochen durchgeführt. In der ersten Legeperiode (24-36. Lebenswoche) wurden 0%, 10%, 20% und 30% Eicheln (Quercus branti) in das Futter gemischt. Die Versuchsumstände hatten keinen signifikanten Einfluss auf Eigewicht, Futteraufnahme, Mortalität und Lebendgewicht. Dagegen zeigte die Legeleistung, die Anzahl der Eier und deren Gesamtmasse eine Signifikanz von $p < 0,01\%$, die Futterverwertung eine Signifikanz von $p < 0,05\%$. Es ist festzustellen, dass ein Anteil von 30% Eicheln im Futter sowohl die Legeleistung als auch die Eizahl, das Eigewicht und die Futterverwertung in der ersten Legeperiode signifikant verringerte. Trotzdem empfehlen wir, Mais zu 20% durch Eicheln bei Legehennen zu ersetzen, da in dieser Konzentration kein bedeutender Einfluss auf die Legeleistung besteht.

(Schlüsselwörter: Legehennen, Eicheln, Futterverbrauch, Eierproduktion, Eizahl)

INTRODUCTION

Feed is the major item of cost in the production of poultry meat and eggs, and energy sources have the highest ratio, in poultry diets. The highest energy sources for poultry nutrition is cereal grains, which is in competition with human food. Finding new energy sources, which are not in competition with human food, is very important. Acorn, which is the fruit of oak trees and provides from the forest, is new and nonconventional energy source. Acorn contains considerable amounts of tannin and other anti-nutritional substances. Rations with above 25% acorn meal produced eggs with coloured yolks and low hatchability (Deboer and Bickel, 1988). Kaushal *et al.* (1971) reported that incorporation of oak kernels at 5 percent level didn't affect the growth rate of chicks during 10-59 days of age. Cicogena *et al.* (1972) reported the result of a trial on the possibility of substituting maize by rice germ meal, acorns and denatured sugar, in diets for broilers, Satisfactory technical and economic results have been obtained only with the 1/3 substitution of maize. The total substitution of maize by the mentioned mixture produced broilers meat with better taste, but provided worse results for all other performance (growth rate, feed conversion, dressing percentage and feeding cost). The aim of this study is to investigate effects of substituting corn with acorn on laying hens performance and egg quality characteristics.

MATERIALS AND METHODS

Birds, housing and experimental design

One hundred and sixty 24 weeks old white leghorn hens were housed in cages located in two open-sided sheds, in double deck stair step cages. The dimension of each cage was 40cm length, 37 cm width and 44 cm height, and two birds were placed to each cage. The experiment was conducted in the experimental henhouse of animal science research station of Dezful in Khoozestan province in the Iran.

Twelve weeks old pullets all of the same breeder flock from a commercial leghorn breeder stock was provided and raised on deep litter floor until 18 weeks old. The length of lightening during rearing of pullet was 10 hours with 14 hours dark pauses. At 18th week of age the pullets were transferred to cages and were fed with immature leghorn-type chickens diets from 18 weeks old to first egg. The composition of pullet diet was formulated according the requirements of N.R.C. 1994, and is shown in *Table 1*.

The 24 weeks old laying hen were weighed and assigned to cages according to a randomized complete block design with four treatments and four replication in four independent separate blocks. Forty birds were randomly assigned to each treatment, and 10 laying hens were placed per replication or experimental unit, which include 5 cages and 2 laying hen were located in a cage.

The experiment was carried out over 12 weeks period, between 24 and 36 weeks of laying hens age, during first phase of egg production. The hens had access to feed and water adlibitum, and provided 17 hours lightening per day and 7 hours dark pauses. During the experimental period, the temperature of the henhouse was fluctuated between 16-24°C.

Table 1**Composition of pullet diets in different ages**

Ingredients & Composition (1)	12 – 18 week (2)	18 week to first egg (3)
Corn (4)	60	70
Soybean meal (5)	14	20
Fish meal (6)	3	4
Barley (7)	20	-
Oyster shell (8)	1.50	4.60
Dicalcium phosphate	0.65	0.55
Salt	0.35	0.35
Premix *	0.50	0.50
Calculated composition (9)		
MEN (Mj/kg) (10)	12.27	12.15
Crude protein (11)	15.20	17.15
Ether extract (12)	3.03	3.20
Crude fiber (13)	3.42	2.97
Calcium	0.80	2
Phosphorus	0.30	0.33
Lysine	0.74	0.90
Methionine	0.28	0.31
Met + Cys	0.54	0.59
Linoleic acid	1.55	1.63

*The composition of premix is shown in table 3. (*Zusammensetzung der Vitamin- und Mineralstoffmischung zeigt Tabelle 3.*)

1. Tabelle: Futterzusammensetzung bei Junghennen verschiedener Altersgruppen
 Zusammensetzung(1), 12-18. Woche(2), Von der 18. Woche bis zum ersten Ei(3),
 Mais(4), Sojaschrot(5), Fleischmehl(6), Gerste(7), Austernschalenmehl(8), Errechnete
 Zusammensetzung(9), MEN- Energie(10), Rohprotein(11), Rohfett(12), Rohfasern(13)

Diets

The composition of the experimental layer diet is shown in Table 2, and composition of premix is shown in Table 3. The control diet (T₀) without acorn seeds, was based on corn, soybean meal (44% protein) and fish meal (60% protein) as the principal sources of energy and protein, respectively. The experimental diets are following:

Treatment-0 (T₀): as control treatment diet based on corn, extracted soybean meal, fish meal and other supplement (basal diet).

Treatment-1 (T₁): The ingredients used for (T₀) + 10% acorn seeds.

Treatment-2 (T₂): The ingredients used for (T₀) + 20% acorn seeds.

Treatment-3 (T₃): The ingredients used for (T₀) + 30% acorn seeds.

Table 2

Composition of layer diets containing acorn seeds

Ingredients & (1) Composition	T0 Control diet	T1 Acorn 10%	T2 Acorn 20%	T3 Acorn 30%
Corn (2)	72	61	50	38.80
Soybean meal (3)	12.40	13.70	15	16.3
Fish meal (4)	4	4	4	4
Acorn (5)	-	10	20	30
Oyster shell (6)	6	4	3	3
Dicalcium phosphate	0.20	0.20	0.20	0.20
Limestone (7)	5	6.30	7	7
Methionine	0.06	0.08	0.10	0.12
Salt	0.25	0.25	0.25	0.25
Premix *	0.50	0.50	0.50	0.50
Calculated composition (8)				
MEN (MJ/kg) (9)	11.75	11.75	11.75	11.75
Crude protein (10)	14.50	14.50	14.50	14.50
Ether extract (11)	3.21	3.57	3.94	4.29
Crude fiber (12)	2.46	2.50	2.70	2.80
Calcium	3.16	3.16	3.18	3.19
Phosphorus	0.24	0.24	0.24	0.24
Lysine	0.70	0.72	0.75	0.77
Methionine	0.32	0.33	0.34	0.35
Met + Cys	0.56	0.56	0.56	0.56
Linoleic acid	1.60	1.55	1.47	1.38

*The composition of premix is shown in Table.3. (*Zusammensetzung der Vitamin- und Mineralstoffmischung zeigt Tabelle 3.*)

2. Tabelle: Zusammensetzung des Legehennenfutters mit Eicheln

Zusammensetzung(1), Mais(2), Sojaschrot(3), Fleischmehl(4), Gerste(5), Austernschalenmehl(6), Kalkstein(7), Errechnete Zusammensetzung(8), MEN-Energie(9), Rohprotein(10), Rohfett(11), Rohfasern(12)

This acorn seeds was picked up from *Quercus branti* species which is famed Iranian oak or Zarossian oak, and grow on Zgros mountain chains of Iran, in a area about 4 million hectares (*Sabeti*, 1994). In the all experimental diets containing acorn seeds was substituted with corn. The experimental diet were formulated according leghorn-type chicken requirements was noted in Nutrient Requirements of Poultry (N.R.C, 1994), and all diets were isocaloric and isonitrogenic.

The calculated nitrogen corrected apparent metabolisable energy (AMEn) content of the diets was 11.75 MJ/kg and crude protein was 145 g/kg. The ratio of energy to protein was 193.33 and the other nutrients content of the diets were balanced by this ratio. The experimental diets were ground and mixed weekly by a special miller and mixer in the Animal Science Research Station of Dezful. Feed intake and remaining in feeder of each experimental unit were weighed weekly for determination feed consumption during week, every phases and finally whole period of experiment.

Table 3

Composition of vitamins and minerals premix *

Vitamin & Mineral (1)	Supplement (2)	Layer supplement (3)	Breeder supplement (4)
Vitamin A	11000000 IU	10000000 IU	12000000 U
Vitamin D3	1800000 IU	2500000 IU	2200000 U
Vitamin E	18000 IU	10000 IU	25000 IU
Vitamin K3	2500 mg	2200 mg	3000 mg
Vitamin B1	1500 mg	1000 mg	2000 mg
Vitamin B2	6000 mg	4000 mg	6000 mg
Niacin	30000 mg	20000 mg	30000 mg
Vitamin B3-Ca Pantnit	12000 mg	8000 mg	14000 mg
Vitamin B6	1500 mg	2000 mg	2000 mg
Vitamin B9 Folic acid	1000 mg	560 mg	800 mg
Vitamin B12	16 mg	15 mg	14 mg
Vitamin H2 (Biotin)	100 mg	150 mg	100 mg
Choline chloride	550000 mg	400000 mg	500000 mg
Antioxidant	10000 mg	10000 mg	10000 mg
Iron (Fe)	50000 mg	50000 mg	40000 mg
Zinc (Zn)	65000 mg	60000 mg	60000 mg
Selenium (Se)	200 mg	100 mg	100 mg
Cobalt (Co)	100 mg	100 mg	100 mg
Copper (Cu)	5000 mg	5000 mg	5000 mg
Manganese (Mn)	100000 mg	80000 mg	100000 mg
Iodine (I)	1000 mg	1000 mg	1000 mg

*Each 5 kg of premix containing Vitamins and Minerals is shown in table and is used per 1 ton ration. (Zu 1 t Futter wurden 5 kg der in der Tabelle dargestellten Vitamin- und Mineralstoff-Mischung gegeben.)

3. Tabelle: Zusammensetzung der Vitamin- und Mineralstoff-Mischung

Vitamine und Minerale(1), Futterergänzung für Broiler(2), Futterergänzung für Legehennen(3), Futterergänzung für Zuchttiere(4)

Measurement and analyses

Egg production in each replicate group was recorded daily and the feed consumption was measured at 7 day intervals. All eggs were collected from each 16 replicate groups once a week intervals were weighed, and the average egg weight, weighted for the total number of eggs laid in each replicated group during one week and summarized in a phase for treatment. Egg number was recorded daily for each replicate groups and summarized in a phases per hen. Individual body weights were recorded at the start and end of this phase and was summarized at the end of each phases per replication and treatments. Feed consumption was recorded weekly for each replicate groups and summarized per hen per.

Egg production percentage or rate of laying was calculated by dividing sum of egg number to sum hen day. Egg mass per hen per day (g) was calculated by multiplying mean egg weight (g) and egg production rate. Feed efficiency was calculated by dividing feed intake per hen per day in gram to egg mass per hen per day in gram. Mortality rate was recorded daily of dead hen and summarized for first phase of egg production. All data for different parameters were recorded daily, weekly and summarized for first phase of egg production.

Statistical analysis

The data was subjected to analysis of variance (Steel and Torrie, 1980), and treatment means were compared by Duncan's multiple range test (Duncan 1955). A statistical analysis of experimental results was made by the STATGRAPHICS (Statistical Graphics System), Version 5 and also Excel version 5 softwares.

RESULTS AND DISCUSSIONS

The performance data between 24 and 36 week of age (first phase of egg production) is presented in Table 4. Rate of egg production significantly influenced by dietary treatments. Treatments (T0-T3) (T1-T3) had significant differences by ($P < 0.01$) and treatments (T2) by $P < 0.05$.

Table 4

Effect of dietary levels of acorn seeds on the laying performance between 24 and 36 weeks of age

Treats (1)	Rations contain acorn % (2)	Egg Laying Rate % (3)	Egg number 84 days (4) ±SD	Egg weight (g) (5) ±SD	Egg mass (g)/h/d ±SD (6)	Feed intake g/h/d (7) ±SD	F.C.E (g) Feed(g) Egg (8) ±SD	Mortality Rate % ±SD (9)	Body weight week 36 ±SD (10)
T0	–	85.63 e ±1	71.72 a ±0.94	57.26 ±0.53	49.10 e ±0.45	110.62 ±2.80	2.27 a ±0.06	12.5 ±4.79	1.64 ±0.08
T1	10	86.58 e ±1.49	72.63ae ±1.28	57.58 ±0.18	49.89 e ±0.92	110.82 ±1.08	2.23 a ±0.06	7.5 ±2.5	1.54 ±0.06
T2	20	84.51 a ±1.38	70.82 a ±1.25	57.50 ±0.49	48.65 e ±0.78	112.36 ±2.89	2.32 ±0.04	7.5 ±4.79	1.60 ±0.04
T3	30	77.22bf ±2.02	64.79bf ±1.66	56.91 ±0.42	43.98 f ±1.20	108.57 ±2.65	2.50 b ±0.09	15 ±6.46	1.49 ±0.10
Mean ±SD S.L	–	83.48 ±0.76 **	70 ±0.66 **	57.31 ±0.21 NS	47.90 ±0.44 **	110.59 ±1.23 NS	2.33 ±0.03 *	10.63 ±2.42 NS	1.57 ±0.04 NS

FCE: Feed conversion efficiency (*Futterverwertungsvermögen*), T: Treatment (*Behandlung*); SD: Standard deviation (*Standardabweichung*); SL: significant level (*Signifikanz*); NS: not significant (*Nicht signifikant*); SL: *= $P < 0.05$, **= $P < 0.01$. Significant differences between the data being in the same column (*Signifikante Differenz zwischen den Daten der gleichen Spalte*): $P < 0.05$: a - b; c - d. $P < 0.01$: e - f.

4. Tabelle: Einfluss der Menge an Eicheln auf die Leistung der Legehennen in der 24.-36. Lebenswoche

Behandlungen(1), Menge an Eicheln (%) (2), Prozentuale Eierproduktion(3), Eizahl in 84 Tagen(4), Durchschnittliches Eigewicht(g)(5), Tagesleistung Eimasse (g/Huhn/Tag)(6), Futteraufnahme (g/Huhn/Tag)(7), Futterverwertung(8), Mortalität %(9), Körpergewicht in der 36. Lebenswoche(10), Mittelwerte(11)

Number of eggs per hen in 84 days was affected by dietary treatments. Treatments (T1-T3) by ($P<0.01$) and treatments (T0-T3), (T2-T3) with ($P<0.05$) were significantly affected by dietary treatments. Feed intake per hen per day, mean egg weight, mortality rate and body weight were not significantly ($P>0.05$) affected by the dietary treatments.

Egg mass per hen per day had significant differences by ($P<0.01$) between treatment (T0-T3), (T1-T3), (T2-T3). Feed [(g) feed intake/(g) egg mass], was shown significant differences by ($P<0.05$) between treatments (T0-T3) and (T1-T3). In the all cases rate of egg production, number of eggs per hen in 84 days, egg mass per hen per day and feed efficiency was significantly affected by the dietary treatments. Especially treatment-3 (T3) containing 30% acorn was shown the worse results. These result could be due to high level (30%) of acorn and because tannin content of acorn (4.7%) in treatment-3 (T3).

This results is in agreement with the reports of (Sell et al. 1989; Sell and Rogler, 1984) who reported the tannin cause poorer egg production, and reduced amino acid or nitrogen digestibility (Rostagno et al. 1973b; Elkin et al. 1978b; Kirby et al. 1983), and also is in agreement with the reports of Chang and Fuller, 1964; Connor et al., 1969; Rostagno et al., 1973a; Armstrong et al., 1973, 1974a,b; Featherston and Rogler, 1975; Elkin et al., 1978a,b, Price et al., 1978a, 1979; Sell and Rogler 1983; Rogler and Sell, 1984; Garwood and Rogler 1987, who reported tannin reduced feed efficiency.

CONCLUSIONS

This investigation revealed for the first time that experimental diets containing different levels of dehulled acorn seeds were not shown significant effects on egg weight, feed intake, mortality rate, body weight, of laying hens, but egg production rate, egg number, egg mass and feed efficiency were affected significantly by experimental treatment diets in first phase of egg production (weeks 24-36). The significant differences due to the treatment containing 30% acorn. The results of this investigation confirm for the first time that in first phase of egg production (weeks 24-36) could be recommended using up to 20% dehulled acorn instead of corn in laying hens ration.

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Effect of soya bean antinutritional proteins on rats and sheep

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ABSTRACT

In the first experiment we showed that isolated soya bean lectin (SBA) and trypsin inhibitor (STI) are unable to suppress food consumption in rats, if administered orally at a level of 100 mg/kg b.w. Other factors connected with raw soya bean may be responsible for suppression. In another experiment defatted raw soya bean flour was administered intraruminally at a level of 10 g/kg b.w. to a sheep fitted with ruminal, duodenal and ileal cannulas. Soya bean lectin (SBA) and trypsin inhibitors appeared in the duodenum within 1 hour; both reached the terminal ileum and had disappeared by the time 24 hours had elapsed. The passage of the lectin along the gut progressively lagged behind that of the inhibitors, which indicates that this lectin binds to the intestinal surface in this species. The inhibitors were neutralised by marked pancreatic hypersecretion resulting in a supraphysiological trypsin level in the intestine. This experiment shows that soya bean antinutritional proteins pass along the digestive tract at different rates, and if administered intraruminally they are not degraded effectively in the forestomachs. It is assumed that this differential passage may also occur in monogastric animals.

(Keywords: lectin, inhibitor, soya bean, rat, sheep)

ZUSAMMENFASSUNG

Einfluss der antinutritiven Eiweiße der Sojabohne auf Ratten und Schafe

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Im ersten Versuch wurde gezeigt, dass das isolierte Lektin (SBA) und der Trypsininhibitor (STI) der Sojabohne nicht fähig sind, die Futteraufnahme der Ratten zu verringern, wenn diesen oral eine Dosis von 100 mg/kg Körpergewicht verabreicht wurde. Für den Rückgang der Futteraufnahme können andere Stoffe der rohen Sojabohne verantwortlich sein. In einem anderen Versuch wurden einem Schaf 10 g/kg Körpergewicht entfettetes rohes Sojamehl intraruminal eingegeben. Dem Schaf waren in einer vorangegangenen Operation Kanülen in Pansen, Duodenum und Ileum eingesetzt worden. Das Lektin (SBA) und die Trypsin-Inhibitoren erschienen innerhalb einer Stunde im Duodenum; beide Stoffe gelangten in den terminalen Ileum und waren nach

24 Stunden verschwunden. Während des Durchlaufes durch den Darmkanal blieb das Lektin immer mehr hinter den Inhibitoren zurück, was darauf hinweist, dass sich bei dieser Tierart das Lektin an die Oberfläche der Darmschleimhaut bindet. Die Inhibitoren wurden durch eine ausgesprochene Pankreas Hypersekretion neutralisiert, was dann ein supraphysiologisches Trypsinniveau im Darm zur Folge hatte. Dieser Versuch zeigt, dass bei intraruminaler Eingabe die antinutritiven Eiweiße der Sojabohne in den Vormägen nicht wirksam genug zerlegt werden und mit unterschiedlicher Geschwindigkeit den Verdauungstrakt durchlaufen. Wir nehmen an, dass dieser differenzierte Durchlauf auch bei monogastrischen Tieren vorkommt. (Schlüsselwörter: Lektin, Inhibitor, Sojabohne, Ratte, Schaf)

INTRODUCTION

Soya bean proteins are divided into high m.w. storage proteins and a low m.w. albumen fraction. The latter contains mostly antinutritional proteins: soya bean lectin and proteinase inhibitors. The trypsin inhibitor of the soya bean was one of the earliest proteins isolated, this being the so-termed Kunitz inhibitor (STI). Later another proteinase inhibitor was isolated: this was the Bowman-Birk inhibitor (BBI), which is a so-termed double-headed inhibitor active against both trypsin and α -chymotrypsin. Soya bean also contains a lectin, a carbohydrate binding protein specific to galactose and N-acetyl-galactosamine residues in complex carbohydrates (soya bean agglutinin, SBA). This protein is largely, but not completely resistant to proteolysis in the gut (Pusztai et al., 1990), requiring the presence of inhibitors to exert its full activity. SBA binds to glycoproteins on the inner surface of the small intestine, resulting in different biological effects (Pusztai, 1991).

In the first experiments we examined the effect of SBA and STI on voluntary food consumption in rats. In the second experiment the effect of the antinutritional proteins was investigated in a ruminant species, the sheep.

MATERIALS AND METHODS

Wistar, SPF-derived 120 g female rats were kept in cages and fed on commercial chow. In another experiment Scottish Blackface wethers (30 kg) were fitted with chronic ruminal, duodenal, and ileal cannulas. The animals were kept in metabolic cages and fed at maintenance level with a ration composed of grass hay and grass cubes with mineral supplements.

For the first experiment SBA was isolated on guar-gum column according to Pusztai et al. (1991). STI and BSA are Sigma products.

For the second experiment raw soya bean was ground, extracted five times with petroleum ether and dried at room temperature. On the basis of dry matter the extracted flour contained 1.2 % STI, 0.4 % BBI and 0.4 % SBA.

In the food consumption experiments the rats were allotted randomly into groups of 4, 5 or 6. After 30 hr fast the animals were transferred to individual cages and had free access to water throughout. Due to the feeding habits of the rats the experiments were started at dusk and terminated in the morning. All manipulations were performed in dim light. The test protein and the control BSA were administered by gastric intubation or intestinal infusion, dissolved in 0.4 ml physiological saline. At the same time intact, pre-weighed cylinders of granulated chow were laid on the feeding grid and removed periodically for weighing to calculate cumulative food consumption over 12, 18 and 24

hours. During the experiment the animals consumed the commercial granulated chow to which they were accustomed.

Trypsin was measured by direct spectrophotometric determination (*Schwert and Takenaka, 1955*) at 253 nm of the hydrolysis of N-benzoyl-L-arginine ethyl ester (BAEE). Trypsin inhibitors were determined by measuring the remaining activity after reaction with excess trypsin. SBA was determined with rocket electrophoresis using rabbit anti-SBA IgG (Sigma) with 0.2 % galactose included in the agarose gel.

RESULTS AND DISCUSSION

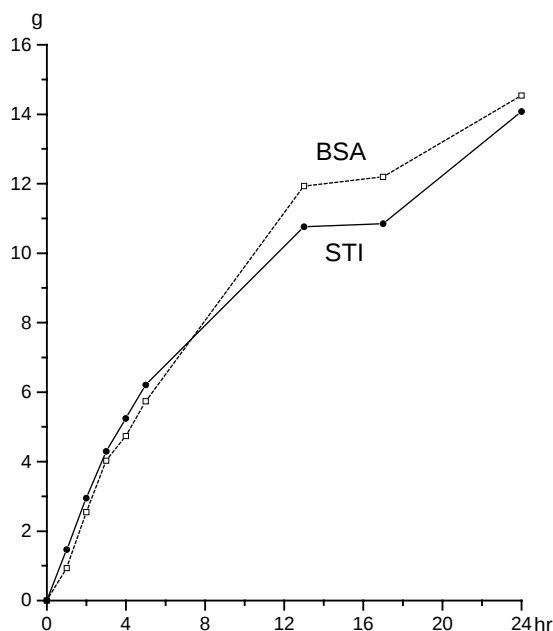
Food consumption

Isolated soya bean lectin (SBA) or trypsin inhibitor (STI) was administered to rats through a gastric tube at a level of 100 mg/kg body weight. Bovine serum albumin (BSA) was used as the control. With both STI and SBA (*Figs. 1 and 2*) the food consumption curves were almost identical in the experimental and the control group. This means that these antinutritional proteins did not suppress food consumption, in spite of their known cholecystokinin (CCK) releasing activity. Observations show that defatted, heat-treated soya bean meal is consumed better than when fed raw; however, the reason for this remains unclear.

Fig. 1

Effect of soya bean trypsin inhibitor (Kunitz-type, STI) on food consumption in rats

Differences between the curves are not significant, $n = 4$

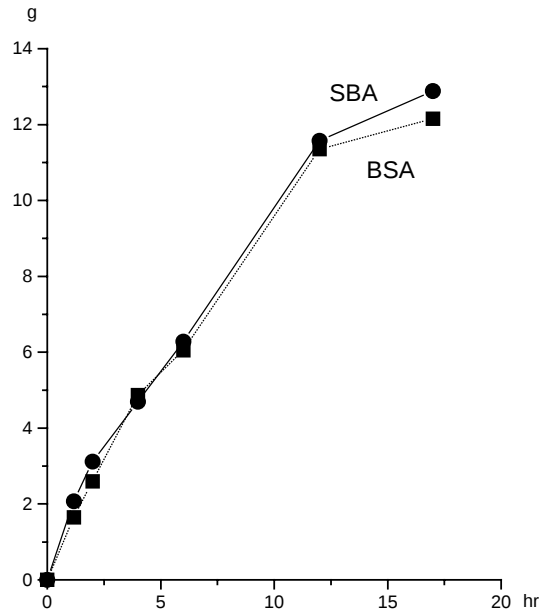


1. Abbildung: Einfluss des Trypsininhibitors der Sojabohne (Kunitztyp, STI) auf den Futterverbrauch der Ratten
(Die Unterschiede zwischen den Kurven sind nicht signifikant)

Fig. 2

Effect of soya bean lectin (SBA) on food consumption in rats

Differences between the curves are not significant, n = 6

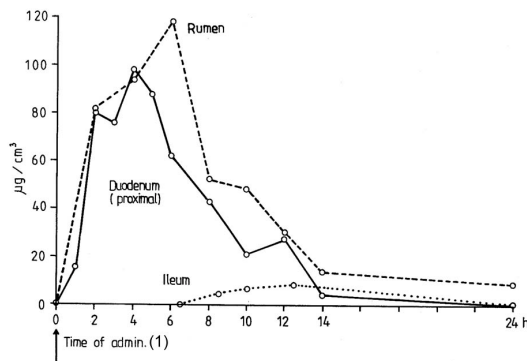


2. Abbildung: Einfluss des Lektins der Sojabohne (SBA) auf den Futterverbrauch der Ratten

(Die Unterschiede zwischen den Kurven sind nicht signifikant)

Fig. 3

Soya bean lectin concentrations in the ovine gastrointestinal tract after intraruminal administration of 10 g/kg b.w. defatted soya bean flour



3. Abbildung: Konzentration des Sojalektins im Verdauungstrakt des Schafes nach intraruminaler Eingabe von 10 g/kg Körpergewicht entfettetem Sojamehl

Zeitpunkt der Eingabe(1)

Effect of defatted soya bean on the sheep

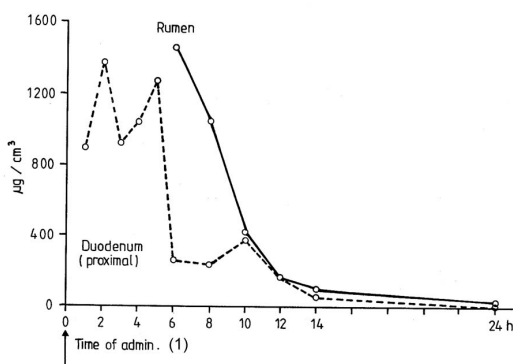
Defatted soya bean flour in the form of a slurry was administered through the rumen cannula at 10 g/kg b.w. (300 g/sheep) in the morning and the daily feed was reduced to half. Samples were taken through the ruminal, duodenal and ileal cannulas for 24 hours and kept frozen until use.

In the rumen several hours were required for the leaching of lectin and inhibitors from the soya bean flour particles and for the homogenisation of rumen content. The concentration of antinutritional proteins then declined steadily (Figs. 3 and 4).

The antinutritional proteins appeared within 1 hour in the proximal *duodenum*, but the increase of the lectin was more sluggish than that of the inhibitor, and the decline of the lectin also occurred later. This difference was even more pronounced in the *ileum*, where the lectin appeared just after the disappearance of the inhibitor (Figs. 3 and 4). This difference shows that the lectin *binds* to the surface of the small intestinal cells, i.e. to the brush border. Both lectin and inhibitor reached the ileum and had disappeared by the end of 24 hours.

Fig. 4

Trypsin inhibitor concentrations in the ovine rumen and proximal duodenum after intraruminal administration of defatted soya bean flour



4. Abbildung: Konzentration des Trypsininhibitors im Pansen des Schafes und dem proximalen Duodenum nach intraruminaler Eingabe von entfettetem Sojamehl

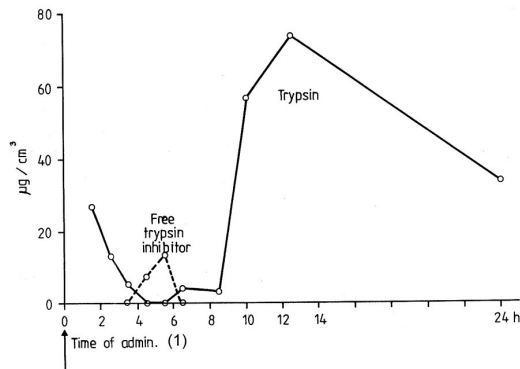
Zeitpunkt der Eingabe(1)

In conclusion, it was ascertained that the two antinutritional proteins (lectin and inhibitor) progressed along the small intestine at *differential rates*, because their interaction with the gut was also different.

In the *ileum* physiological trypsin activity declined to zero in the first hours, due to the appearance of the inhibitor, which came to be in excess above trypsin for a few hours (Fig. 5). However, a new surge of trypsin started and was elevated to supraphysiological concentrations after the 8th hour. This finding indicates a strong *pancreatic reaction* that is mediated, obviously, by the CCK-releasing effect of the antinutritional proteins (Green and Lyman, 1972; Brand and Morgan, 1981; Calam et al., 1987; Jordinson et al., 1997; Pusztai et al., 1997).

Fig. 5

Trypsin and inhibitor concentrations in the ovine ileum after intraruminal administration of defatted soya bean flour



5. Abbildung: Trypsin- und Inhibitorkonzentration im Ileum des Schafes nach intraruminaler Eingabe von entfettetem Sojamehl

Zeitpunkt der Eingabe(1)

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A mezőgazdaság területén a P3-Blu-Gard, a P3-Horolith N, a P3-Asepto N és a P3-Unisept készítményeinkkel vagyunk jelen, mely szerekkel a tőgy egészséges "karbantartását" és higiénikus tejnyerést biztosítunk.

P3-BLU-GARD® tőgyfertőtlenítő

A P3-Blu-Gard® erőteljes baktericid, virucid és fungicid tulajdonsága miatt különösen alkalmas a szubkilinikai és klinikai tőgygyulladások kialakulásának megakadályozására, mivel előli a tőgypatogén csírákat a tőgybimbó bőrén, segít megakadályozni a negyedeken keresztüli fertőződést és több órás védelmet nyújt a fejés utáni kritikus időben.

A P3-Blu-Gard® különösen hatékony a Staphylococcus, a Streptococcus és az E.coli törzsekkel szemben.

Glicerín tartalmánál fogva kíméli és ápolja a tőgybimbó bőrét.

Toxikológiailag ártalmatlan, jód-, aldehyd-, klórmentes és nem képez maradványanyagot a tejben. A DLG által ellenőrzött és engedélyezett termék.

P3-UNISEPT® por alakú tisztító és fertőtlenítő szer

A P3-Unisept® a fejőberendezések, tejfeldolgozó berendezések egy fázisban történő tisztítására és fertőtlenítésére alkalmas nagy-koncentrációjú (alkalmazási koncentráció: 0,25% !) savas szer, melynek adagolása független a víz keménységétől.

Klór-, foszfát- és nitrát-mentes. A DLG által ellenőrzött és engedélyezett termék.

P3-ASEPTO N®

Nagy hatású lúgos fertőtlenítő-tisztítószer fejőberendezésekhez és tejhűtő berendezésekhez. Aktív klór hatására biztonságosan tisztít és fertőtlenít, tökéletesen eltávolítja a zsír és a fehérje-maradványokat, kíméli a berendezéseket, készülékeket, fékezett habzású, DLG által bevizsgált.

P3-HOROLITH N®

Savas tisztítószer fejőberendezésekhez és tejhűtő berendezésekhez, amely eltávolítja a zsír- és fehérje-maradványokat, kíméli a berendezéseket, készülékeket, fékezett habzású, eltávolítja a tejkő, mészkő- és vaslerakódásokat, fékezett habzású anyag.



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