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Editorial office

University of Kaposvár, Faculty of Animal Science

H-7400 Kaposvár, Guba Sándor u. 40.
H-7401 Kaposvár, P.O.Box. 16.
Tel.: 36-82-314-155, Fax: 36-82-320-175
e-mail: csapo@mail.atk.u-kaposvar.hu

Editorial assistants
Barna Róbert
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PROCEEDINGS
OF THE
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'ANIMAL SCIENCE DAYS'

ENVIRONMENT FRIENDLY AND EU CONFORM ANIMAL HUSBANDRY

Authors bear the responsibility for the content of their papers and also for language editing!

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University of Kaposvár, Faculty of Animal Science, Kaposvár

New alternatives in the environmental friendly animal production in Hungary

P. Horn, J. Stefler
University of Kaposvár, Faculty of Animal Science, Kaposvár, H-7400 Guba Sándor u. 40. Hungary

ABSTRACT

Authors summarise the main general features to be considered in restructuring animal production in an environmental friendly way, in Hungary dealing with the feed production, feed and water efficiency of animals used per unit product, animal welfare related controversies regarding resource efficiency and product safety, and aspects of global and regional competitiveness in the various animal production sectors. The role of ruminants is discussed as playing a significant role in restoring the sustainability of Hungarian agriculture, increasing environmental friendliness of both plant and animal production.
(Keywords: new alternatives, environmental friendly animal production, grassland utilisation, Hungary)

INTRODUCTION

Those countries known as highly developed agriculture economies have a special characteristic insofar, that both plant and animal agriculture are well developed. Without a strong and viable animal production sector it is not possible to maintain a sustainable agricultural production, it is difficult to ensure the necessary added value contribution to the national economy. At the same time sustainability by its complex nature (*Olesen et al.*, 2000) involves production chains and procedures applied which must fulfill the requirements of environmental friendliness.

The present situation of the hungarian animal agricultural sector is unprecedented in the past century. All statistical data analized, show clearly that during all peaceful periods of the 20th century (1911, 1938, 1985) the animal population of Hungary was over 3.2 million animal units (an animal of 500 kg liveweight equivalent).

Since 1990 till 1995-1996 the total animal population dropped to 1.6-1.7 million animal units, without significant increases till the present time. The dramatic reduction of the animal stocks, mainly cattle, pigs and sheep is completely atipical in our modern agricultural history, and poses a great threat for the future to maintain a sustainable agricultural production sector (*Horn*, 1997, 2000).

SOME MAIN GENERAL FEATURES TO BE CONSIDERED IN RESTRUCTURING ANIMAL PRODUCTION IN AN ENVIRONMENTAL FRIENDLY WAY

It can be stated that the environmental pressure caused by animal production in Hungary is far less as in most advanced EU countries, playing also a decisive role on the export markets within and outside Europe. This factor gives us a great flexibility in developmental strategies.

In designing future developmental programs in animal production we have to consider some fundamental conditions enhancing environmental friendliness and sustainability.

- In both quantitative and qualitative developmental programs of animal production domestic feed production should cover the great majority of the animal feeds required. Importation of feed components of smaller volume is acceptable (protein rich feeds, amino acids, probiotics, enzimes, vitamins etc). In those countries where animal production is based on significant feed imports, the manure and slurry produced in situ, poses extremely high environmental pressure as have been shown by de *Boer et al.* (1997) for the Netherlands explicitly for the macro elements N, P and K, leading to unsustainable production systems. In *Table 1* a calculation is presented published by *Olesen et al.* (2000) showing the main data regarding an environmentally acceptable, sustainable pig production in the Netherlands. Both alternatives represent significantly reduced pig output compared to the present situation.

Table 1

Sustainable pork production parameters for the Netherlands

Denomination	Parameters
Agricultural land available for feed production (ha)	285.000
Total N produced annually (million kg)	53.62
Total N need of a pig (fattening + repr.) (kg)	8.25
Manure production of a fattening pig (kg)	5.67
Fattening based on domestic feed production, sustainable pig production 6.42 million slaughter pigs/year	
Maximal sustainable pig production based on N equilibrium 9.45 million slaughter pigs/year	

Based on data published by Olesen et al., 2000

- In most countries it can be assumed with great probability that both feeds and water prices will rise in the future, therefore in all those branches of animal agriculture which have to produce great volumes of animal products in good quality (milk, table eggs, poultry and pig meat) only breeds and technological systems should be used and applied which enable us to produce a unit of product from the least amount of feed (economic optimum) and water. Better feed conversion correlates with better water conversion, both lead to reduced manure, slurry and waste water output too, thus reducing the pressure on the environment per unit product produced, contributing to improved sustainability.

  How much impact genetic improvement exerts on feedstuffs saved and manure produced in the poultry meat production is shown in *Table 2*, based on *Shalev* and *Pasternaks* (2000) calculations.

Table 2

The effect of genetic improvement per annum on feed saved and on the reduction of manure output in the poultry meat production

Denomination	Chicken broiler	Turkey	Water fowl
World production (million tons)	51.7	4.7	2.7
Population sizes (million)	22876	306	625
Annual genetic gain in live weight (%)	2.01	2.56	4.32
Feed quantity saved (1000 tons)	1113	349	258
Reduction in manure output (1000 tons)	1292	402	297
Reduction in N load (1000 tons)	23.3	7.2	5.3
Reduction in P_2O_5 load (1000 tons)	14.2	4.4	3.3
Reduction in K_2O load (1000 tons)	8.4	2.6	1.9

Based on data of Shalev and Pasternak (2000)

Annual genetic gains reduce feed consumption by 1.720.000 tons, and reduce manure output by 1.991.000 tons on a world wide basis in the poultry meat production sector. Both efficiency improving indicators contribute to environmental safety and thus enhancing sustainability.

- A certain controversy and new challenges are facing those engaged in animal production in Hungary as EU animal welfare regulations require changes in managemental-technological systems mostly affecting the pig and even more so the poultry production sector. The dilemma seems to be the greatest in egg production, as most producers use battery cages, applying relatively high density cages with small group sizes. In most EU countries where so called alternative systems of egg production and meat chicken production are already used more extensively, more and more informations are known, most of them reporting higher mortality, new health problems in the flocks (increased parasitic incidences, cannibalism etc). Litter and partly free range managemental more extensive systems are associated with lower feed and water efficiency, increased environmental pressures. Recently both in the egg and broiler meat production increased incidence of risk factors occur endangering the general aspirations to match the more and more strict food safety regulations. In the next future the so called animal welfare oriented technological-managemental systems in poultry production have to be examined more carefully from the aspects of food safety and also on their direct and indirect effects on the health of the people working with the flocks.

  It seems however very probable that under more extensive managemental conditions in poultry meat production new genotypes have to be developed, and the much better environmental adaptability of the female sex compared to males will become of great practical importance, as the sex x nutritional and sex x rearing environmental interactions are of great significance in growth and meat traits and also in viability (*Horn*, 2001) both in turkeys and broiler chicken. Under more extensive nutritional and rearing conditions the females of the presently used commercial broiler and turkey breeds can express their inherent growth and meat producing potential significantly better compared to males.
- We think a fairly clear distinction has to be made between the various branches of animal production in that respect, how much pressure globalisation, or “regionalisation” including only the EU and neighbouring countries will put on production.

The most severe competitive pressure has to be faced in the pork, broiler chicken, and turkey production, strong “regional” competition in the milk and table egg, partly so in beef and mutton production.

In all the previously mentioned branches of animal agriculture the main “border conditions” outlined previously have to be considered seriously in planning future strategies. Much more freedom – due to less globalized competitive pressures – in choosing breeds, feeding and managemental technologies to be applied will be practicable in waterfowl, rabbit, horse, game animal, and fresh water fish breeding and production.

Special market niches and ecological conditions will allow also to develop or maintain specific breed x managemental combinations in beef, mutton even pig, chicken or turkey production. It should be considered however that even small specific market niches require not only a stable high quality, but a stable continous supply too. High quality means also sufficient quantity.

ROLE OF RUMINANTS IN AN ENVIRONMENT FRIENDLY ANIMAL PRODUCTION

Considering the special nutrient requirements and physiological characteristics of ruminants consuming mainly roughage type biomass, and producing a relatively large quantity of manure, their role is important to preserve an ecological balance, and to maintain a sustainable agricultural production.

Naturally to ensure environmental friendliness and sustainability of production animal density has to be kept within strict limits considering eco-geographical and environmental conditions.

In Hungary cattle is the dominating species among ruminants. International statistical data indicate, that the proportion among ruminants cattle are predominant where grasslands are abundant serving as main feed source. This typical situation is characterising countries or regions where human population density, is low, pastureland dominates. These countries play a decisive role in beef production (*Table 3*).

In Western Europe, mostly highly populated, housing of cattle is typical, and the cattle population per unit of agricultural area is high. Under those conditions to maintain the environment friendly character of cattle production needs large efforts to be successful. Major rule to be considered is, to limit the number of animals kept per unit area to prevent overloading the environment.

Hungary is transitional between the types, it is closer to overseas countries regarding cattle density. The available grassland area, the special features of arable crop production (grain and corn-belt type area) would enable us to maintain a significantly higher cattle population easily without any danger of jeopardising environmental safety or sustainability. Despite these obvious facts, - due to the great decreases in ruminant animal populations during the last decades the utilisation of our grasslands decreased by 50% (*Table 4*).

As the non-utilised grassland increased, deterioration of the environmental condition increased (erosion, unfavourable changes in plant species composition, increased wheed surfaces etc). To maintain grassland biotopes in healthy condition repopulation of those areas by grazing species is unavoidable in the future, to increase environment quality by an environment friendly animal production. In this respect not only cattle and sheep, but also meat type horse and farmed deer species may have to play a significant role (*Table 5*).

Table 3

The characteristics related to the cattle breeding in some Central European Western Eruropean and Overseas countries

Country	Acreage in 1000 km^2	Density of population (person/100 ha of agricultural area)	The percentage of grassland to the total area	Density of cattle population in 100 ha grassland	Percentage of beef cattle
Hungary	93	168	13,5	67	5
Poland	312	206	13,4	194	3
Bohemia	78	241	11,0	125	8
Slovakia	49	218	12,0	116	9
Rumania	238	252	19,2	69	2
Denmark	43	193	14,0	322	7
Great Britain	40	343	47,1	102	37
France	244	192	23,8	154	34
The Netherlands	551	770	35,5	321	1
Germany	357	471	21,1	212	9
Italy	301	365	17,2	136	21
USA	9.363	61	26,8	12	76
Canada	9.970	39	2,6	49	66
Argentína	2.780	20	52,0	35	83
Brazília	8.512	65	20,1	89	68
South Africa	1.221	42	65,5	13	86
Australia	7.741	4	59,3	6	71

International Statistical Yearbook, KSH, 1998

Table 4

Change of ruminant livestock and utilization of grassland

Denomination	1935	1950	1960	1970	1980	1990	2000
Grassland, 1000 ha	1.615	1.475	1.438	1.281	1.294	1.190	1.148
From that:							
hervested, %	40	40	40	35	33	30	27
grazded, %	60	60	45	30	35	30	28
unitilized, %	0	-	15	35	32	40	45
Ruminant livestock unit							
Cattle (unit)	1.507	1.777	1.577	1.546	1.534	1.571	868
Sheep (unit)	103	74	169	215	219	128	89
Ruminants (unit)	1.612	1.852	1.746	1.761	1.753	1.699	957
Change compared to 1950		100	94	95	94	91	51

Table 5

Possiblities in the trend and measure in the development of grassland based animal production

Denomination	2000	2005 (expected)	2010 (expected)	Dimension of change
Ewe population				
Number (thousand)	965	1200	1600	+535
Grass requirement (thousand ha)	250	400	700	+450
Beef cattle				
Number (thousand)	25	130	230	+205
Grass requirement (thousand ha)	30	200	400	+370
Growing cattle Hefer replacement				
Number, (thousand)	180	230	320	+140
Grass requirement (thousand ha)	110	140	200	+90
Dual purpose cattle (Hungarian Simental)				
Number (thousand)	70*	50	50	-20
Grass requirement (thousand ha)	50	50	50	0
Alternative grass utilizating species (meat horse, deer, goat etc.)				
Number (thousand)	10	20	40	+30
Grass requirement (thousand ha)	10	20	40	+30
Grass requirements of grazing live stock (thousand ha)	450	810	1390	+940
Hay requirement of non grazing animals (sport horse, dairy cow) (thousand ha)	200	200	200	0
Utilization of grassland, %	55	65	80	+25

**One part of animal keepers will give up milking and change for beef cattle*

Unfortunately present agricultural supporting schemes do not enhance developments in the previously mentioned directions, and they will probably not coincide with possible quota systems under negotiations with the EU.

In cattle production a healthy process took place in the last decade, as liquid manure almost totally disappeared from cattle farms. More than 80% of cattle is untied in resting boxes, more and more deep litter is predominating. In these straw based managemental systems, manure handling is environment friendly. The large grainland areas lead to “straw richness”.

To increase the ruminant population would be also beneficial because of their larger high quality manure output. Present calculations show that for a healthy, sustainable and environment safe arable crop production, we would need 5-6 times as much good quality organic manure compared to the amount we at present produce and use. On the other hand at present we utilise only 20% of the grain straw and corn stalk as litter for cattle and other livestock (*Table 6*). A new equilibrium is needed in the future.

Table 6

Relation between the number of ruminants and plant poruduction

Denomination	Area (million ha)	Seed crop (million ton)	Straw/stalk (million ton)	Manure required for arable crops (million ton)
Arable land	4.5			45
Grain	1.6	6.6	6	
Corn	1.2	7.8	25	
Requierement of ruminants (litter)			1.2	
Corn stalk consumption of beef cattle			0.03	
Manure production of ruminants				6

Model calculation based on data provided by the Hungarian Statistical Office, 2001

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Corresponding author:

Péter Horn
University of Kaposvár, Faculty of Animal Science
H-7401 Kaposvár, P.O.Box 16. Hungary
Tel.: 36-82-314-155, Fax: 36-82-320-175
e-mail: steflerj@mail.atk.u-kaposvar.hu

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

The future key players in environment friendly farming and animal welfare based on new legislation in Croatia (A review)

V. Rupić, B. [1]Antunović, T. [1]Florijančić
University of Zagreb, Faculty of Agronomy, Zagreb, HR-10000 Svetošimunska 25., Croatia
[1]University of J.J. Strossmayer, Faculty of Agriculture, Osijek, HR-31000 Trg Svetog Trojstva 3., Croatia

ABSTRACT

There is a high demand of nowdays civilization for producing huge amounts of different kinds of food from agriculture. Pressure of competition between producers forces them to produce in the most economic and efficient way. They are trying to follow these trends by going into intensive farming, which opens many questions about environment friendly animal husbandry and animal welfare as well. On the other side, we can find increased care about consumers covered by EU (European Union) standards where many consumers are ready to pay more for the same product if it has clear history that starts from the field itself. Still, Croatia remains, for now, the part of the World where most consumers prefer cheaper price of food instead of clear history, which allows producers to think in their economic way. Recently, Croatia has brought new legislation concerning this topic in order to prepare itself for joining EU. Therefore, we can expect in next few years firm interaction between key players in farm animal welfare: consumers, farmers, food retailers, media, politicians, vegetarians, welfare campaigners and farm animals itself. Scientists are going to be involved in this power struggle as well with everyone's expectation to contribute objective investigations and researches. This paper analyses how much the Croatian standards are confirmed by those from EU, goals, strengths, possible weaknesses, opportunities and dangers faced of different key players, as well as scientists' role in this power struggle, which will continue until the players see the mutual benefit of balancing conflicting interests.
(Keywords: key players, environment, animal welfare, legislation, Croatia)

INTRODUCTION

From the time of establishing its independence as a country in 1990, the main strategic goal of the Republic of Croatia has become to get closer and step-by-step involve into the European integration processes. One of the most required preconditions being postulated by the countries that already are the members of the EU (European Union) is adjusting the complete legislation of countries candidates. This refers to the strict regulations concerning ecology, and, within it, animal welfare as well.

EUROPEAN UNION DIRECTIVES AND DEMANDS

EU (European Union) started its job on legislations concerning animal welfare more than 25 years ago. Documents having being issued by EC (European Council) from that time oblige legislators from national governments, primarily the EU members, but also the candidates for joining EU, to adjust their regulations and, what is more, to issue even higher standards. Responsibility for EU legislation is in hands of the *Directorate General for Health and Consumer Protection*, which is covering three huge aspects:

- Farm animals' protection (EEC, 1978, 1988a; EC, 1997d, 1999, 2000, 2002),
- Protection of animals during transport (EC, 1991a, 1995, 1997c, 1998b, 2001),
- Protection of animals while being slaughtered (EEC, 1988b; EC, 1993).

One of the first regulations about keeping farm animals was presented as a *Councle Directive on the approximation of laws, regulations and administrative provisions of the Member States regarding the protection of animals used for experimental and other scientific purposes* (EEC, 1986). Subsequently, a more concrete directive named *Council Directive of laying down minimum standards for the protection of calves* (EC, 1991b, 1997a, 1997b) was issued. *Council Directive concerning the protection of animals kept for farming purposes* (EC, 1998a) still presents general regulation about protecting all species of animals being raced for producing food, wool, leather, fur or for other purposes, including fishes, reptiles and amphibians. These regulations are based on the conclusions of the *European Convention for the protection of animals kept for farming purposes* (EEC, 1978) and accepted by *Farm Animal Welfare Council*, which is competent for establishing standards about animal welfare on farms, during transport and in slaughtering units. This Directive points out the importance of "five freedoms":

- "Freedom from hunger and thirst" that is to ensure free admittance to fresh water and food required for full health and vitality;
- "Freedom from discomfort" that is to ensure adequate environment with shelter and adequate and comfortable stalls;
- "Freedom from pain, injures and diseases" regulates prophylactic measures and quick therapy;
- "Freedom to express normal behavior" insures adequate space and facilities, and company of the animals own kind;
- "Freedom from fear and stress" is describing conditions and treatment required to avoid mental suffering.

Such an incorporated legislation that takes care about preconditions for animal welfare, especially concerning animals kept on farms, is giving minimal standards according to which national governments should accept most of the strict regulations defined by EC in five conventions covering international transport, animals for breeding (especially those on farms), animals for slaughtering and laboratory animals and pets.

ADJUSTMENT OF CROATIAN LEGISLATION

Republic of Croatia has announced its serious willingness for joining the countries candidates for becoming EU members in aspects of ecology and animal welfare by signing and accepting *Council Directive on the protection of animals at the time of slaughter or killing* (EC, 1993) and *UNECE (United Nations Economic Commission for Europe) Convention about accessing to informations and participating of public opinion in forming decisions about environment* (UNECE, 1998). Currently, the *Convention about international transport of animals* is in preparation (Ministry of agriculture and forestry, in preparation). Croatia has even given its concrete contribution to the *International Conference on the Domestication of the Bluefin Tuna* by presenting *Regulation on protecting tunas* (*Katavić et al.,* 2002a). This data gains in importance taking in account the fact that Croatia is "by the sea" country with rich fish fond, especially tunas (*Thunnus thynnus* L.) that are being produced in still ecologically preserved Adriatic Sea (NN, 1999a; *Katavić et al.,* 2002b).

According to above-mentioned legislation, the Croatian Parliament has presented a list of new statutes that are controlling this problematic and in high degree respect and accept important regulations from EU conventions and directives.

One of the first and basic acts was the *Statute on protecting environment* (NN, 1994), which was in order to reduce life and health threatening risk to people and insure and improve life quality for the benefit of current and next generations. The basic aim and purpose of this Statute is long-lasting protection of biological variability of natural populations and protection of ecological stability as well. To emphasize, and in this way to stimulate protection of animals, subsequently the *Statute on animal welfare* (NN, 1999b) was presented. This Statute determines animal welfare concerning the ways of keeping animals, their housing, feeding, as well as their protection and attitude toward them. Concretely, the following aspects are discussed in the Statute: protection of animals during breeding, protection of animals during treatment and zootechnological measurements, protection of animals while being slaughtered; protection of animals during transport, protection of companion animals, wild animals in nature, animals in zoos, circuses and exhibitions, abandoned and starving animals and animals for experimental purposes and other scientific investigations.

Furthermore, some of the following "professional" statutes have incorporated regulations that are to pay attention on environment protection and animal welfare.

- *Statute on veterinary medicine* (NN, 1997b, 2001d) is discussing animal health protection and measures that have to be done in cases of occuring of specific deseases, but speaks also in undoubtfull and direct way about veterinary role concerning animal welfare. The accent is put on protection of animals from mistreating, suffering and pain during any kind of manipulation (breeding, transport, experiments, slaughtering etc.). The Statute determines subsequent statements:
  - Every animal owner must treat animals in human way and protect them from sufer and pain, as well as require veterinary help on time;
  - Proper veterinary help and care has to be provided to sick or injured animal as soon as possible, except if disease or injure is such that animal has to be anaesthetized immediately;
  - Stalls and buildings where the animals are kept in have to be suitable to belonged to species and categories of animals and equipped in the way to satisfy their biological needs;
  - Animals have to be provided with free access to hygienically proper food and drink;
  - Scientific researches and experiments on animals can be provided only in medical, veterinary, pharmacological and other health institutions and animals must not be exposed during experiments to torture and suffer.
- *Statute on animal husbandry* (NN, 1997a) is determining the way of breeding and producing of "in breeding way" valuable animals, artificial insemination of animals, market with "in breeding way" valuable animals, required hygienic conditions for keeping domestic animals, environment protection in breeding and exploitation of domestic animals, quality of fodder and animal products, organization of raising "in breeding way" valuable animals and other questions important for efficiency and improvement of animal husbandry.

- *Statute on ecological producing of agricultural and food products* (NN, 2001a) is determining ecological production of agricultural products and food, processing in ecological production, market with ecological products, unprocessed vegetable and animal products and products partially or completely composed of such pre-products, ways of marking in ecological production, providing professional and inspective supervision and other questions important for processing unique system of ecological production. The purpose of this Statute and ecological production is protection of people and animal health, protection of nature and environment and protection of consumers.

THE LATEST SUB-LEGISLATIVE REGULATIONS IN CROATIA – ONE STEP CLOSER TO EU DEMANDS

As it could be seen if read in details, mentioned statutes are not enough worked out concerning some questions about ecology, particularly in the sense of protecting environment, animal welfare and ecological production and processing of provisions of vegetable and animal origin and the need for revising by introducing sub-legislative regulations is obvious. In this purpose, some ministerials (Ministry of agriculture and forestry, Ministry for protecting environment and area arrangement etc.) presented in last and this year, and on the base of mentioned statements and following world and especially European legislative trends in domain of ecology, package of sub-legislative regulations, trying in this way to make preconditions for implementation of signed obligations from European conventions and directives:

- *Regulation on conditions and ways of transporting animals* (NN, 2001b) – determines general and special conditions for transporting animals, ways of transporting, obligations of transporter, international transport and supervision above this Regulation in praxis. It covers transport of ungulates, cows, sheeps, goats, swine, poultry, domestic birds, rabbits, other mammals and birds, other vertebrates and cold-blooded animals;
- *Regulation on conditions that have to be fulfilled by shelters and hygienic services for animals* (NN, 2001c) – determines conditions that have to be fulfilled by shelters and hygienic services for animals concerning accommodation, way of building, technical arrangement, equipment, way of working, veterinary and sanitary reqirements and hygiene;
- *Regulation on processing in ecological production* (NN, 2002e) – determines and describes additional matters and other products of non-agricultural origin, as well as products of agricultural origin that are not being produced in ecological way but involve components, additives and additional matters that are alowed for usage in processing of provisions for human and animal usage;
- *Regulation on processes and conditions to acquire the symbol of ecological product* (NN, 2002d) – determines processes and conditions to acquire the symbol of ecological product, way of its assignment, as well as shape and content of symbol, which is being given by the Ministry of agriculture and forestry for one producing year;
- *Regulation on declaration of eco-product* (NN, 2002a) – determines the shape and content of declaration used for marking ecological products;
- *Regulation on ecological production in processing fibers* (NN, 2002b) – determines rues, procedures and normatives concerning production from row cotton, wool, hoofs, silk, flax etc.

- *Regulation on conditions and way of registering in registration books about eco-production of agricultural and food products* (NN, 2002g);
- *Regulation on professional supervision in eco-production* (NN, 2002f) – determines way and methodology of supervision of ecological production through so-called supervision units;
- *Regulation on ecological production of animal products* (NN, 2002c) – for sure is the most important regulation from this package. It is separated in four basic parts: general rules, animal husbandry, apiculture, fishery and aquaculture. The Regulation determines minimal zootechnological requirements in animal husbandry, aquaculture and in ecological production of animal products, and involves rules, technics and certain normatives in breeding of domestic animals, plans of production unit, conditions of transitional period, species and breeds of animals, way of keeping animals, requirements in reproduction, feeding, care, treating, slaughtering and transporting animals. Ecological production of animal products is a part of total agriculture production, whithin which harmony of producing sistems in agriculture has to be ensured. There should be an aspiration to breed and naturaly exploate healthy, resistant and to people usefull animals that are addopted to conditions of breeding area. Also, breeding and exploatation should be as much as possible based on the lowes of nature with keeping each animal in as much as it can be natural environment with ensured ecological conditions. This regulation is a concrete sub-legislative act that respects the hugest part of things mentioned in EU legislation. However, one of the majour shortage is consedered to be omitting wellfare of reptiles and amphibians.

The value of this new legislation is huge because it introduces in Croatian economy term “ecological product” that much differs in its technological and producing concepts from up to the present classic agricultural products. It is to be presumed that very few products will fulfill mentioned requirements, but it is also for sure that products that will gain declaration “ecological” will really be ecological.

By presenting the package of sub-legislative acts in domain of ecology, legislation of the Republic of Croatia has approached strict legislation presented by EU Council. Still, some questions have to be worked out in more details. Therefore, it is necessary to work further on bringing new, more concrete and detailed regulations, but also to make preconditions in praxis, so that extended legislative and sub-legislative regulations could be efficiently implemented on place.

THE FUTURE KEY PLAYERS IN CROATIA – WHAT CAN WE EXPECT TO HAPPEN?

The period when new legislation is being introduced to some country causes increased interactions between sides that are directly involved in new events. By recognizing each side’s goals, strengths, possible weaknesses, opportunities and dangers faced, as well as characteristics of Croatian animal husbandry and its market, it is possible to predict the subsequent events.

When we think about the key players in the power struggle that will happen in Croatia in next years by putting demands of EU legislations to Croatian low and praxis, we have to start from *animals* themselves, apart from the fact they should serve to the peoples’ pleasure, not opposite. Their goals are very simple and could be reduced to three points: to live, to express natural behavior and instincts and to suffer not more than necessary. Their interesting and unique life forms get peoples’ attention and in peoples’ nature is to feel compassion for vulnerability and innocence that easily could be found in animals. However, they are often abused and exploited by those who are not taking responsibility for their inner emotions and issues and limited means of communication and mental differences put animals in subordinate position. Therefore, it is important to influence people to meet needs of animals as their own and to fight against lifestyle determined by ignorant and insensitive people.

Farmers are the second key players with the goals to enjoy an occupation of raising livestock and providing material security for their families. Family properties will very possible become the important production source for some products in Croatia (e.g. milk). Because of their close contact to animals through previous practical experience of livestock needs and practical feeling of economic realities, they will accept more easily new legislative about animal welfare than big producers. To make their position easier, farmers should communicate their situation more effectively to consumers and discuss and work with welfarists rather then condemn them. The biggest dangers they will be faced to are increased costs of high welfare and ecological farming and competition from global trade.

Food retailers are the third link in chain with main goals to enjoy the occupation of food retailing, to increase revenue from food sales and to decrease customers' complaints. The position between farmers and consumers make this group more independent of farmers and welfarists' pressure groups. This group could easily become ignorant of farming methods and reluctant to be involved directly on farms. However, the pressure from consumers and new legislation will force them to ensure that quality assurance schemes are effectively policed and to mediate between farmers and consumers. In this position, food retailers could be caught in the middle of conflicting pressures, which is considered to be the biggest danger for them.

Consumers are the most influencing key players because they have voting, purchasing and complaining power. However, because of insensitivity to needs and problems of farmers, as well as inexperience of farm animals and farm economies, marketing, media, their emotional reactions and ideologies could easily mislead them. Consumers can express their willingness to pay more for high welfare product, but hypocrisy through supporting high welfare but buying cheap low welfare product is very possible. Because of the big power of these key players, they can easily make confusion and chaos from conflicting informations and views, as well as demand impossible from farmers and food industry.

The special kind of consumers are *vegetarians*, who can be placed as a separate group of key players. Some of them (militant) have a goal to discourage others from eating meat. Usually, members of this group have strong personal convictions and self-discipline, but because of relatively small percentage in society, their power is not strong enough. However, because of similar views on animal farming, their interests are very often overlapping with those from welfarists.

Media (press, radio, TV) will play very important role in the future because of its influence on the most powerful and numerous key players, consumers. Their goals are to provide informed comment and news on public issues and to maintain and increase number of readers, listeners or viewers. Because of the temptation to sensationalism and to inflame conflict and passions, as well as lack of experience and understanding of farming, media can produce scandals that could be productive or contra-productive. To make them productive, it is important that journalists present balanced and factual comments from all the players and to provide constructive rather than destructive forum.

The demands from *welfare campaigners* can be reduced to one main – to improve quality of life for farm animals. They feel sensitivity and compassion for suffering and are lead by moral "high ground": "Do as you would be done by!" However, they can easily become insensitive to the economic difficulties of farmers and release subjective approach. The positive approach should be to awaken farmers' and public awareness of animal suffering and to encourage action, as well as fight ignorance and insensitivity, but on the way to dialogue and work with farmers rather than condemn them. Otherwise, welfarists could easily become lead by anthropomorphism with not being able to recognize that animal needs may differ from human. In order to avoid suffering to animals, they could in this way cause suffering to farmers and their families.

Politicians are involved as key players because of their ability to institute or threaten legislation. However, their goals are also to represent public interests, to contribute to the nation's economic and moral welfare and to maintain and increase support of voters. The last one could become dangerous if decisions are being made on the base of number of possible voters. To make their position productive, politicians should encourage dialogue, collaboration and mutual respect between opposing interests and bring players together to work out balanced and mutual solutions.

SCIENTISTS' ROLE IN THIS POWER STRUGGLE

Taking in account all mentioned goals, strengths and opportunities, it is obvious that we as *scientists* will be caught in this power struggle by many questions to be resolved, with everyone's expectation to contribute objective investigation and research. There is also a question of how high can degree of objectivity be if research is founded by one side of this struggle. Furthermore, welfare questions cannot be resolved by science alone. However, we can foster objective understanding of livestock' needs, analyze dynamics of welfare issues and devise economic and practical ways of meeting livestock needs taking in account emotional components of welfare issues.

Whichever course this power struggle between different key players will take in Croatia in the future, it is for sure that it will continue until they see the mutual benefit of balancing conflict interests and we as scientists are here to help them to get through this transitive period by providing them with objective informations.

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Corresponding author:

Boris Antunović
University of J.J. Strossmayer, Faculty of Agriculture
HR-31000 Osijek, Trg Svetog Trojstva 3., Croatia
Tel.: 385 31 224 285, Fax: 385 31 207 017
e-mail: bantunov@suncokret.pfos.hr

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Adaptation of slovene livestock to environment friendly animal husbandry

J. Osterc, S. Čepin, I. Štuhec, J.[1]Jurkovič
University of Ljubljana, Biotechnical Faculty, Zootechnical Department, Domžale, SI-1230 Groblje 3., Slovenia
[1]Emona Farma Ihan, Domžale, SI-1230 Breznikova cesta 89., Slovenia

ABSTRACT

Environment friendly animal production is considered as the best production due to the natural conditions in Slovenia. Small farms, on average having 5-6 hectares are the main holders of Slovene agriculture. These small scale farms are oriented to animal production, where ruminants prevail. The prescribed number of animals per hectare of land for feedstuff production regarding European and Slovene legislation enables environment friendly methods of husbandry. In Slovenia there are eight large scale pig farms that produce 2/3 of fattened pigs for the market. On five smaller pig farms, slurry is applied on their own fields and on the fields of surrounding family farms. On three larger ones the slurry is separated and as concentrated organic fertiliser transported to the more distant fields. The remaining part of the slurry undergoes further processing. On one of the farms anaerobic rotting of slurry is performed, where the formation of bio-gas is used to provide electricity. Poultry manure is mostly used on the fields, only a smaller part as concentrated organic fertiliser. In Slovenia we are in the process of adaptation to the legislation which is in line with EU regulations and which provides minimal animal protection requirements in livestock production.
(Keywords: Slovenia, livestock, sustainable agriculture, legislation, practical use)

INTRODUCTION

The Republic of Slovenia belongs to the group of countries which have a very diverse relief and very different quality of agricultural land, both representing rather unfavourable conditions for intensive animal production. Two thirds of the farmland in Slovenia is spread on areas with such conditions, therefore it is difficult to organise intensive animal production without harmful effects on environment. Steep mountain slopes do not permit the usage of powerful mechanisation, and fragmented patches of land do not allow cheaper technologies, such as pasture. Small farms in these regions have to rely on production that can give best results in such limited conditions. Animal production proved to be one of them, enabling farmers to improve their income per land unit. However, small farms are the obstacle for more prosperous larger herds, and thus cheaper production on one hand, but on the other, they are the representatives of the picturesque and attractive Slovene countryside. They are also important for the development of tourism, offering additional employment, and promoting their farm goods by selling them to tourists. Home made farm products will be, as expected, even more appreciated when sustainable farming is introduced in these areas (*Osterc*, 1997).

Additional problem for the Slovene agriculture represents the karst, covering at least one third of the land. Underground world of the karst, and its permeable ground do not allow industrial methods in animal production, neither the maximal level of fertilisation with animal manure, otherwise accepted in normal farming conditions.

In Slovenia there are few cultivated fields, only 0.08 hectares per capita, where grains for human nutrition, and concentrates for animal feeds can be produced. For this reason we produce less than half of grains for animal feeds, so more than half have to be purchased. The purchase of grains also means the purchase of many plant nutrients, which end up in manure. Inadequate usage of manure can therefore be a great burden to the land and harmful for the environment.

The mentioned factors are the main reasons why we consider environment friendly livestock production as the only real possibility for Slovene agriculture. After our independence in 1991, when we got our own state, we started to adapt the Slovene livestock production to sustainable production, which is at the same time environment friendly and also kind to animals (*Osterc*, 1998, 1998a). In the last decade a lot has been achieved, but we still have a lot of work in this respect.

THE STATE OF FACT IN SLOVENE AGRICULTURE

Slovene agriculture is dispersed. More than 90% of farmland is private in the possession of farmers, the rest is state owned, often given to farmers on lease. Private farms, also called family farms, are small (*Table 1*).

Table 1

Number of family farms in Slovenia; size structure in the period from 1991 to 2000

Year	No. of farms	Size of farms – ha ALU** (% rate)				Average size (ha)	
		Up to 2	2-5	5-10	Over 10	All the land	ALU
1991- ECF*	111951	34.1	36.5	21.8	7.6	7.8	4.1
2000	86336	26.6	35.2	25.6	12.6	...	5.3

*Source: SURS, 2000; Agricultural inventory 2000 – Data for April 2002; *European standard comparable farms; according to census 1991; **Agricultural land in use*

Data in *Table 1* also tell us that the number of farms in the last decade dropped for as much as 25615, or 22.9%, or 2.5% at yearly level. On average (9 years) 2846 farms were abandoned, which means that as many as 7 to 8 farms disappeared each day. According to the 1991 census on farm heritage and data on development ambitions on Slovene farms, *Kovačič* (2002) states that there are about 40% of farms, which are going to die out as production units with the flow out of the current generation. It is expected that in regard to this prognosis, the approximate number of 112000 farms (1991) will be reduced to 67000 by the year 2010, which also means that each year 2200 to 2300 farms will disappear. Furthermore, we can expect this process to be equally, if not even more intense in the next ten years, especially if we bare in mind the coming strict economic conditions. This means that by the year 2010 there will only be about 60000 farms left in Slovenia.

However, the decrease in the number of farms contributes to the improvement of size structure, which can be seen in *Table 1*. The presented data clearly shows the rising trend in size group above 5 hectares of farmland in use, and a falling trend in the smaller size group. Additionally, the average size of farms, measured in ha ALU, increased for as much as almost 30%. Similarly, the percentage rate of farms with over 10 ha of ALU increased 66% in the last decade. But, there are still 87% farms cultivating less than 10 hectares of farmland. If the current trend of farm disappearance continues, the average functional size of farms may increase to close to 7 hectares of farmland. Compared to other European countries this does not contribute to the improvement of ownership structure.

According to *Kovačič* (2002) there are mostly cattle farms in Slovenia. In spite of drastic reduction in the number of farms in Slovenia, the number of cattle in the republic decreased only 10% in the last ten years. The remaining farms increased the number of cattle. Here, cattle production relies on feedstuff that is produced on the farms. Farmers are buying only the concentrates as the addition to the basic ration. On the majority of farms, milk production does not exceed 6000 kg of milk in lactation, therefore the additionally purchased concentrates in the ration also do not attain over 20% of dry matter. This means that the additionally purchased plant nutrients equal the amount of nutrients sold from the farm as animal products. Careful balance of nutrients enables these farmers to make the plant nutrients circle complete. This way they avoid overloading of environment with harmful plant nutrients.

Cattle – dairy cows and fattening bulls are produced also on farming enterprises which developed from the former state combinates and cooperatives. Here, the size of herds is adapted to the available agricultural land, so that all cattle manure is used on their own fields.

Sheep and goats – are also kept on farms, mostly depending on the available farmland. In the last ten years the number of sheep increased five times, and the number of goats three times. According to the statistical data there are about 100000 sheep and more than 22000 goats in Slovenia at present (*SURS*, 2002).

The situation is somehow different in the case of pig production. Close to 40% of pork is produced in Slovenia on eight large pig farms. Very large are three pig farms, where 60000 to 80000 fattening pigs can be produced on each of them annually. Most of the large farms have a problem of not having adequate farmland, where pig feedstuff could be produced. One of these farms is even without any farmland. It has to be mentioned that about 12.5% of the separated slurry is accepted by family farms close by and applied to their fields. Large farms are strongly or entirely dependent on feed purchase. Such high concentration and no farmland is a consequence of past industrialisation of Slovene agriculture. Today it represents a great obstacle in the efforts of adaptation to ecological requirements in livestock production. This problem was the reason why Slovenia made the decision in 1985 to abandon building of large scale pig farms, and rather promote pig production on small scale family farms. Currently, close to 60% of pork is produced on family farms. According to the analysis of 730 pig farms, we are talking of larger family farms with 8.9 hectares of their own farmland and 5.2 hectares of the land on lease (*Pribožič-Kramar*, 1999). About 125 pigs of all categories are produced here. The average animal unit (AU) / ha is 1.3 AU of pigs, or 2.0 AU of all animals per one hectare of the agricultural land. Self-supply of pork in Slovenia varies between 70% and 80%.

Poultry production is well developed in Slovenia. Poultry meat is produced much above the market needs. There is also enough turkey meat and hen eggs. The main part of poultry production is organised by three large enterprises. At the moment they are in the process of organised joined production. Heavy concentration of animals at one place is not a case here, because the mentioned enterprises organise the production through cooperative farmers, who also have enough farmland for poultry manure to be utilised.

ADAPTATION TO ENVIRONMENT FRIENDLY LIVESTOCK PRODUCTION IN SLOVENIA

Legislation and other regulations

By signing the Agenda 21 in Rio de Janeiro in 1992, Slovenia is, like other countries in this project, obliged to put all the efforts to the sustainable development in agriculture. Because of this agreement, and because of the previously mentioned sensitive environmental conditions, Slovenia joined the process of preparation and acceptance of legislation and other provisions which promote sustainable agriculture, and as such, also the sustainable livestock production.

In the year 1993 the Slovene Parliament adopted an important document "Strategy for Agricultural Development in Slovenia". With this document Slovenia accepted the obligation to develop its agriculture mostly on family farms, because here the principles of sustainable agriculture and thus eco-social development could best be implemented. Further to this, the agricultural principles of EU countries are stated in the mentioned document.

Following was the preparation and adoption of certain documents, representing the basics for the implementation of sustainable principles in Slovene livestock production, at the same time adapted to EU legislation.

Environment can be seriously threatened by unsuitable usage of animal manure, in regard to time and the amount. This is why the document "Provisions on application of dangerous substances and plant nutrients to soil" was accepted in 1996 (*Uradni list RS*, 1996, *Ministrstvo za okolje…*, 2000). This provision states maximal levels of plant nutrients permitted to be applied to the soil by using animal manure, annually. These levels are as follows: 210 kg nitrogen, 120 kg phosphorus – expressed as P_20_5, and 300 kg potassium – expressed as K_20. The prescribed levels allow farmers to have 3 animal units (AU, or 1500 kg live weight of cattle) per hectare of farmland, or 2 AU pigs, or 2 AU poultry. This provision also prescribes the most appropriate time for the application of separate fertilisers. If single economies do not have enough land for the utilisation of animal manure, they have to organise the acceptance of surplus by other owners or users of agricultural land, or they must organise reproduction and marketing of surplus manure. In 1996 the "Environmental Protection Act" and "Act on Veterinary Practice" were adopted, both discussing the problem at some places. In the same year the "Convention on Animal Biodiversity" was signed, and on the base of this document, "Gene Bank in Animal Husbandry" was founded. The latter presented grounds for the research project "Preservation of Autochthonous Farm Animal Breeds in Slovenia". Today, the research includes 18 autochthonous breeds of eight domestic animal species: 3 horse breeds, 1 cattle, 1 pig, 4 sheep, 1 goat, 1 poultry, 1 Carniolan honeybee, 1 Marble trout, and 5 autochthonous dog breeds (*Šalehar et al.*, 2001).

"Animal Protection Act" was adopted in 1999 and lays down some ethological and ethical requirements for animal production.

A decree from 1996 was completed and adapted in the year 2000 with the "Guidelines on Good Agricultural Practices in Regard to Fertilisation" (*Uradni list RS*, 2000), where the exact instructions on storage and usage of animal manure are presented.

We also have to mention the important document "Rules and Regulations on Ecological Production of Farm Goods, Mainly Foodstuffs", where the rules for animal production are included.

Of large importance for the development of sustainable livestock production is in the year 2002 adopted "Act on Animal Husbandry" (*Uradni list RS*, 2002), dealing with exact methods for the sustainable livestock production, providing also the basics for financial support in different sustainable livestock production practice.

We have listed the most important provisions and guidelines, adapted to similar acts and documents in EU, and presenting the foundation for sustainable, environmental and animal friendly production. The mentioned documents enabled the acceptance of “Agri-environmental Programme of Slovenia” (SKOP) in 2001 (*Ministrstvo za kmetijstvo…*, 2001). It promotes the agricultural practice focused on its environmental function. Livestock production is part of agriculture therefore it will gradually adapt to the regulations on environmental protection. The adaptation will, no doubt, reduce negative and retain positive effects of livestock production on the environment. According to the programme, farms that will reduce animal density to 1.9 AU per hectare of farmland will get direct payments, as will farms, introducing one of the sustainable livestock production methods. Furthermore, direct payments are going to be provided for farmers who will start with mountain pasturing, as well as those, who will take over the production of autochthonous and traditional animals. SKOP has started the experimental period last year, and is expected to be fully practised by the year 2006.

ADAPTATION OF SEPARATE, ESSENTIAL ANIMAL SPECIES

As we have mentioned, the usage of animal manure is most dangerous for the environment, if inadequately used. Among different substances, nitrogen is the most threatening, because in bigger quantities it can be washed into the soil and can spoil underground natural water reserves. Other substances are just as dangerous, especially if they reach rivers, lakes, etc in bigger quantities. This is why we are going to present the adaptation efforts for separate, more important animal species. Methods for solving the problems on animal manure usage will be discussed, with the main goal to reduce or, if possible, to suppress the negative effects on the environment.

Cattle

In line with the Provision form 1996, cattle production family farms, as well as larger farming enterprises must have the number of animals adapted to the available farmland, so that they can use all the manure on their fields. On intense dairy farms and on farms with intense fattening of bulls, special problem represents the application of slurry. Some of these farms will have to arrange adequate capacities to store slurry for longer periods, which will enable slurry application to the fields at appropriate time of the year. Distribution of slurry is also problematic, since the farmers are still in need of equipment, which would allow as little nitrogen emission to the atmosphere as possible.

Lately, Slovenia is also facing the growing specialisation in cattle production. Less and less farmers are oriented to milk production, and more to the production of suckler cows. The number of suckler cows has reached 50% of cow population in Slovenia. This kind of production prevails in regions with unfavourable farming conditions, therefore there is no problem of burdening the environment with animal manure, for animal density is less than 1.9 AU per hectare of farmland. Currently, there is also a constant rise in the number of farms starting with ecological farming and introduction of farming control. Such farms have no problems with animal manure surplus.

Small ruminants

Sheep and goats are usually produced on less favourable areas, mostly hilly and mountainous regions. During summer months animals are outside on pastures and in winter they are kept in stables with deep litter. Thus, negative effects on environment are almost none.

Pigs

In Slovenia pigs are produced on family farms and on eight large scale pig farms, which were in the former Yugoslavia state owned, but are today private enterprises. Two thirds of all the pigs are produced on family farms, but due to lower productivity and slow turnover of herds, they produce only 40% of market pigs. Most family farms have enough farmland, their own or on lease, where the manure, mostly slurry can be applied. The situation is different on large pig farms. Although five of them made arrangements with neighbouring farmers to take the slurry and use it on their fields, there is still a problem occasionally, mostly in winter months, when the storage for slurry becomes too small. This happens on family farms and on large pig farms. On these problematic locations new storage capacities will have to be build.

Special problem in this respect are three large scale pig farms with the capacity of 60000 to 80000 fattening pigs each. One of them has no land where the slurry could be used. Anyhow, in line with the EU directive IPPC (Integrated Prevention and Pollution Control) these farms will have to adjust the production till 2010. They are trying to find the most suitable solution for the slurry problem, thinking of the application of purifying plant on the farm combined with complete purification on municipal plants. Pig slurry can easily sediment. This characteristic is favourable for the separation process, where the thinner part can be used for washing the canals in stables, and the thicker part, the result of further separation, represents concentrated organic fertiliser with 30% of DM. Concentrated manure can easily be transported to more distant farmland, and the farmers like to take it for the application on their fields. It can well be used for composting, as well. Many customers are interested in buying it. The remaining thin part of the slurry after the separation undergoes further processing. The most suitable proves to be anaerobic rotting, where the end product results in bio-gas. It is a mixture of methane and carbon dioxide in the rate 70:30, and used to produce electricity. In April this year Slovenia legally settled the usage of bio-gas following EU regulations and announced to purchase all the electrical energy by paying the guaranteed price. Thus, the anaerobic rotting of slurry and production of bio-gas became financially very interesting. The liquid, which remains after the rotting process, is planned to be drained to the municipal purifying plants. Unfortunately, the remaining liquid still has too high nitrogen content, so additional processes will be required to further reduce this element.

Still, we can easily say that a good work has already bore fruits, especially in the case of appropriate usage of pig and cattle slurry on cultivated land. In addition, quite some investments have been made in regard to slurry storage facilities, which are required mainly in winter months when the application of slurry is not allowed (from 15th November to 15th February). Much better are also the logistic processes in the transportation of slurry. In order to reduce the amount of slurry at its source (in and around the stables) the reduction of water used for technological processes and omission of meteoric water, both represent as much as 2/3 of the total amount of slurry in lagoons, have been strongly considered. In future plastic covers will be used on slurry storage lagoons, which will at the same time prevent the emission of ammonia to the atmosphere, thus reducing the unpleasant smell in the environment. Since the animals on small farms had been substantially reduced, the farmland is adequately scarcely fertilised with animal manure. Large livestock production farms can therefore without much effort find small farmers who are prepared to take the liquid fraction of slurry for the fertilisation of their fields. In such cases the separation process is not applied, especially if the storage capacities are big enough. The emission of ammonia to the atmosphere depends on the method of slurry application. The applying equipment and the methods of application are constantly improving, but the prices of modern new mechanisation are very high. Therefore, governmental support on these investments would be appreciated.

Poultry

Owners of the majority (90%) of poultry in Slovenia are three poultry production enterprises; all three are in the process of joined production in one large enterprise. Each one will specialise in one line of poultry production. Apart from the egg production unit the mentioned enterprises have poultry production organised on farms throughout Slovenia. Such dispersion means low animal density, and the usage of poultry manure on the fields is not problematic. Yet, on some production plants, where such utilisation is not possible because of bigger amounts of poultry manure, they compost it and produce rich organic fertiliser. It can be bought in suitable shops everywhere in Slovenia. Fertiliser BOGATIN, for example, produced by JATA EMONA enterprise contains 75-85% DM, 45-55% organic matter, 5-6% nitrogen, 4-5% P_20_5, 2-3% K_20, 7-12% CaO, 1.5-2.5% MgO. It has pH value 6.6-7.0. People, who grow their own vegetables in small gardens, like to use organic fertiliser.

CONCLUSIONS

Because of the highly sensitive natural conditions for farming in Slovenia, because of the strong wish to preserve healthy environment and attractive countryside, to keep the agricultural land cultivated and in the function of successful food supplier, to keep the remote country areas populated, and because we wish to respect the EU requirements – Slovenia would like to become the EU member shortly – we have decided for environment friendly livestock production with respect to all the essential ethological requirements in animal husbandry. We are sure that in our conditions these goals can best be achieved on family farms (*Osterc* and *Ferlin*, 1996; *Osterc*, 1996a). Because of this strong belief we have stated in our political documents that we shall promote eco-social agriculture on family farms. After its independence in 1991 Slovenia tries to actively participate in the international associations which are contributing to the environment friendly agriculture. A lot of Slovene legislation has already been adapted to the EU legislation, the rest will be adapted in the near future. Directions leading to livestock production which is environment friendly and at the same time kind to animals became legal by adopted legislation and promoted by the governmental support, especially by direct payments, as it is done in EU countries. We are certain that such decisions are in the long run the best for the agricultural development in the Republic of Slovenia.

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Corresponding author:

Jože Osterc
University of Ljubljana, Zootechnical Department
SI-1230 Domžale, Groblje 3., Slovenia
Tel.: 386 1 7217 848, Fax: 386 1 7211 701
e-mail: joze.osterc@bfro.uni-lj.si

SECTION 1

ENVIRONMENT FRIENDLY ANIMAL BREEDING

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Nutritional possibilities to reduce the N and P excretion of pigs (A review)

Cs. Szabó, L. Babinszky, J. Tossenberger
University of Kaposvár, Faculty of Animal Science, Department of Animal Nutrition
Kaposvár, H-7400 Guba Sándor u. 40., Hungary

ABSTRACT

Manure disposal is a major problem in highly intensive pig production areas, especially for nitrogen and phosphorus, because of water and air pollution. Among farm animals the monogastric species excrete most of the nitrogen and phosphorus, due to the digestibility properties, protein and amino acid supply and improper manure handling. Sows, weaners and slaughter pigs excrete approximately 75%, 45% and 70% of the nitrogen, and 75%, 40% and 60% of the phosphorus consumed, respectively. In total about 34000 ton N and 8000 ton P can potentially pollute the environment yearly from the pig and poultry sector in Hungary. Therefore, it is important to reduce the amount of these elements in the manure and urine. Our objective was to discuss the nutritional possibilities to reduce N and P excretion of pig farming in Hungary. The potential N and P pollution in Hungary is about 5.0 and 1.1 kg per ha of arable land, respectively. These values are far below the legislation in France, Denmark and The Netherlands (Jongbloed et al., 1999). However, by improper manure and slurry handling the regional emission can be even higher. In Hungary the introduction of dietary nutrient recommendations based on ileal digestible amino acids, ideal protein concept and digestible phosphorus is in progress. Therefore, about 20-percentage reduction in N excretion can be expected. Shifting recommendation from total P to digestible P will not reduce significantly the P emission. Since the P emission per ha is quite low in Hungary and legislation is not foreseen, the dietary inclusion of microbial phytase will depend on economical considerations.
(Keywords: phosphorus, nitrogen, pig, excretion)

INTRODUCTION

Nowadays, there is an increasing awareness of the impact of livestock production systems on the environment, especially in countries with dense animal populations. In countries facing with a surplus of manure and a serious concern about the effect of ammonia emissions on environmental acidification and the pollution of ground and surface water the most important pollutants are nitrogen and phosphorus. Among farm animals the monogastric species excrete most of the nitrogen and phosphorus, due to the digestibility properties, protein and amino acid supply and improper manure handling. Sows, weaners and slaughter pigs excrete approximately 75%, 45% and 70% of the nitrogen, and 75%, 40% and 60% of the phosphorus consumed, respectively (*Peet-*

Schwering and *Hartog,* 2000). *Table 1* shows the estimated N and P excretion of pigs , broilers and laying hens in Hungary.

Table 1

Estimated N and P excretion of pigs , broilers and laying hens in Hungary in 2000

	Sows	Fattening pigs	Piglets	Total	Laying hens	Broilers	Total
N excretion[a] kg/year/head	22.4	4.24	0.56		0.77	0.07	
Total N excretion[b], t/year	7795	13992	595	**22382**	10980	1152	**12132**
P excretion[a] kg/year/head	5.4	0.82	0.13		0.22	0.012	
Total P excretion[b], t/year	1879	2706	138	**4723**	3137	197	**3334**

[a]Jongbloed and Lenis (1993); [b]Based on Jongbloed and Lenis (1993) and Statistical Yearbook of Hungary (2001)

A single pig in the 30 to 100 kg live weight range consume 6.8 kg N, but only 2.6 kg N used for maintenance and tissue accretion (*Jongbloed* and *Lenis,* 1993). The remaining nitrogen is excreted via faeces and urine into the environment. In the case of phosphorus we can calculate with 1.5 kg intake during fattening period and with 0.8 kg excretion. In total about 34000 ton N and 8000 ton P can potentially pollute the environment yearly from the pig and poultry sector. Therefore, it is important to reduce the amount of these elements in the manure and urine.

The actual N an P emission depends on many factors, therefore, in this paper, we aim to discuss the nutritional possibilities to reduce the N and P excretion of pig operations in Hungary.

REDUCING NITROGEN EXCRETION

The first approach for improving the efficiency of N utilisation by the pigs is to ensure that the supply is at all times appropriate for growth potential of the animals, or to their physiological needs. The digestibility of dietary proteins and amino acids was for a long time expressed by means of the apparent digestion coefficient measured from the faeces, similarly to that of other nutrients. However, results obtained from digestion physiology research prove that bacterial flora in the colon not only synthetises protein, but at the same time catabolises it. This is why digestibility of dietary proteins measured from the faeces underestimates the actual value in some cases, while in others overestimates this value (*Schröder*, 1988).

For this reason, in a number of western European and north American countries calculations are based upon the ileal digestibility of proteins and amino acids. The apparent disadvantage of this method is that the amount of amino acids absorbed in the colon is not taken into account.

However, it would not be correct to regard this as a source of error, since in the postileal section of the intestine (the colon) the various nitrogen bonds are absorbed almost exclusively in the form of ammonia, and thus are not involved in protein synthesis (*Just et al.,* 1981) but are excreted in the urine. Hence, only the amount of amino acids absorbed before the end of the small intestine has significance with respect to animal nutrition.

In swine diets lysine is the first limiting amino acids in most cases. Without crystalline amino acids the requirements of lysine can be met only with higher crude protein level. This results that other amino acids are supplied in excess, which amount needs to be deaminated and excreted via urine. In growing pigs, amino acid composition of balanced, or ideal, protein represents the balance in which amino acids are required for maintenance and body protein accretion (ARC, 1981; *Fuller et al.,* 1989). An important benefit of the ideal protein concept is, that the requirements for all dispensable amino acids and total crude protein can be quickly derived after the requirements for one amino acid are established. This concept may also be used to reduce amino acid excesses that occur in practical swine diets, without affecting animal performance. The improvement of the amino acid profile can result about 20-30% reduction in N excretion *(Table 2).* The crude protein level can be reduced about 10-20% without negative effect on daily gain and feed conversion ratio. However, with a very low protein diet (about 11%) optimally balanced in amino acids, a reduction in growth performance can be expected (*Tuitoek et al.,* 1997), suggesting a deficiency of non essential amino acids. Changing the feeding strategy is also an efficient way to reduce N excretion. The protein and amino acid requirements gradually change by age forming a curve. Therefore, a single diet can not meet exactly the requirement. Even using only a two phase feeding the N excretion can be reduced about 8% (*Latimier* and *Dourmant*, 1993; *Kim et al.,* 2000). Using multi-phase or blend feeding the N emission could be reduced up to 50% compared to a single phase feeding (*Bourdon et al.,* 1997). However, it must be pointed out, that the development of such feeding techniques for reducing N excretion by the pigs requires a good knowledge of amino acid availability in the feedstuffs, and of changes in amino acid requirements according to growing stage or physiological status (*Dourmad et al.,* 1999). Therefore in practical conditions only moderate reduction of dietary crude protein content can be proposed.

Table 2

The effect of dietary crude protein content reduction with amino acid supplementation on growth performance and N excretion

LW range, kg	CP reduction to control, %	Effect on daily gain	Effect on feed conversion	Reduction in N excretion, %	Source
30-102	13	ns[a]	ns	21	*Dourmad et al.*, 1993
	24	ns	ns	36	
33-96	12	ns	ns	24	*Gundel et al.*, 2000
20-55	10	ns	ns	14	*Tuitoek et al.*, 1997
	22	ns	ns	35	

[a]*Not significant*

REDUCING PHOSPHORUS EXCRETION

According to the data obtained from various investigations, pigs retain for maintenance and weight gain barely 30% of phosphorus ingested with the diet, the remaining 70% being excreted in the faeces and urine (*Table 3*).

Table 3

Phosphorus retention in growing pigs

	***Tossenberger* and *Kakuk* (1992)**	***den Hartog* and *Swinkels* (1993)**	***Schwarz* (1994)**
Intake, %	100	100	100
Excretion, %	70	70	67
Retention, %	30	30	33

Similarly to the protein and amino acid supplementation, the first approach to reduce phosphorus excretion is to ensure that the supply is at all times appropriate for the growth potential of the animals, or to their physiological needs. The low net utilisation of P is mainly due to the quite low P digestibility in pig diets, resulting in a high faecal excretion of P. At other hand, the recommendations for P requirements were based on total P content. Therefore, they were imprecise and included large safety margins (*Fernández et al.,* 1999). Consequently a more precise basis for P recommendations would be digestible P. This can be justified by model calculations (*Table 4*). If diets formulated on the basis of total P content, only diets with components having highly digestible P content reach the recommended dietary digestible P level. However, the differences between total and digestible phosphorus content of diets is identical in all case although decreasing with increased P digestibility of dietary components. This means, that applying the digestible phosphorus concept in diet formulations will decrease the P excretion if components with higher P digestibility will be preferred in swine diets.

Table 4

Total and digestible P content of diets formulated to meet either total or digestible P recommendation[a] of NRC (1998)

		Main dietary components							
		Soybean meal Maize		**Soybean meal Maize Fishmeal**		**Soybean meal Maize Wheat**		**Soybean meal Barley Wheat**	
	NRC,	Basis of diet formulation							
	1998	TP[b]	DP[c]	TP	DP	TP	DP	TP	DP
Total P, g/kg	5.0	5.0	5.2	5.0	5.1	5.0	5.0	5.0	4.6
Dig. P, g/kg	2.3	2.1	2.3	2.2	2.3	2.3	2.3	2.7	2.3
Total-Dig., g	***2.7***	***2.9***	***2.9***	***2.8***	***2.8***	***2.7***	***2.7***	***2.3***	***2.3***

[a]Growing pigs from 20-50 kg; [b]Diets formulated to meet the NRC (1998) recommendation for dietary total P; [c]Diets formulated to meet the NRC (1998) recommendation for dietary digestible P

Most phosphorus of plant origin is present as phytic acid (30-70%), which is poorly available to non-ruminant animals. The availability of phytic acid P may be improved either by adding microbial phytase or by using phytase-rich cereal diets (*Tossenberger et al.,* 1993). The intrinsic phytase activity is high in wheat, triticale and barley, and low in maize, oats and oil meals. Due to the different intrinsic phytase activity, 10% of the phytate content of maize and 48% of the phytate content of wheat can be transformed into an absorbable form (*Tossenberger et al.,* 1993). Therefore, the effectiveness of microbial phytase supplementation depend on diet composition.

The regulation of P homeostasis in the body occurs mainly through control of P excretion in urine and P absorption. Physiologically, fractional P absorption decreases and the urinary P excretion increases when pigs are fed above their requirement. Conversely, fractional P absorption increases and the urinary P excretion decreases when pigs are fed below their P requirement. When pigs are fed P according their physiological P requirement, urinary P excretion is very low. This is well demonstrated in *Table 5*. The experimental data demonstrate that, if phosphorus is supplied according to the recommendations and phytase supplementation is applied, the amount of P excreted in the faeces is decreased, due to better digestibility of phosphorus. The excess phosphorus absorbed from the intestine was, however, excreted in the urine. This indicates that pigs had substantially more P available that their physiological requirements. Experimental results published indicate that the digestibility of P can be improved about 10-30 percentage units (*Simons et al.,* 1990; *Cromwell et al.,* 1993; *Tossenberger,* 2001). Addition of microbial phytase to pig diets (about 500 FTU/kg) can improve P digestibility up to about 65% (*Poulsen et al.,* 1999). If the diets are heat treated, most of the phytase, intrinsic and microbial, might be inactivated. Therefore, the effect of feed processing should also be accounted in calculation of P requirements.

Table 5

Changes in phosphorus balance in growing pigs by the effect of phytase addition, given identical daily phosphorus intake

	Phytase supplementation, FTU/kg feed		
	0	500	1000
Daily P Intake, %	100.0	100.0	100.0
Daily P excretion, %			
in urine	9.5	19.3	23.4
in faeces	50.7	41.9	37.7
Daily P retention, %	39.8	38.8	38.9

(Tossenberger, Pálos, Babinszky, unpublished data)

IMPLICATIONS

The potential N and P pollution in Hungary is about 5.0 and 1.1 kg per ha of arable land, respectively. These values are far below the legislation in France, Denmark and The Netherlands (*Jongbloed et al.,* 1999). However, by improper manure and slurry handling the regional emission can be higher. In Hungary the introduction of dietary nutrient recommendations based on ileal digestible amino acids, ideal protein concept and digestible phosphorus is in progress. Therefore, in N excretion about 20-percentage reduction can be expected. Shifting recommendation from total P to digestible P will not significantly reduce the P emission. Since the P emission per ha is quite low in Hungary and legislation is not foreseen, the dietary inclusion of microbial phytase (500 FTU/kg) will depend on economical considerations.

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Corresponding author:

Csaba Szabó
University of Kaposvár, Faculty of Animal Science
Department of Animal Nutrition
H-7401 Kaposvár, P.O.Box 16., Hungary
Tel.: 36 82 314 155, Fax: 36 82 316 705
e-mail: szabocs@mail.atk.u-kaposvar.hu

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Interactions of organic agriculture, rural development and environment protection

Z. Szakály, Cs. Sarudi, A. Máthé, V. Szente, A. Budvig
University of Kaposvár, Faculty of Animal Science, Institute of Economics and Organizations
Kaposvár, H-7400 Guba Sándor u. 40., Hungary

ABSTRACT

Rural development has recently been placed in focus in economic policy of developed countries. Rural development itself is considered as an answer to a circle of problems that covers economics with low income level, lack of alternative employment capabilities and migration from rural areas. Within national economy sectors it is ag economy that has the strongest connection with rural areas mainly because the rural area itself delivers the operation field and labour base of ag economy (especially of agriculture and forestry). Agriculture and forestry is the user and partially the producer of renewable resources, in other words they offer special environment economic services. In Hungary the biomass can be taken the most important renewable resource. Organic farming has a special place within food economy and this specialty can be connected to any function of the rural area. Rate of organic lands remarkably increased in recent years because not only of state subsidies but also of increasing demands and the ever growing sense for environment. This overall development reached Hungary, too. In December 2001 the estimations showed 79,187 ha and within this 49,490 ha had been registered as approved organic area. It means 1.3% of total agricultural land. Organic farming - as producers say - contributes to conserving the environment and the rural land. The same is stated by those consumers who decided to buy organic foods.
(Keywords: rural development, organic agriculture, environment protection, eco-tourism)

INTRODUCTION

Rural development has recently been placed in focus in economic policy of developed countries. Rural development itself is considered as an answer to a circle of problems that covers economics with low income level, lack of alternative employment capabilities and migration from rural areas.

Rural politics turned to be in foreground in the 80s and during 90s it was integrated into common agricultural and structural politics. It is well traceable that agricultural, rural and environment policies are more and more harmonised and its key point is the realisation the requirements of sustainable development. New tendency is that rural areas are gaining in value. It is an accelerating process originating on one hand from the need for the most complex manifestation of rural functions (economic, ecological, community as well as cultural and social functions). On the other it comes from the idea stating that rural areas are forming not only living space for the local inhabitants but offer necessary services for the whole society, therefore accepting and developing rural values is an interest of the society.

According to Buckwell's approach *rural environment* covers every aspect of natural environment (biodiversity, living spot and resources protection but also landscape protection) as well as of artificial environment (conserving traditional architecture, archaeological sites and other elements of historical heritage). *Rural development* includes local population, its way of life, employment characteristics, income structure, dwelling conditions, service levels as well as cultural aspects just as traditional handcrafts, dishes, language, clothing and habits. Since agriculture is a historically determining economic activity in rural areas its effects primarily determines the rural ways of life (*Buckwell,* 1997).

New rural development policy of EU can be featured by *multisectoral and integrated approach*. It can be clearly seen that agriculture plays an important role in conserving heritages of rural areas and creating alternative income resources is an integrated element of rural development politics. Rural development steps and measures are handled as complex "packages" by EU that can shape the *five main directions* of supporting rural areas:

- Strengthening agricultural and forestry sectors.
- Forestry is officially accepted as a key element of rural development.
- Improving competitiveness of rural areas.
- Conserving environment and European rural heritage.
- Environment friendly ag systems are supported through agri-environmental regulations.

AGRICULTURAL ECONOMY IN RURAL DEVELOPMENT

Within national economy sectors it is ag economy that has the strongest connection with rural areas mainly because the rural area itself delivers the operation field and labour base of ag economy (especially of agriculture and forestry). Ag economy ultimately determines the income positions not only of agricultural and forestry employees but of rural families and communities, therefore it is also a *settlement forming factor*. During production processes it has strong and direct connections with living environment, renewable natural resources, so it has an effect on natural environment (primarily on soil, surface waters, flora and fauna). Hence ag economy is multilateral, multifunctional social factor and its role seems to be a long term one.

Ag economy - in most countries - is the biggest land consuming sector. In Hungary the proportion of ploughland is 51%, forest 19%, vineyard and orchard 3%, grassland 12%. The sector practically covers as much as 85% of the country and it is an outstanding value in Europe. Perspectives of intensive land utilisation are excellent and this alone - in comparison with EU countries - can *strengthen the importance* of agriculture and forestry within rural development.

Ag economy has also an important role in employing the rural population, however the number of people employed in agriculture shows a constant decrease. Despite this decrease the number of ag employees is still twice as much than that of the countries with developed agriculture mostly because of the high ratio of agricultural area and high proportion of labour intensive branches as well as of high population density. An important aim of rural development to avoid the decrease the employment capacity of agriculture and forestry because during recent years only a small part of labour capacity released by this two branches was taken over by other economic sectors growing this way the number of unemployed people.

Agriculture and forestry mean *target markets* for other rural enterprises. Overall decline in agrarian sector, lack of capital, dramatic drop in level of investments, however, cut back the demand for industrial inputs and certain services. Shifting the sector into a growing line, in the same time, means additional markets for other sectors of national economy.

Agriculture and forestry is the *user and partially the producer of renewable resources*, in other words they offer special environment economic services. In Hungary the biomass can be taken the most important renewable resource.

The above mentioned special services include the conservation of natural environment as well as providing capacities for human recreation. Both activities are connected to the ecological function of rural areas and this way they ensure complex manifestation of other functions, the harmony with economic functions and through the latter they form the base of sustainable development.

Agricultural economy, however in a limited range, area and time, can fulfil certain *social functions* especially in areas where severe and long lasting employment problems occur, maintaining agricultural production seems to be unnecessary from economic points of view but from social political aspects - being no other chance of employment - still remains justifiable. Financial and moral consequences of taking up excessive and long lasting unemployment is definitely more severe than maintaining labour intensive and supported agricultural production. In this range one can found social land granting programs, raising the substantial level of poor population segments, forest cultivation, reculturing wasted grass- and arable lands (even in the form of public purpose employment) etc.

CONNECTIONS BETWEEN ORGANIC FARMING AND RURAL DEVELOPMENT

Organic farming has a special place within food economy and this specialty can be connected to any function of the rural area:

- Its economic role is represented by widening the range of employment, creating new workplaces, improving the population keeping ability of the area.
- Its ecological function is well connectable to environment- and landscape conservation and hence in an indirect way to maintaining biodiversity.
- Social and cultural functions mean in this context the revitalising and developing of traditional farming methods.

Organic (eco-) farming delivers an ever growing domestic and international market background for producers in rural areas covering the whole production chain from raw material to selling end products. It is important, however that organic farming has to be concerned as a complex and integrated system. It means on one hand that the shift to organic farming should include not only the production of organic raw materials but also the processing, packaging and marketing of them. On the other hand it is important to establish the organisational and interest forms and systems which cover the production itself, the equipment and genetic base supply, small and medium size processing facilities, packaging, advisory and marketing management. Regarding growing domestic and foreign consumation trends, good price positions, lack of export restrictions organic farming can turn itself into a new "alternative" employment segment in many areas of the country. In this way the previously ignored factor of rural development can potentially turn into a dinamising engine of regional development.

BACKGROUNDS OF ORGANIC FARMING

When *Rudolf Steiner,* the father of antroposophy, kept his first lecture on biodinamic agriculture in 1924 he couldn't even guess that 70-80 years later massive thousands of people would refer to his opinions. His method turned the interest toward the protection of environment and highlighted the importance that man should live *with* the environment instead of simply living *in* it. The new movement suffered a drop back during the war and the following years and not sooner than the 80s it began to emerge again and spread over first in developed countries (U.S.A., West-Europe) where population recognised the importance of environment protection mainly driven by oil crisis, acid rains, damaging ozone shield and the Chernobil catastrophe in 1986. Spreading of this environment friendly farming method was effected (beyond ideology) by economic factors, namely the overproduction. By this method, even with smaller yields more healthy and better selling goods can be produced even for domestic markets. As a result the social acceptance of organic farming improved and the size of registered organic areas grew year by year.

Organic farming is based on the definition of ecology as former namings just as "ecological", "biological" represent it. Its basic aim is ensuring sustainable development whereas it uses again, from time to time to locally available reserves. Among basic principles of organic farming can be found the protection of soil and environment and this implies the usage of natural capacities of plants, animals and the landscape and willingly tries to improve the quality of the environment. Artificial add-on products are only limitedly used, synthetic fertilisers, herbicides and medicines are fully avoided (*Yuseffi* and *Willer,* 2002).

In Hungary, similarly to other countries the phrase of multifunctional agriculture came into foreground stating that yield level, production costs are no longer taken as primary indices but environmental effects, health effects, aspects of landscape value and employment issues get higher priorities. Organic farming as the most important breakthrough point has its potential for further development since more and more countries separate remarkable amounts of money for environment saving eco-producers for whom the obtained subsidies can cover the income gap caused by lower yield levels.

ORGANIC AREAS IN HUNGARY AND IN THE WORLD

Rate of organic lands remarkably increased in recent years because not only of state subsidies but also of increasing demands and the ever growing sense for environment. According to estimations organic area size is expected to dynamically grow in the near future. *Table 1* shows the changes in organic areas on continents between 2000 and 2002.

Table 1

Organic land size in the world, tsd ha

Continent	January 2000	January 2002
Australia	1,850	7,700
Europe	3,200	4,200
North-America	1,130	1,300
Central- and South-America	550	3,700
Asia	45	90
Africa	25	60
Total	6,800	17,050

Source: own calculation after M.Yussefi, H. Willer, 2002 and SÖL, 2000.

Beside Australia and South-America it is Europe where remarkable area increase can be observed. It can be stated that market demand for organic products is the strongest in Europe, as much as 46% of the world's organic product output is sold in this continent which possibly can be explained by its economic development level. As for production area size Italy has to be highlighted where the area size reaches 1,04 million hectares and in the last two years showed an increase of 32% (*Yuseffi* and *Willer,* 2002).

This overall development reached Hungary, too. In December 2001 the estimations showed 79,187 ha and within this 49,490 ha had been registered as approved organic area. It means 1.3% of total agricultural land (SÖL, 2000). *Table 2* shows the changes of registered and pre-registered organic area sizes in Hungary along with the number of producers from 1996 to 2001.

Table 2

Organic area size and number of producers in Hungary

Item	1996	1997	1998	1999	2000	2001
Organic area (ha)	11390	15772	21565	32609	47221	79178
Number of producers	127	161	330	327	471	764

Source: Biokontroll Hungaria Plc., 2002.

In recent years a remarkable growth in organic area sizes could be observed which potentially follows the tendencies mainly due to the National Agricultural Environment Protection Program. According to estimation within short time it can reach 300,000 ha and that is significant even in European scale.

TURNOVER OF ORGANIC PRODUCT AND CONSUMER PREFERENCES

Development can be understood in a wider aspect than simply explained by production size and producer number. Turnover on organic products increased also significantly reaching world-wide 26 billion USD in 2001. It means a 23% increase in market potentials when compared to previous year. Organic foods share on average 1.9% of total food consumption. The numbers indicate the growth of consumer number but also the ever widening organic product choice. According to optimistic forecasts, by 2010 cca. 10-25% of total agricultural area will be turned into organic farming through the world (*Yuseffi* and *Willer,* 2002).

Organic farming - as producers say - contributes to conserving the environment and the rural land. The same is stated by those consumers who decided to buy organic foods.

In Germany (*Hinderer,* 1996) several market surveys were conducted in past years analysing the buying motivation factors in case of organic foods. While only healthiness had been placed first before 1996, in the same year highest rank was awarded to the following motives:

- 53% Ecology, ecological product
- 20% Healthy lifestyle
- 19% Rejecting industrialised agricultural production

According to a Dutch study about 50% of answers stated *healthiness* and 30% referred to *environment friendly production* as highest rank motive (ZMP, 1999).

In Hungary a market survey was designed and set by *Székely* in 1993 involving 713 organic food consumers and 1,000 control consumers. Highest motivation factors in buying organic foods were *health* (92.3%), *environment protection* (48.3%), *better flavour* (36.3%), *lower processing level* (23.7%) and *less packaging* (4.5%).

A year later organic product retail units and consumption were investigated by *Bódi* (1994) who conducted the survey in Budapest and in Szeged and asked 200 consumers and 16 retail handler. The consumers were exclusively organic product buyers. Their motivation rank showed *conserving health, improving wellness, environment protection.*

Mokry and *Frühwald* in 1999 found that on organic food market the best part (80%) of consumers decided to buy organic products because of the healthiness, 18% said that environment protection is the main aspect and only 2% explained the decision by the tastiness of the product.

Our survey involved 423 people and 87% of them thought the organic products to be more healthy than the traditional ones mainly because of reduced quantities of chemical residues (*Szente,* 2001).

After getting acquainted with buying preferences of consumers it seems to be worthy observing the special possibilities in marketing of organic foods.

ORGANIC FARMING, ECO-TOURISM AND ENVIRONMENT PROTECTION

European Union is supporting the development of rural areas, environment protection and conservation and maintaining landscape capacities. From 2002. the official channel of this support is the SAPARD frame program where one of the target activities is organic farming in a wider context, that means production, processing and marketing. Eco-tourism is also supported which serves for the environment in different aspects:

- *Recreation in rural environment*: contributes to development of rural infrastructure, improves the population keeping ability of the area and offers work places.
- *Offering organic foods*: Producer offers and sells locally grown organic foods for the guest.
- *Fairs, exhibitions, local eco-markets*: Displaying, offering and selling eco-products by regional or micro regional producers.
- *Organising programs:* traditional pig slaughting or a simple animal fair can attract a number of visitors.

- *(Re)Forming architecture style:* traditional building materials and styles that reflect a certain nature based sense.
- *Innovation, offering high quality services:* targeting on conscious and self defining market segments.

In West-European countries a well proved method is to open up eco-restaurants and hotels, where the foods and dishes are prepared from controlled organic materials but even the architectural issues reflect the closeness to nature.

It can be concluded that organic farming respects the nature- and environment protection in multiple ways:

- First, the producer who fulfils the requirements of organic farming, regardless whether he decided by his own individual values or by economic interests.
- Second, the consumer, who serves for the environment when buying organic foods.
- Third, both of them since one of the crucial point of organic farming is optimising, and that is when both the producer and the consumer tends to achieve the highest available quality through the least minimal costs. Best alternative for it is the local selling of goods since in this way there is no pollution by transport emissions, no need for long term storage etc. Beside these factors the eco-tourism means another effective marketing channel.

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Corresponding author:

Zoltán Szakály
University of Kaposvár, Faculty of Animal Science
H-7401 Kaposvár, P.O.Box 16., Hungary
Tel.: 36 82 314 155, Fax: 36 82 316 705
e-mail: szakaly@mail.atk.u-kaposvar.hu

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

The environmental friendly relations of goat milk product manufacturing

O. Szigeti, Z. Szakály
University of Kaposvár, Faculty of Animal Science, Institute of Economy and Organisation
Department of Agricultural Economics and Marketing, Kaposvár, H-7400 Guba Sándor u. 40., Hungary

ABSTRACT

The strategy of the Hungarian agriculture and rural development predicts a promising future to the breeding and raising of small ruminants (sheep, goat). Though, in the first half of the 1990s, the population of both breeds decreased dominantly, now their number is increasing. Goats can make perfect use of both those pasture areas that are not valuable for other animals and those ones that are not used for crop production any more because of their inefficient productivity. With a small amount of investment, a significant profit can be gained with a high quality management. Thus it can be an excellent source of income ever for the less capital-intensive entrepreneurs. 90% of the domestic stock can be found in groups of less than 25 animals at small-scale and family enterprises that is its role in human employment is also dominant. Due to the small dimensions of enterprises, they could have a dominant role in region maintenance, too. These characteristics are equal to the principles supported by the EU. Small ruminants produce organic products that are more and more demanded and will become parts of modern nutrition in the future. There is a good market for goat milk and for the products made from it, as there is an increasing demand for healthier eating habits. Two trends are developing nationally. One way of milk processing is the production of traditional goat diary products (cheese, curd). These goods are considered as own products of Hungary, and can operate as Hungaricums. The other trend is represented by more complicated products produced by a developed technology. Products made from goat milk are more useful for the filling of a market niche than for the satisfying of heavy demands. As a consequence, basically the production of quality products should be preferred to mass production.
(Keywords: goat milk product, friendly relations, quality and ecological product, healthy eating)

GENERAL CONDITIONS OF THE GOAT BRANCH

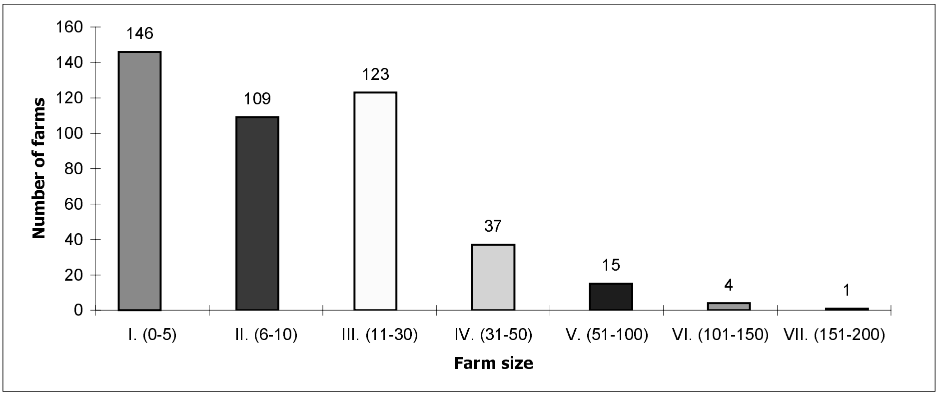
The strategy of Hungarian agriculture and rural development predicts a promising future to the breeding and keeping of small ruminants (sheep, goat). However, the number of both species decreased significantly in the first half of the 90s, nowadays their number shows an increasing tendency.

It is hard to determine the exact size of the goat branch. As regards estimations, there might be about 30,000 goats inland but the bigger proportion of this stock is not registered anywhere. Partly because breeders are in lack of information and they refuse (are afraid of) registration, and partly because they use a great proportion of goats for lamb breeding in flocks of sheep. The registration of the branch would become complete if it were worth getting into the system for those who are still standing apart because of the support of first-class goat milk.

According to the 1999 data of the *National Association of Hungarian Goat Keepers and Breeders*, processed as per farm size, it can be stated that *most of the producers (33.6%) keep less than 5 mother goats*. The 86.9 percent of the members has a stock smaller than 30 goats, and only the 8.5 percent of the producers – breeders owns such a big stock (31-50 mothers) that employs and keeps a whole family (2 adults). Unfortunately, the proportion of farms bigger than this is insignificant (4.5%). In this processing, the data relating to farm size of 435 out of the 562 members of the association were evaluated *(Figure 1*).

Figure 1

Formation of farm numbers per category
Total numbers of farms: 435

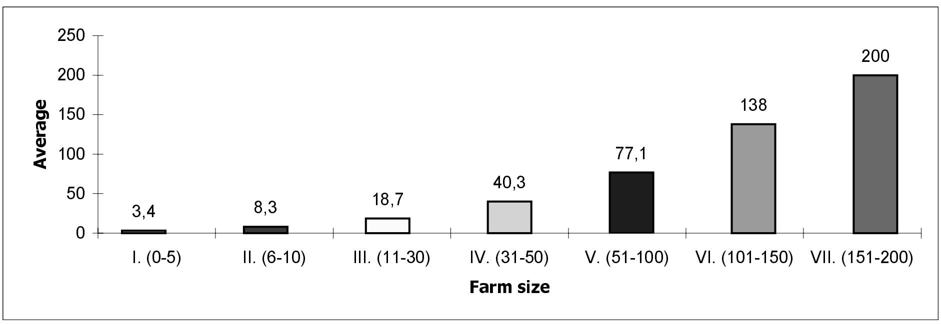


Source: National of Hungarian Goat Keepers and Breeders

The formation of the average number of mothers according to farm size showed an interesting picture *(Figure 2*).

Figure 2

Average number of mothers per farm category

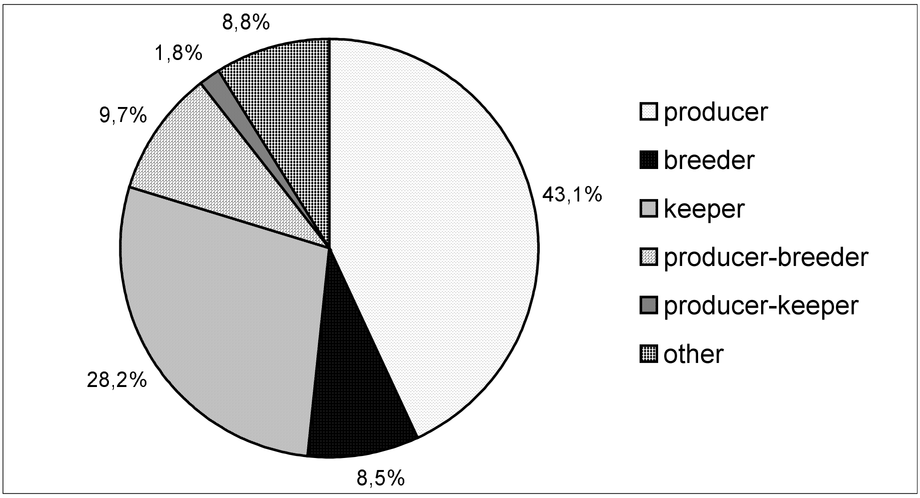


Source: National of Hungarian Goat Keepers and Breeders

The division of farms regarding the producing direction upon the evaluation of the association was not surprising at all *(Figure 3*). A significant proportion of those who want to live on the products of goats *could be assigned to the categories of producers (product manufacturers) and keepers (just have goats)*. Slightly more than 18 percent of them formed an opinion that their activities equal the definition of breeding.

Figure 3

Division of farms according to producing direction



Source: National of Hungarian Goat Keepers and Breeders

THE ENVIRONMENT AND LAND PROTECTING ROLE OF GOATS

Sheep and goats as grazing animals select possibly; they like grazing grass full of full value with high quality nutritive value and high mineral and vitamin content. After feeding according to necessities and requirements, the small ruminants produce *ecological products* that are more and *more popular and becoming the basic part of modern nutrition in the future.*

Grazing is the most profitable way of utilisation of lands of poor quality and pastures of sodic soil.

The complete territory of pastureland in Hungary is 1,140,000 ha; out of which 170,000 ha consists of national parks and nature conservation areas. The 60 percent of the total pastureland is productive and the 40 percent of it is soil protective and inconditional grass. *The 55 percent of total pasture can be utilised only with sheep and goats*. The rational usage of pasture is mainly hindered by ownership, as several owners do not even care for leasing his land as a pasture to be able to save the costs of cutting *(Mucsi et al.,* 1999).

The goat branch has such possibilities in store, potentially, which are worth mentioning from the point of view of *land farming*. Goats can utilise pasturelands perfectly, which can not be utilised by other animals and land s that were removed from agricultural production because of their poor productivity. Due to oversizing, its environment burdening effect can be felt, which can be controlled with a number adjusted to the environment. This is the reason for the development of the co-ordinated, scheduled sectoral system. As compared to cattle, with an equal investment, a prominently *bigger profit can be made* with a high quality management. This way it can be an excellent source of income even for less profitable entrepreneurs. The 90 percent of the domestic stock can be found in groups of less than 25 animals. These are such small-scale or family enterprises that do not amount to the large-scale size. This is the reason for the development of the goat branch, since *its role in human employment is also determining*, as human work demanding technologies are applicable. Due to the small- scale number control, it would have a significant role in *nature conservation* as well. These characteristics equal the principals which, in one hand, are defined in land farming, in the other hand, are supported by the EU.

According to the strategy of the Hungarian agriculture and rural development, animal husbandry has to be developed in support of *three goals* – firstly, the supply of native population, secondly, its role in employment, thirdly, the increase of export income. Basically, *the manufacturing of high quality products* should be placed into prominence instead of mass production.

The small ruminants provide economical product manufacturing only with the technology of pasture raising. This way our pasturelands will become reusable. Both sheep and goats can have major roles in the progress of rural development.

THE MARKET OF GOAT MILK PRODUCTS

Goats serve as a staple source of food to the east of Hungary and at the Balkans. However, in Western Europe, products made from goat milk were put on the market as luxury consumer product and an *increasing demand* can be seen for them. Due to its component values, goat milk has become a possible ingredient of healthy eating. These articles of food are only available for a certain social stratum, mainly not as staple food but as luxury goods.

In Hungary, goat keeping has fallen into the background so far, so we fell behind the neighbouring countries. Neither the quality of the breeding stock nor the breeding technology fulfils the quality requirements. In the last few years, in Hungary, a demand has emerged for the so-called alternative products, which meet the demands of healthy eating among other things. In the case of articles of goat milk basis, demand is supplied with foreign products. The *domestic* goat stock and *products* made from goat milk have not been able to compete with foreign products, yet, as *neither the quantity nor the quality parameters meet the requirements of the market.*

On the side of demand, an increasing demand is emerging for the alternative products and this way for the food of goat milk basis, too. This demand could be supplied from the domestic product manufacturing if the backgrounds of infrastructure, co-ordination and logistics were available. This requires a national level programming that helps to operate and develop the whole branch in harmony *(Marticsek et al.,* 1999**)**.

GOAT MILK PROCESSING

A small proportion of produced milk is processed industrially because the conditions of the branch still have not been regulated. It is due to the fact that small- and medium sized enterprises that produce articles from goat milk started to prosper in the last 1 – 1.5 year and *the organised procurement of goat milk started only in certain parts of the country* in 1999. The enlargement and generalisation of this can be expected from 2000. From the purpose of learning and controlling the quality characteristics of the milk produced, a series of examinations were carried out in different parts of the country. Relying upon the results, a detailed proposal relating to the basic parameters of *first-class goat milk* was made. *The enlargement this to a standard is in progress.*

Because of their narrow range, the appearance of dairy products of goat milk basis on the market was also hindered.

The scattered character of the territories requires a new method - based on pre-processing - in organising procurement. The collected semi-prepared products are the basis of the manufacturing of new products.

The amount of the estimated workable goat milk available is 3-6 million litres. Out of this, The goat milk processed industrially amounts to 500,000 litres. It is utilised by 2 bigger and 3-4 smaller dairy plants. *The bigger proportion of the produced goat milk is used for feeding animals and for domestic use at the moment.* At least one third of goat milk products on the market are homemade (without authorisation).

The positive nutrition-physiological effects of goat milk are rather well known. However, the current *supply of goat milk products is poor* and it is particularly constricted to two groups of products nationally. Different flavoured and non-flavoured pieces of goat cottage cheese and soft cheese – non-flavoured or matured with mildew – represent the choice of goods. Apart from some initiatives, long lasting, semi-hard and hard cheese, processed cheese, goat milk based dairy drinks, sauerkraut products and desserts (puddings) are absolutely absent from the range.

Out of the numerous obstacles of the increase of industrial processing there are *three* very important ones:

- territories of production are totally scattered;
- a unified qualifying system and set minimum prices fixed to the quality are missing;
- the organised production development necessary for the industrial processing was not set up.

Becoming aware of the situation, in 1998, the American *ACDI/VOCA* non-profit, consultant organisation and the *National Association of Hungarian Goat Keepers and Breeders* launched a sectoral development programme. Currently, this work is being done by the *Alternative Agricultural Enterprises Developing Public Company* and the Association in question.

The *Alternative Agricultural Enterprises Developing Public Co*. was established in the May of 1998, as a professional successor of the American *ACDI/VOCA* organisation. The organisation is engaged in managing alternative branches. They start from product development then, through quality control and expert advisement; they put the product on the market. The purpose in every case is to market the product and to stabilise its position there. According to their interpretation, alternative branches are: different from the traditional, classical ones in material, processing technology and appearance, and they are performed mainly by small- and medium sized enterprises with the aim of making money.

PROSPECTS OF PROGRESS

The strategy aiming at the development of the branch can be defined as follows:

- the complete notoriety of the branch shall be established (farm- and goat number);
- it is necessary to improve and stabilise market relations, domestic market demands and consumption shall be increased with making meet and dairy products known;

- testing and market introduction of new products shall be hastened;
- quality control systems shall be introduced in meat and dairy manufacturing with the purpose of better quality and bigger selling safety of products;
- goat breeding shall be made one of the basic means of environment and land protection and of upholding the population and of regional development (*Kukovics*, 1999).

As far as we try to supply consumer demands for goat milk products according to EU standards, we have to create the proper conditions, too.

There is an opportunity for *manufacturing quality proven products* with co-ordination according to a programme. Due to *market research* the chance of overproduction decreases, furthermore, overproduction can be prognosticated. What is more, products are made to meet the demands of the market, and they follow flexibly the emerging fluctuation and changes in quality.

If the sectoral system will developed successfully with co-ordinated work, such a logistical process could rise that will make the creation of the connection possible between the producers and processors. This way such products *can come into the marke*t that meet the requirements established in the EU. As a result, we can manage to make domestic goods get into the shops, and goat keepers will have a safe job. This does not simply involve the development of a single branch but it also has a *positive effect on the whole agriculture* because of the development of one element of the complex rural integration.

Nearly 100% of sheep and goat products has possibility of export. Income from goat milk is indispensable to the profitability of both goat keeping and enterprises. The development of the branch is not restricted by the EU, as products made from goat milk do not depend on EU quota that is their production is not limited by quantity but quality. This means that the increase of production is not limited.

As a consequence, we can state that goat milk processing can be a dynamically growing branch not only from the point of view of Hungarian dairy industry but that of rural development, as well.

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Corresponding author:

Orsolya Szigeti
University of Kaposvár, Faculty of Animal Science
H-7401 Kaposvár, P.O.Box 16., Hungary
Tel.: 36 82 314 155, Fax: 36 82 320 175
e-mail: porsi@mail.atk.u-kaposvar.hu

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Prospects for environment friendly livestock production in Slovenia

S. Kavčič
University of Ljubljana, Biotechnical Faculty, Department of Animal Science, Domžale, SI-1230 Groblje 3., Slovenia

ABSTRACT

This paper aims at an assessment of Slovenian livestock production potential in light of approaching EU accession. Emphasis is given to environment friendly production, taking into account current production structures and anticipated agricultural policy after accession. Economic effects of different accession scenarios have been studied, applying APAS-PAM methodology. Results reveal importance of negotiation outcomes for Slovenian livestock production. Programmes for environmental and landscape assistance will have much higher impacts on future livestock production and proportion of recognised environment friendly farms than at present.
(Keywords: livestock production, EU accession, economic forecasts, Slovenia)

INTRODUCTION

The next European Union (EU) enlargement will have multiple impacts on candidate countries agriculture. As previous enlargement shows, farmers will have to adjust their quantities supplied, shift products and modernise in order to be competitive. Price movements due to harmonisation will probably change competitiveness and influence trade balance. Moreover, even small price variations and minor modifications in budgetary support may dramatically change the level of income earned by producers on both sides (in "old" and "new" member states), which can, in the end, lengthen the integration process for new member states. Assessment of market and income effects has been a subject of numerous studies (*Banse*, 2000; *Münch*, 2000; *European Commission*, 2002a). Their common message is that enlargement and full adoption of CAP measures by the candidate countries would lead in most of them to increased production levels and improved income position of agriculture.

The conclusions of the Berlin Summit of March 1999 and the European Commission negotiation strategy of 30th January 2002 clearly defined the financial framework of EU enlargement in the area of agricultural policy. The figures reveal that the newly-coming Member States will not be fully participating in CAP direct payments. The reason lies on lower current price levels as well as potentially negative social and macroeconomic effects in candidate countries. In addition, higher prices are expected to be a stimulus to growth of agricultural production in the new members, and this could consequently create serious additional budget pressures on CAP. The same argumentation for a two-tier agricultural policy after EU enlargement is expressed also by *Pouliquen* (2001). Therefore, it is clear that the issue concerning budgetary payments is on top of the political agenda in the negotiating process of the next EU enlargement.

The significance of the agricultural sector in Slovenia is relatively small, accounting for around 3.5% of GDP and 6% of total employment after transition, with a further decreasing rate over the last four years. Contrary to other candidate countries, producer prices in Slovenia are almost at the EU level and due to the natural and structural conditions, Slovenia is a net importer of food, with a smaller potential for production growth. Private-owned land is mostly divided between 86 thousand small, mainly part-time family farms (Agricultural census 2000 data, according to Eurostat definition) with an average farm size of 5.2 ha utilised agricultural area (UAA). Few agricultural enterprises have evolved from the formerly "social" agricultural estates. Detailed farm size structure in 2000 along with share of farms with livestock is presented in *Table 1*. 7 out of 8 Slovenian farms have less than 10 ha UAA and less than 10% of farms have no farm animals.

Table 1

Farm structure and frequency of livestock on Slovenian farms in 2000

Farm size (UAA, ha)	Number of farms	%	Number of farms with livestock	%
Landless	44	0.1	44	0.1
> 0 to 2 ha	23363	27.0	17538	22.6
> 2 to 10 ha	52188	60.4	49434	63.7
> 10 to 50 ha	10700	12.4	10493	13.5
> 50 to 100 ha	98	0.1	86	0.1
> 100 to 500 ha	59	0.1	35	0.0
> 500 ha	15	0.0	7	0.0
Total	86467	100	77637	100

Source: special processing of agricultural census data (SORS, 2002)

The level of support for agriculture in Slovenia is significantly higher than in any other candidate country. PSE estimates by OECD (2001) show that for the whole period of 1992-1999 Slovenian producers were subsidised. It is apparent that market price support represented more than 80% of total agricultural support. In 1995-1999, average percentage PSE in Slovenia (41%) was above the OECD level (35%) and nearly the same as in EU (42%). The high PSE levels in Slovenia reflect substantial domestic price support and border protection for the most important agricultural commodities (milk products, beef and pork), as well as steadily growing budgetary transfers to producers. In addition, the Slovenian agricultural policy framework (objectives and measures) is already close to that of the CAP. Direct payments and intervention mechanisms (but not quotas), introduced by the 2000-2002 agricultural policy reform, aim to adjust domestic policy to such a degree that accession will not yield dramatic modifications for producers.

The objective of this paper is to contribute to the discussion on EU enlargement with the estimation of the possible impacts (production trends, agricultural income and competitiveness) for the livestock sector in Slovenia. By the use of relevant empirical tools it is tested whether Slovenian animal farming will actually depend on the level of EU direct aids and other budgetary provisions after accession. Emphasis is given to prospects for most of family farms with relatively low concentration of animals per area farmed. In the second part of the paper a crude estimation of Slovenian livestock production, which could be characterised as low input and therefore close to environment friendly, is carried on. The paper concludes with discussion on likely development of Slovenian livestock production and opening of some dilemmas, which should be solved before Slovenian accession to the EU.

MATERIALS AND METHODS

The accession simulation part of the analysis is based on a synthetic-type, multi-market, partial equilibrium model APAS (Agricultural Policy Analysis Simulator) together with a policy analysis matrix (PAM) to explore agricultural price and trade policy options in Slovenia. The APAS is designed as a national sector model, taking into account the specific features of Slovenian agro-industry and recent policy changes (*Kavčič*, 2000). It is primarily focused on market projections. On the other hand, PAM has been used for analysing income, protection and competitive issues for the same policy scenarios.

The model includes all most important agricultural "PSE commodities" (arable crops: wheat and maize, barley and sugar beet; livestock products: milk, beef, pork and poultry, eggs and sheep meat). Together these commodities account for approx. 80% of Slovenian gross agricultural output. In this paper only livestock production model results are presented. Data and scenarios for APAS-PAM modelling are described by *Kavčič* (2002).

Estimation of low, medium and high input share of Slovenian livestock production has been carried out on the ground of modified FAO approach (*FAO*, 2001). FAO definitions are not very precise and one can expect that "production environment", judged as high input in some part of the world (i.e. Subsaharan Africa), will be treated as medium input or even low input in Western Europe. Therefore, one can expect that personal judgement will have high impact on information obtained from some statistical sources of data.

Approach that can not avoid this subjective opinion about the level of human intervention, has been extensively discussed in a group of Slovenian livestock experts and judged to be most appropriate for application in Slovenian situation as it stands (i.e. data availability). Classification of farms has been done in two steps. The first stage involves farms' classification into four operation types, what has been done on the ground of herd size (as proxy of farms market orientation), followed by second division into "production systems" within already calculated number of households. Subsistence farms are certainly less managed/modified by human intervention, therefore (as a rule) the highest share was allocated as low input production system. Opposite is true for large scale commercial farms. For each species separate distribution criteria have been proposed and discussed with local experts. Special attention in discussion is paid also to the fact that 60% of Slovenian farms have on their farmyards 2 or even more livestock species (*Table 2*).

Table 2

Number of animal species* on Slovenian farms

Number of species	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Number of farms	11858	23719	36220	11439	2567	515	120	27	1	1
Share (%)	13.7	27.4	41.9	13.2	3.0	0.6	0.1	0.0	0.0	0.0

**Only 10 most important species listed in table 10 included in tabulation*

RESULTS AND DISCUSSION

Detailed scenario results of likely EU accession impacts for Slovenian agriculture has been already presented elsewhere. The most recent results can be found in *Erjavec* et al. (2002) and *Kavčič* et al. (2002). Therefore, here are presented only the most interesting one, related to production, income and competitive issues, which are most closely connected also with the topic of this paper - namely, to likely prospects for Slovenian livestock production. Model results for livestock production are summarised in *Tables 3, 4, 5* and *6*. They refer to year 2004, the year of expecting Slovenian accession to the EU.

Mainly due to price and budgetary revenue disparities, assumed by both accession scenarios, some significant changes in livestock production can be predicted even in the short run (*Table 3*). Pork, poultry and eggs production would be affected most by the price reduction, while milk production would be reduced due to quotas imposed. Only beef production is expected to increase significantly or - under least favourable conditions, which are more realistic - at least not drop. The extent of change depends strongly on compensation eligibility (number and level of premium rights).

Table 3

Projected domestic livestock production under various policy scenarios (BS=100)

Scenario	Milk	Beef	Pork	Poultry	Eggs	Sheep meat
EUe+	98.2	114.4	97.1	99.0	92.8	101.0
EUe-	90.4	113.3	93.1	92.0	77.6	102.1
EUp+	86.0	102.1	97.6	99.6	93.2	95.8
EUp-	86.0	100.3	93.7	92.6	78.1	93.4

The results of the policies under the optimistic EUe+ scenario point to a slight or even significant improvement in the income situation of many sectors, including that of dairy farmers (*Table 4*), when expressed per unit of production. But the projection is the opposite in the case of more likely EUp. scenario. Income deterioration is certainly much higher, when taking into account production quotas in calculation of sector income (*Table 5*).

Table 4

Likely agricultural income situation and rate of production rentability

	Scenario	Milk	Beef	Pork	Poultry	Eggs	Sheep meat
Income	BS	1,088	137	221	25	178	491
(EUR/hd*)	EUe+	1,100	408	220	-24	-5	731
	EUe-	889	378	145	-192	-282	782
	EUp+	1,049	172	184	-31	-19	493
	EUp-	848	149	114	-198	-292	461
Rentab.	BS	110	82	87	95	94	84
(%)	EUe+	111	110	87	91	82	103
	EUe-	99	107	80	79	62	107
	EUp+	108	85	84	91	81	84
	EUp-	96	82	78	79	61	82

**10 pigs or sheep, 10,000 chickens or 100 layers*

A significant improvement, but conditioned upon direct payments, is expected only in currently discriminated beef and potentially sheep meat production. Situation is expected to be the worst in poultry and egg sectors. In the case of non-competitive food processing industry, a rapid stagnation of intensive livestock production is expected.

Table 5

Sector and aggregate agricultural income forecast (BS=100)

Scenario	Milk	Beef	Pork	Poultry	Eggs	Sheep meat	Aggregate
EUe+	99	340	96	-93	-3	150	**129**
EUe-	74	312	61	-706	-123	163	**105**
EUp+	83	127	81	-123	-10	96	**87**
EUp-	67	109	48	-732	-128	88	**64**

In the case of realisation of the current Commission proposal (*European Commission*, 2002b), farmers' incomes at the aggregate level will significantly deteriorate in comparison with the baseline scenario. Should direct payments as assumed under EUe. be granted and prices of commodities remain relatively high (EU.+ scenario), the income situation will be improved, what is projected also in *European Commission* projection (2002a). On the contrary, it will decline dramatically with the proposed starting level of direct payments (25% + top ups) and without a significant increase (to the EU average level) of competitiveness of the domestic food industry. The difference between the quasi equal treatment accession scenario (EUe+) and the baseline one is very significant - approximately 29%, but deterioration under more realistic EUp+ is around 13%, and under also highly probable EUp- even 36%. The situation to be expected if nothing crucial happens by the end of accession negotiations is somewhere between EUp+ and EUp-, therefore the income reduction in the rank of a quarter.

Domestic resource cost ratio (DRC) and the rate of bilateral competitiveness (RBC) were estimated for all products under consideration. Results obtained are presented in *Table 6*.

Table 6

Indicators of competitiveness for key livestock commodities

	Scenario	Milk	Beef	Pork	Poultry	Eggs	Sheep meat
DRC	BS	1.71	4.88	3.48	1.21	3.22	2.93
	EUe+	1.71	3.71	1.07	1.39	1.78	2.88
	EUe-	2.10	5.01	1.29	3.09	10.87	3.88
	EUp+	1.70	3.71	1.07	1.39	1.78	2.88
	EUp-	2.09	5.01	1.29	3.09	10.87	3.88
RBC	BS	0.75	1.12	1.02	0.73	0.82	1.09
	EUe+	0.74	0.65	1.04	0.80	1.12	0.81
	EUe-	0.87	0.68	1.23	1.29	3.02	0.77
	EUp+	0.77	1.03	1.11	0.82	1.15	1.09
	EUp-	0.91	1.11	1.31	1.31	3.16	1.14

RBCs show relatively favourable competitive position of Slovenian agriculture in the event of non-discriminative EU agricultural policy environment (EUe+), conditioned upon (competitive) domestic food industry. Opposite is the case in a liberalised situation on agricultural markets (DRCs above 1 or even negative, with no exemption). Differences between various commodities are obvious. Cattle (dairy and beef) production under subsidised CAP regime seems to be more competitive than pork, poultry, eggs and sheep meat production. The reasons for this are mainly high direct payments and/or highly protected markets, resulting in high revenues in proportion to domestic opportunity costs. Sheep meat production with relatively small direct payments (EUp) is unlikely to be competitive. Pork, eggs and poultry production is far from being competitive under speculation of non-competitive domestic food industry. It is important to stress that EU accession - even under equal treatment scenario - would not significantly improve the competitiveness of great majority of investigated commodities. In cases where RBC ratio decreases under EUp in comparison with baseline (only beef), it is a consequence of still high discrepancy between domestic agricultural policy and the current CAP. For many commodities, the competitiveness of the food processing industry with lower or higher prices for rough materials could have much greater impact on the economic situation of agricultural production than agricultural policy environment itself.

Results obtained for main species applying procedure for classification of livestock farms into input intensity production systems are summarised in *Table 7*.

Table 7

Distribution of Slovenian livestock production by production systems (%)

Species	No. of farms	Share of farms with livestock			Livestock popula-tion (000)	Share of livestock population		
		Low input	Medium input	High input		Low input	Medium input	High input
Cattle	56,097	42.2	39.7	18.1	500	27.7	48.5	23.8
Sheep	4,330	73.5	23.8	2.6	96	59.2	36.4	4.3
Goats	4,775	78.1	20.3	1.6	29	60.9	32.5	6.6
Horses	4,634	18.4	54.7	27.0	14	15.1	58.2	26.7
Pigs	44,623	69.7	23.4	7.0	602	19.2	11.9	68.9
Chicken	56,687	52.7	39.2	8.1	5,835	5.5	5.8	88.7
Turkey	1,361	42.2	47.3	10.5	200	1.4	2.2	96.4
Ducks	2,771	41.9	48.9	9.2	20	27.6	49.9	22.5
Geese	908	46.2	46.9	6.8	4	34.8	48.7	16.5
Rabbits	12,682	68.1	22.4	9.4	180	49.5	31.9	18.5

Discrepancy between distribution of farms and according to population is obvious for all species with exemption of horses. Almost opposite picture is noticed in the case of pigs and poultry, where relatively small number of large farms has important share of the whole population. In these circumstances of highly concentrated livestock production it is difficult to talk about environment friendly and animal welfare production. On the other side extremely low share of high input production systems is significance of small ruminant production (sheep and goats). Almost normal distribution is noticed in cattle population as economically most important livestock sector (nearly half of total agricultural income in Slovenia comes from milk and beef production), but still with important share of low intensity farms. Most of low input and many of medium input farms are eligible to claim for special budgetary support under current CAP. This is also the feature of current Slovenian agricultural policy.

CONCLUSIONS

APAS-PAM model results show the sensitivity of Slovenian livestock production on accession conditions. The accession with relatively low level of direct and structural payments and considering low competitiveness of the food industry is far from being attractive for Slovenian producers. The general picture is even the opposite to the one that can be expected taking into account several general conclusions about EU enlargement effects. In the case of no eligibility for the whole amount of direct payments (equal treatment as current Member States), accession means a reduction of total agricultural income with enormous deterioration within some sectors (pork, poultry and eggs) and slight improvement only in currently discriminated beef sector.

Income assistance for environment friendly production seems to be much more important in the near future, when many of farmers will find it difficult to keep current income level in economic environment of decreasing producer prices, constrained milk production and very limited number of premium rights. Many of part time and more risk averse farmers will still have on their farmyards more livestock species, what usually have negative economic consequences (higher production costs). On the other side this kind of production easily follows multi-functional concept of agriculture and usually gives higher level of satisfaction to non-professional animal holders. Since such livestock production is treated as more sustainable way of natural resources utilisation, it is also easier to get public funds for supporting so called environmental programmes. In conditions prevailing in Slovenian agriculture it seems socially justified to support farmers seeking their opportunity in low input sustainable systems of farming. This especially holds for cattle, sheep and goats production to preserve already overgrown natural landscape.

It is expected that dispersed farm structure will prevail in Slovenian livestock production for a long time after EU accession, with important share of non-professional farms not only by number, but also by their contribution to volume of production and particularly by their importance in providing non-production functions and services to the society. This has to be reflected in the outcome of accession negotiations, enabling necessary budgetary support for production in less favoured areas and for sustainable type of farming.

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Corresponding author:

Stane Kavčič
University of Ljubljana, Biotechnical Faculty, Dept. of Animal Science
SI-1230 Domžale, Groblje 3., Slovenia
Tel.: 386 1 72 17 810, Fax: 386 1 72 41 005
e-mail: stane.kavcic@bfro.uni-lj.si

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Farm animal welfare legislation in Slovenia

I. Štuhec, N. [1]Siard, M. [2]Dobeic
University of Ljubljana, Biotechnical Faculty, Zootechnical Department, Domžale, SI-1230 Groblje 3., Slovenia
[1]Federation of Slovenian Societies Against Cruelty to Animals, Škofije, SI-6281 Sp. Škofije 17a., Slovenia
[2]University of Ljubljana, Veterinary Faculty, Institute of Environmental and Animal Hygiene with Animal Behaviour
Ljubljana, SI-1115 Gerbičeva 60., Slovenia

ABSTRACT

Slovenia is one of the candidate countries for the EU accession. Consequently, the legislation must be regulated in accordance with the EU directives. The important role in preparation of Slovenian farm animal welfare legislation has the Animal Welfare Council (AWC), established in 2001.
(Keywords: animal welfare, animal protection, legislation, Slovenia)

INTRODUCTION

Slovenia is a young country. Animal Protection Act was adopted after eight years of its independence, in December 1999. According to the article 38 in the mentioned act, the minister in competence of animal husbandry must establish Animal Welfare Council (AWC) and name its members. The mentioned article also defines the terms of reference of AWC:

- monitoring animal welfare conditions and suggesting measures,
- suggesting criteria for approval of experiments on animals,
- giving opinions and suggestions on animal welfare legislation in preparation and on other animal welfare issues,
- giving opinions and suggestions on other issues on request from government officials.

In line with the sixth paragraph of article 39 of *Animal Protection Act* (1999), Minister of agriculture, forestry and food adopted the *Animal Welfare Council Rule* (2000). The rule lays down the structure, tasks, competence and work procedure of AWC. AWC was established in May 2001. It has nine members: five university teachers and researchers from the fields of veterinary medicine, medicine, pharmacy, biology, animal science, one representative from meat processing industry, one from farmers association and two representatives from animal welfare organisations.

ANIMAL WELFARE LEGISLATION ADOPTED BEFORE THE ESTABLISHMENT OF AWC

Prior to the establishment of AWC some animal welfare legislation was adopted, most importantly *Animal Protection Act* (1999). The following rules and one decree were also adopted: *Animal Shelters Rule* (2000), *Rule on Ethical Commission for Animals in the Experiments* (2000), *Transport of Animals Rule* (2000, 2001) and *Decree on Rearing Free-living Animals in Captivity* (2001).

Animal Protection Act consists of the following ten parts:

I. General provisions; II. Protection of animals (rearing of animals, transport, ill and injured animals, procedures on animals, experiments on animals, slaughter and killing); III. Care of abandoned animals; IV. Animal protection organisations operating in the public interest; V. Awards and acknowledgements; VI. Animal welfare council; VII. Competence of official authorities; VIII. Control; IX. Penalties; X. Transitional and final provisions.

The opinion of AWC is that the act is not well prepared. At many points it is too detailed, it includes the provisions that should have been included in the rules. The act should be general, not including the provisions that might change shortly because of the new scientific evidence. Therefore, one of the important tasks of AWC in the near future will be the amendment of the Animal Protection Act. Probably the act would be better if it were reviewed by AWC before the adoption. However, AWC was not established at that time.

THE WORK OF AWC ON HARMONISATION OF SLOVENIAN ANIMAL WELFARE LEGISLATION WITH THE EU LEGISLATION

The first important task of AWC after its establishment was the revision of the following drafts:

- Protection of Rearing Animals Rule
- Protection of Animals in Experiments Rule

Both drafts were prepared by Veterinary administration of Slovenia in accordance with the EU directives. During the past five months, AWC has thoroughly revisioned the Protection of Rearing Animals Rule. The provisions were checked for the accordance with EU directives. The rule is prepared in accordance with the following EU directives:

- *Council Directive 91/629/EEC laying down minimum standards for the protection of calves,*
- *Council Directive 91/630/EEC laying down minimum standards for the protection of pigs,*
- *Council Directive 97/2/EC amending Directive 91/629/EEC laying down minimum standards for the protection of calves,*
- *Commission decision 97/182/EC amending the Annex to Directive 91/629/EEC laying down minimum standards for the protection of calves,*
- *Council Directive 98/58/EC concerning the protection of animals kept for farming purposes,*
- *Council Directive 1999/74/EC laying down minimum standards for the protection of laying hens,*
- *Commission decision 2000/50/EC concerning minimum requirements for the inspection of holdings on which animals are kept for farming purposes*
- *Council Directive 2001/88/EC amending Directive 91/630/EEC laying down minimum standards for the protection of pigs,*
- *Commission Directive 2001/93/EC amending Directive 91/630/EEC laying down minimum standards for the protection of pigs,*
- *Commission Directive 2002/4/EC on the registration of establishments keeping laying hens, covered by Council Directive 1999/74/EC.*

The Protection of Rearing Animals Rule has a short general part, laying down minimum standards for all rearing animals. It includes: I. General provisions, II. Protection of rearing animals; III. Transitional and final provisions.

The general part is followed by appendices. The first three are laying down minimum standards for the protection of calves, pigs and laying hens. The fourth appendix is a form for annual report, prepared by inspectors. The main standards from the first three appendices are presented here.

Appendix 1: Protection of calves

Calves, older than 8 weeks, must be housed in groups. The minimal space allowance is presented in *Table 1*.

Table 1

Minimal space allowance per group housed calf

Live weight	Minimal space allowance per animal (m^2)
less than 150 kg	1.5
150 – 220 kg	1.7
220 kg and more	1.8

Calves must not be kept permanently in darkness. Natural or artificial lighting must be provided between 9 a.m. and 5 p.m with the intensity of at least 80 lux. All calves must be inspected by the person responsible for the animals – the calves kept inside at least twice a day and the calves kept outside at least once a day. Permanent tether is prohibited. The lying area must be comfortable, clean, adequately drained and must not adversely affect the calves. Appropriate bedding must be provided for calves less than two weeks old. The diet must be adapted to the age, weight, behavioural and physiological needs of the calves.

Appendix 2: Protection of pigs

The minimal unobstructed floor area available to each weaner or rearing pig reared in a group is presented in *Table* 2.

Table 2

Minimal floor area per pig in a group

Average live weight (or category)	Minimal floor area (m^2)
10 kg or less	0.15
10-20 kg	0.20
20-30 kg	0.30
30-50 kg	0.40
50-85 kg	0.55
85-110 kg	0.65
more than 110 kg	1.00
Gilts after service	1.64
Sows	2.25
Boars (in pens not used for natural service)	6.00
Boars (in pens used also for natural service)	10.00

When sows or gilts are kept in groups of 6 or less than 6 animals the unobstructed floor area must be increased by 10%, while in the groups of 40 or more animals the unobstructed floor area may be decreased by 10%. For pregnant animals, part of the area required must be of continuous solid floor (at least 0.95 m^2 per gilt and 1.30 m^2 per sow). A maximum of 15% is reserved for drainage openings. When concrete slatted floors are used, the maximum width of the openings and the minimum slat width must be as presented in *Table 3*.

Table 3

The requirements for concrete slatted floors

Categories of pigs	Maximum width of the openings (mm)	Minimum slat width (mm)
Piglets	11	50
Weaners	14	50
Rearing pigs	18	80
Gilts after service and sows	20	80

Pigs must be kept in light with an intensity of at least 40 lux for a period of at least 8 hours per day. The level of noise should not exceed 85 dBA. Constant or sudden noise should be avoided. Animals must be inspected at least once a day by the person in charge. The lying area must be clean, dry and must not have any harmful effects on animals. The diet must be adapted to the age, weight, behavioural and physiological needs of the pigs. Pigs must be fed at least once a day, the access to fresh water must be permanent.

Boar pens must allow the boar to turn around, hear, smell and see other pigs. Sows and gilts must be kept in groups from 4 weeks after the service to 1 week before the expected time of farrowing. The side walls in the pen where the group is kept must be longer than 2.8 m; in case of less than 6 animals in a group the side walls must be longer than 2.4 m.

In the farrowing crate, the lying area must be clean, dry and comfortable. Suitable nesting material must be given to the animals, unless it is not technically feasible because of the slurry system. To satisfy their hunger and the need to chew, all pregnant sows and gilts must be given a sufficient quantity of bulky or high-fibre food as well as high energy food. The use of tethers for sows and gilts is prohibited. In the nests for piglets the floor must be solid or covered with mat, or littered with straw or any other suitable material. If castration or tail docking is practised after the seventh day of life, it can be performed only under anaesthetic. Reduction of corner teeth by grinding or clipping must be done not later than the seventh day of life. Piglets should not be weaned at less than 28 days of age. The piglets may be weaned up to seven days earlier if they are moved into specialised housings which are emptied and thoroughly cleaned and disinfected before the introduction of the new group and which are separated from housings where sows are kept. Weaners and rearing pigs should be kept in stable groups with as little mixing as possible.

Appendix 3: Protection of laying hens

The animals must be inspected by the person in charge at least once a day. The lighting regime must follow the daily rhythm of the animals – there must be 8 hours of uninterrupted darkness, allowing the hens to rest. Beside the general provisions, applicable to all rearing systems, the provisions specific for the different systems are stated. These systems are: alternative systems, unenriched cages and enriched cages.

For the alternative systems the provisions are as follows:

- either linear feeders providing at least 10 cm per bird or circular feeders providing at least 4 cm per bird,
- either continuous drinking troughs providing at least 2.5 cm per hen or circular drinking troughs providing at least 1 cm per hen,
- at least one nest for every seven hens; in case of group nests at least 1 m^2 nest space for 120 hens,
- adequate perches (at least 15 cm per hen), not placed above the litter,
- at least 250 m^2 of littered area per hen, the litter occupying at least one third of the ground surface.

Four levels are maximum in the systems with more levels. The headroom between the levels must be at least 45 cm. If hens have the access to open runs, the access holes must be at least 35 cm high; a total opening of 2 m must be available per group of 1000 hens. Open runs must be appropriate to the stocking density and to the nature of the ground, they must provide shelter from inclement weather and predators and they must have fences. Stocking density must not exceed nine laying hens per m^2 usable area. If the usable area corresponds to the available ground surface, stocking density may be 12 hens per m^2.

For the unenriched cages the provisions are as follows:

at least 550 cm^2 of cage area per hen, measured in a horizontal plane,
at least 10 cm of length of feed trough per hen,
at least 10 cm of length of continuous drinking channel per hen, or at least two nipple drinkers or two cups in a cage,
cages must be at least 40 cm high over at least 65% of the cage area and not less than 35 cm at any point,
floor slope must no exceed 14% or 8°; if floors have other than rectangular wire mesh, steeper slopes are permitted,
cages must have claw-shortening devices.

For the enriched cages the provisions are as follows:

- at least 750 cm^2 of cage area per hen, 600 cm^2 of which shall be usable. The height of the cage must be at least 20 cm at any point (other than that above the useable area). No cage shall have a total area that is less than 2000 cm^2,
- nest,
- litter – such that pecking and scratching are possible,
- perches, allowing 15 cm per hen,
- at least 12 cm of length of feed trough per hen,
- at least two nipple drinkers or two cups within the reach of each hen,
- cages must have claw-shortening devices.

In this short description no dates when the different requirements come into force are mentioned, because some of them might still be open for negotiations with EU. The Protection of Rearing Animals Rule was the first one thoroughly discussed and revised by AWC. The next in line is the Protection of Animals in the Experiments Rule, which will be presented at another occasion.

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Corresponding author:

Ivan Štuhec
University of Ljubljana, Biotechnical Faculty, Zootechnical Department
SI-1230 Domžale, Groblje 3., Slovenia
Tel: 386 1 7217 863, Fax: 386 1 7241 005
e-mail: Ivan.Stuhec@bfro.uni-lj.si

SECTION 2

ANIMAL HEALTH AND PATHOLOGY

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Rodents as possible reservoirs of leptospirosis in extensive swine breeding systems

Ž. Cvetnić, J. [1]Margaletić, M. [2]Đikić, M. [1]Glavaš, D. [3]Djikić, S. Špičić, I. [2]Jurić, K. [1]Salajpal

Croatian Veterinary Institute, Zagreb, HR-10000 Savska cesta 143., Croatia
[1]University of Zagreb, Faculty of Forestry, Zagreb, HR-10000 Svetošimunska cesta 25., Croatia
[2]University of Zagreb, Faculty of Agriculture, Zagreb, HR-10000 Svetošimunska cesta 25., Croatia
[3]University of Zagreb, Faculty of Science, Zagreb, HR-10000 Ulica kralja Zvonomira 8., Croatia

ABSTRACT

In the territory of the Forestry of Velika Gorica in the economic unit "Turopoljski Lug" investigations were carried out on the distribution of leptospira in rodents and swine of autochthonous breed of Turopolje living on that area and traditionally being extensively bred. In total the samples of 31 rodents of the following species were analysed: Apodemus (A.) agrarius, A. sylvaticus, A. flavicollis Clethrionomys glareolus, Microtus (M.) agrestis and M. arvalis. In addition, 52 blood sera of Turopolje swine were analysed. The distribution of leptospirosis in rodents and swine was demonstrated by isolation of rhinoculture (rodents) and findings of antibodies to leptospira by the reaction of microscopic agglutination. The antibodies to leptospirosis were established in six (19.4%) out of 31 blood samples of rodents analysed and of all the samples bacteriologically analysed leptospira were isolated from 1 sample 3.2%. The largest number of positive serological reactions was established in the species A. flavicollis and the antibodies to leptospira serovar (sv.) sv. australis (in three cases) and sv. pomona (in one case) were demonstrated. In the species C. graleoulos sv. sejroe and sv. australis (in one case each) were established. In swine the antibodies were established in eleven (21.1%) blood samples out of 52 blood samples of Turopolje swine analysed. The antibodies to sv. icterohaemorhagiae (two swine), sv. australis (seven swine), sv. pomona and sv. grippotyphosa (two swine) were demonstrated. Our investigation revealed the distribution of identical sv. of leptospira in rodents and swine living in the same territory (sv. australis and sv. pomona). The mice-like rodents are natural reservoirs of leptospira, thus representing a significant potential source of infection for swine kept in extensive breeding systems.
(Keywords: rodents, swine, leptospirosis)

INTRODUCTION

Leptospirosis is an acute septicaemical contagious disease of different kinds of domestic and wild animals and humans (zoonoses). The causes are different types of leptospira. Leptospirosis is a mild, benign, not so often severe septicaemia in piglets and young swine and in pregnant sows it causes abortions or stillborn or piglets alive but incapable to live. The sources of the infection are sick animals shedding leptospira in the urine. Small rodents are natural reservoirs of leptospira and may be the carriers for life. The urine of rodents and domestic animals contaminates the environment, grass, surface waters, muddy and swampy areas where leptospira persist, so such contaminated environments are the sources of infection for animals and humans.

Cho et al. (1998) described the findings of leptospira in 9.9% of rodents of *A. agrarius* kind and isolated *sv. icterohaemorrhagiae. Songer et al*. (1983) analysed 358 rodents from six localities in Arizona, isolated leptospira in 10.4% of them with *sv. ballum* as a dominating species. *Morales et al.* (1978) described the isolation of leptospira *sv. pomona* from the kidneys of rats (*Rattus norvegicus*) which were the source of *sv. pomona* on a swine farm. In 48.6% of rat kidneys the authors found changes which could be associated with leptospirosis. As a source of leptospira *sv. pomona* on a swine farm *Whyte* and *Ratcliff* (1982) specified a field mouse (*Mus musculus*). Besides for swine, the rodents can be a source of leptospira also for other animals. *Kuiken et al*. (1991) identified voles (*M. arvalis*) as possible sources of leptospira *sv. hardjo* and *sv. grippotyphosa* in cattle. *Michel et al.* (2001) identified nutria (*Myocastor coypus*) as a possible source of leptospira for animals and humans. The authors reported that in six regions of France 738 nutrias were analysed serologically and bacteriologically. In particular regions positive reactions were established in 16.5% to 66% of nutrias. From those leptospira *sv. icterohaemorrhagiae*, *sv. sejroe* were isolated. *Borčić et al.* (1986) identified a striped field mouse (*A. agrarius*) as our natural reservoir of leptospira *sv. pomona*. The findings of positive reactions to leptospirosis were described in many kinds of wild animals (*Modrić* and *Karlović*, 1977; *Borčić et al.* 1989; *Kovačić et al.* 2001; 2002).

In this paper the investigations on the prevalance of leptospirosis in small rodents and autochthonous Turopolje swine are presented. Different kinds of mice-like rodents and their distribution in a particular region are described. They are also indicated as possible potential sources of infection for swine kept in extensive breedings.

MATERIALS AND METHODS

In the investigations for sampling small rodents the traps of "Sherman" type were used for catching the rodents either dead or alive (*Baumler* and *Brunner*, 1988; *Margaletić*, 1998). The traps were set in hunting areas. Apples and the mixture of oat flakes and sardines in oil were used as baits. The determination of sampled units was carried out according to *Niethammer* and *Krapp* (1978; 1982). In total the samples of 31 rodents were analysed serologically (blood samples) and bacteriologically (kidneys).

In swine blood for serological analyses was taken by puncturing the veins *cave cranialis*, *jugularis* or an ear vein. On that occasion the blood samples of 52 Turopolje swine were serologically analysed. The swine were kept in an extensive system in the woodlot of English oaks and swampy meadows according to an old Croatian technology of low feed input and utilizing the natural resources and taking care of the balance in the environment.

The distribution of leptospirosis in small rodents and Turopolje swine was demonstrated by the findings of antibodies in their sera. As an evidence of antibodies in the sera of rodents and swine the method of microscopic agglutination was used as a standard way of serological diagnostics and classification of leptospira. In the case of demonstrating antibodies the blood samples are analysed in further dilutions of the sera (1:100, 1:200 etc.) The findings of the highest titre of antibodies for a particular antigen of leptospira and respectively the serovar in the sera indicates the "probable" serovar which caused the infection (*Johnson,* 1976). All the blood samples were analysed with the antigens of *L. interrogans* sv.: *icterohaemorrhagiae, ballum, australis, pomona, grippotyphosa, sejroe, saxkoebing, tarassovi, canicola, bataviae* and *hardjo*. The kidneys of the rodents were set on Kothof's media with the purpose of isolating leptospira.

RESULTS AND DISCUSSION

In the sampled material the following species of small rodents were identified: *A. agrarius, A. flavicollis, A. sylvaticus, Clethrionomys glareolus, M. agrestis* and *M. arvalis.* In the sampled material *A. flavicollis* was a dominating caught species. In total 31 rodents were entrapped. In the sample of 31 caught rodents the antibodies were established in six (19.3%) animals. The most serologically positive reactions were established in the species *A. flavicollis* in four rodents out of 10 caught and in the species *C. glareolus* positive reactions were established in two rodents out of five caught ones. In other species serologically positive reactions to leptospirosis were not established. In the species *A. flavicollis sv. australis* (in three cases) and *sv. pomona* (in one case) was established, while in the species *C. glareolus sv. sejroe* and *sv. australis* was established (*Table 1*).

In swine the antibodies to leptospira were established in eleven (21.1%) blood samples out of 52 blood samples of Turopolje swine. The antibodies to *sv. icterohaemorrhagiae* (in two swine), *sv. australis* (in seven swine), *sv. pomona* (in one swine) and *sv. grippotyphosa* (in one swine) were demonstrated (*Table 2*).

Table 1

Presentation of the caught rodents by species and the findings of antibodies to leptospira

Kind of Rodent	Caught Animals	Findings of Antibodies to Leptospira
Apodemus agrarius	2	0
Apodemus flavicollis	10	4
Apodemus sylvaticus	9	0
Clethionomys glareolus	5	2
Microtus agrestis	2	0
Microtus arvalis	3	0
Total	31	6

Table 2

Presentation of the number and percentage of positive animals investigated with particular types of leptospira

L. interrogans	**Positive swine blood samples**		**Positive rodents**		**Total number of animals positive to leptospirosis**	
	Number	**%**	**Number**	**%**	**Number**	**%**
sv. icterohaemorr.	2	18.2	0	0	2	11.8
sv. australis	7	63.6	4	66.6	11	64.6
sv. pomona	1	9.1	1	16.7	2	11.8
sv. sejroe	0	0	1	16.7	1	5.9
sv. grippotyphosa	1	9.1	0	0	1	5.9
Total	11	100	6	100	17	100

The epizooties of leptospirosis can be understood only if being considered as a wider biological phenomenon, as is the case with many other anthropozoonoses. An age-long persistence of leptospira genus is made possible by animals. On the list of leptospira reservoirs there is a large number of animals, mostly vertebrates - mammals, birds and amphibians. The survival of leptospira in nature is made possible by a so-called "basic host" which in certain natural biocenosis and symbiosis makes their survival possible.

This is known for *sv. icterohaemorrhagiae* where the basic host is a migrant rat (*Rattus norvegicus*), *sv. grippotyphosa* and a field vole (*M. arvalis*), *sv. pomona* and a striped field mouse (*A. agrarius*) and a swine, *sv. sejroe* and a house mouse (*Mus musculus*), *sv. saxkoebing* and ayellow-necked mouse (*A. flavicollis*) (*Borčić*, 1982). The species mentioned can be the carriers of certain leptospira sv. for their whole life, which was particularly well investigated in rats and *sv. icterohaemorrhagiae* (*Zaharija*, 1954). The natural foci of leptospiroses spread along our large rivers Sava and Drava and they are supported by a field vole (*M. arvalis*) which is a natural reservoir of *sv. grippotyphosa* (*Borčić et al.*, 1987). Another example of such a natural focus is a striped field mouse (*A. agrarius*), specifically for *sv. pomona* (*Borčić et al.*, 1986). In these regions in mice-like rodents the presence of some other leptospira is also demonstrated: *sv. saxkoebing, sv. australis, sv. bataviae*, hence, it is presumed that here they also find favourable conditions for survival (*Borčić et al*., 1978). In our investigations *A. flavicollis* was a species in which the antibodies to leptospira were demonstrated most often, being followed by the species *Clethrionomy glareolus*. *Borčić et al*., (1978) identified a striped field mouse (*A. agrarius*) and a timber vole (*C. glareolus*) as the most prevailing animal species infected with leptospira.

Our findings of 19.3% of serologically positive rodents is rather high. *Cho et al*. (1998) described the findings of leptospirosis in 9.9% of rodents of *A. agrarius* kind. *Songer et al.* (1983) found the antibodies to leptospira in 10.4% of rodents at six localities in Arizona.

Borčić et al. (1989) carried out the investigations concerning the presence of leptospirosis in roe deer, fallow deer, hares and wild boars. The authors reported that the antibodies were most often found in boars, specifically in 13 (11.6%) out of 112 blood samples of the boars analysed. The findings of 21.1% of seropositive reactions to leptospirosis in Turopolje swine is quite considerable and indicates the possibility of contacts of the swine mentioned and the rodents in Turopoljski Lug. Surely, this is favoured by the surroundings, wet and swampy soil suitable for the development of leptospira and exactly in such areas these investigations were carried out. Such conclusion is indicated by almost the same percentage of swine (21.1%) and rodents (19.3%) serologically positive to leptospirosis as well as the findings of antibodies to *sv. australis* in 63.6% of positive swine and 66.6% of rodents and also the findings of antibodies to *sv. pomona* in 9.1% of swine and in 16.7% of rodents.

Leptospirosis in swine is mostly a mild disease and rarely a severe septicaemia. Most often it is manifested by abortions in heavily pregnant sows or by delivering dead piglets or those incapable to live. The most frequent serovares causing abortions in swine are *sv. pomona* and *sv. tarassovi* (*Zaharija* and *Perić*, 1966). Swine can be the carriers of leptospira germs for a year after the incidence of the infection (*Zaharija et al.*, 1976). *Morales et al.* (1978) described the isolation of leptospira *sv. pomona* from the kidneys of rats which were the source of *sv. pomona* on a swine farm. *Whyte* and *Ratcliff* (1982) as a source of leptospirosis *sv. pomona* on a swine breeding farm identified a field mouse (*A. agrarius*).

Kuiken et al. (1991) reported that voles (*M. arvalis*) were the possible sources of leptospira *sv. hardjo* and *sv. grippotyphosa* also in cattle.
Leptospirosis is zoonosis, thus *Fališevac* (1951) reported on the focus of leptospirosis in a swine breeding in which five women got ill with leptospirosis in the period of one month.

CONCLUSIONS

In the region investigated leptospirosis spreads in rodents and Turopolje swine. In the same area the prevalence of identical serovar of leptospira has been noted in rodents and swine *(sv. australis* and *sv. pomona*).

The mice-like rodents are the natural reservoirs of leptospira and represent a significant potential source of the infection for swine kept in extensive breedings and thereby represent also a danger for humans.

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Corresponding author:

Željko Cvetnić
Croatian Veterinary Institute
HR-10000 Zagreb, Savska cesta 143., Croatia
Tel.: 385 1 61 23 000, Fax: 385 1 61 90 841
e-mail: cvetnic@veinst.hr

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Pathological changes in organs of clinically healthy Turopolje breed hogs

R. Sabočanec, D. [1]Djikić, K. Čuljak, M. Robić, A. [2]Kostelić, I. [2]Jurić, I. [3]Jerković, M. [2]Đikić

University of Zagreb, Faculty of Veterinary Medicine, Zagreb, HR-10000 Heinzelova 55., Croatia
[1]University of Zagreb, Faculty of Science, Zagreb, HR-10000 Ulica kralja Zvonomira 8., Croatia
[2]University of Zagreb, Faculty of Agriculture, Zagreb, HR-10000 Svetošimunska 25., Croatia
[3]Agrocor Ltd. Co. Zagreb, Croatia

ABSTRACT

Histopathological examination of organs of four autochthonous Turopolje breed hogs kept outdoors showed changes in cardiac and skeletal muscles, liver and lungs. In all four cases cardiac muscle fibers showed homogenization and fragmentation with medium to strong perymisium activation, indicating the chronic nature of dystrophic changes, as well as an attempt of tissue reparation. Between individual muscle bundles an empty space was noticed, indicating transudation from generally thickened blood vessel walls. This state can be described as edema, except for the similar, but reticulated spaces in two cases, which were described as fat deposition in cardiac muscle. Similarly, skeleton muscle showed homogenization and fragmentation with the loss of bands of skeletal muscle, perimysium multiplication and proliferation of connective tissue fibers. Blood vessel walls in skeletal muscles grew extremely thick. In both, cardiac and skeletal muscles numerous sarcocysts of various sizes were found. Described states are of hyaline-waxy type of degeneration, with attempts of regeneration and reparation. Degenerative conditions are consequences of microelement Selenium and vitamin E deficiency. Described changes in cardiac muscle are described as cardiopathy, which together with the changes on skeletal muscle could be described as systemic myopathy. Lungs of two animals showed chronic hyperplastic bronchitis, peribronchitis and emphysema, together with some areas of lung atelectasis. In both cases the parasite sections were noticed. In two cases liver showed hydropic vacuolar changes in hepatocytes. In liver interstitium there were some mononuclear cell infiltrative proliferation rich in eosinophyles. In one case there was a well-defined nodular mononuclear lymphoid cell formation, with lymphoid cells of varying size, but without specific structure. That resembles lymphodenoid hyperplasia. All the changes described above indicate that Turopolje pigs kept outdoors, although clinically healthy, are under the burden of chronic dystrophic reparation and regeneration processes of possible nutritional deficiency stress, bacterial infections and parasitic invasions.
(Keywords: histopathological changes, organs, turopolje breed pigs)

INTRODUCTION

Systemic myopathies and myocardiopathies are recently recognized as one of major problems for veterinarian experts as well as stockbreeders. It is hard to point the most susceptible animal species, because all species are equally susceptible. Through histopathological examination of organs of Turopolje breed hogs we have to accept the fact that myopathies and myocardiopathies are not the most prominent problems just in intensive stock production. In literature data selenium and E vitamin deficiency are stressed as etiological factors for mentioned myopathies. Acid and washed out terrains, especially those rich in sulphuric unions and intensively fertilized especially with nitrogenous fertilizers, are poor in selenium and it is in a form difficult for plants to resorbe. *Schwartz* and *Foltz* (1957) have proved that selenium can prevent liver necrosis in rats and exudative diathesis in chicks. In that time it was already established that liver necrosis and exudative diathesis could be prevented with vitamin E. Based on those facts a question araised weather the organisms need additional selenium when adequate quantities of vitamin E are available. *Thompson* and *Scott* (1968 and 1970) gave the answer through examination of pancreatic necrosis in chicks. Namely, additional E vitamin did not, but addition of selenium improved the health status in animals. *Katić et al.* (1967) reported on dystrophy in year old lambs, stressing that the reason is not completely established, although pointing on many proofs that vitamin E and selenium have the most important etiological role. Also, they reported that blood levels of vitamin E in domestic animals depend on species and food. According to *Forenbacher* (1984) myopathies in domestic animals are result of constituent dispositions, especially carbohydrate diet, stress and tocoferol and selenium deficiency. Researches from *Patterson* and *Allen* (1972) are interesting. They investigated organic compositions in muscles of pathologically changed and healthy pig quarters. In their investigations no significant differences were found, so for the “syndrome of asymmetric hind quarters” in their opinion, the etiology lies in unilateral under nutrition, which is probably caused by poor vascularisation. For thickening of blood vessels *Grand* (1961) and *Van Vleet et al.* (1976) pointed that pathological processes take place in capillaries of smaller blood vessels of heart, skin, skeletal musculature, colon, stomach etc. They noticed that PAS positive material is accumulated in endothelium and subendothelially, which causes thickening of blood vessels with complete or incomplete occlusion of lumen. *Reetz* and *Bergmann* (1984) reported interesting findings. They examined heart muscles of 132 pigs approximately 120 kg weighted, 50 pigs were slaughtered as healthy, 50 were slaughtered because of circulatory collapse during transportation and 30 died during transportation. In 50% of animals swelling of intima and media of blood vessels were found and in all animals muscular elastic thickening of intima was established. According to *Grabarević* (1986) etiology of dystrophic-reparatory processes in heart and skeletal muscles is multicausal, although major cause is E vitamin and selenium deficiency. *Čuljak* (2001) stated that excessive amounts of protein in meals represent a burden for liver and other organs in processes of detoxication of ammonia and other metabolical products. Liver is central laboratory of organism with more than 3000 enzymes and 100 functions. Real proteins in pigs meal are composed of 20 ammino acids, which are divided as essential, semi essential and non-essential, and deficiency causes problems in digestion, motility, skin and hair changes, decreased immune response and failure of other functions. Along with ammino acid and vitamin deficiencies degenerative changes occur, primarily in liver. Besides, toxic products lead to decreased liver function and intoxications which are manifested as gastrointestinal disorders, liver and kidney dystrophies along with heart dystrophy with reflex stasis of blood in lungs and hypostatic pneumonia which is often mentioned in human medicine. Besides synthesis, liver does deposing and absolute or relative deficiencies along with stress often lead to pathological changes in liver. For example in intoxications and mikotoxicoses fat metamorphosis, bleeding and adenomatous hyperplasions take place.

Starving and stress lead to decrease of liver glycogen, which can be replaced, but differential diagnosis is hardened, since it mimics fat metamorphosis (*Čuljak*, 2001). The decrease of glycogen from musculature has even greater importance, since it cannot be replaced and animal, even if it survives, remains permanently undersized. Speaking about proteins, it has to be mentioned that their sufficiency causes basis or background for Glasser disease in pigs (Diseases of Swine, 1999).Pathological changes in lungs are without doubt ecological factors which on certain way predispose, or open the doors to living agents, which thereafter cause all pathological problems, inflammatory or reparatory-productive characters.(Diseases of Swine, 1999).

MATERIALS AND METHODS

For our investigation we used organs of Turopolje breed fattened (castrated) hogs (autochthonous Croatian breed). Hogs were kept in fenced vertical log frames in a region cca 40 km from Zagreb in so called outdoor system of biocenosis of oak wood and bot hornbeam wood in regular continental climates. Hogs were breed by means of old Croatian technology of low input of food and by use of natural resources (grass, acorns) of ecological system. Each animal was daily given additional 1-1.5 kg of corn (grain). Hogs were slaughtered at 18 months of age, with abattoir weight of 58-101 kg. On the slaughtering line samples of organs were taken (heart, muscle, liver, lungs), fixed in 10% formaline, embedded in wax and cut on microtome on 4-5 micrometers thin slides. Thereafter slides were stained with Hematoxylin-Eosine. In the cases of hydropsy and vacuolization in hepatocites Sudan III method was used to eliminate fat metamorphosis.

RESULTS AND DISCUSSION

Histopathological examination of organs revealed dystrophy of heart and skeletal musculature, particularly prominent in a form of homogenization and fragmentation of muscle fibers with perimisium activation (*Figure 1*). On certain places activation was quite prominent and indicated reversible chronic processes. Such changes were noticed in heart (*Figure 2*) and skeletal muscles (*Figure 3*). In literature data many authors mention selenium and vitamin E deficiencies as etiological factors of mentioned myopathies. Through analysis of breeding and keeping of investigated animals we could conclude that selenium and E vitamin deficiencies are causative agents, since food was delivered from fields of intensive agriculture and fertilized with nitrogenous fertilizers. Also, in investigated animals stress has main role, and prominent exhaustion of immunocompetent organs is present. *Carlsten et al.* (1994) described protective effects of tocopherol and selenium combination as well as propranolol in pigs subjected to experimental restraint stress, which significantly reduced intensity of necrosis in myocardium. In myocardial and skeletal muscles we have found blood vessels sclerosis (*Figure 4*), probably as a result of deficiency, but possibly other toxic materials. Liver (*Figure 5*) and lungs changes are partly of parasitic origin, i.e. migration of larvae and have chronic character, which is visible as interstitial pneumonia and athelectases (*Figure 6, 7*) and interstitial proliferative hepatitis. In some focuses in lungs cross sections of parasites were seen and eosinophyles were detected in liver. The case of limphadenoid hyperplasia in liver (*Figure 8*) cannot be completely explained, although it can be described as limphadenosis or stem centers expansion as a result of general anemia.

Figure 1

Hyaline waxy type of degeneration with perymissium activation in sceletal muscle

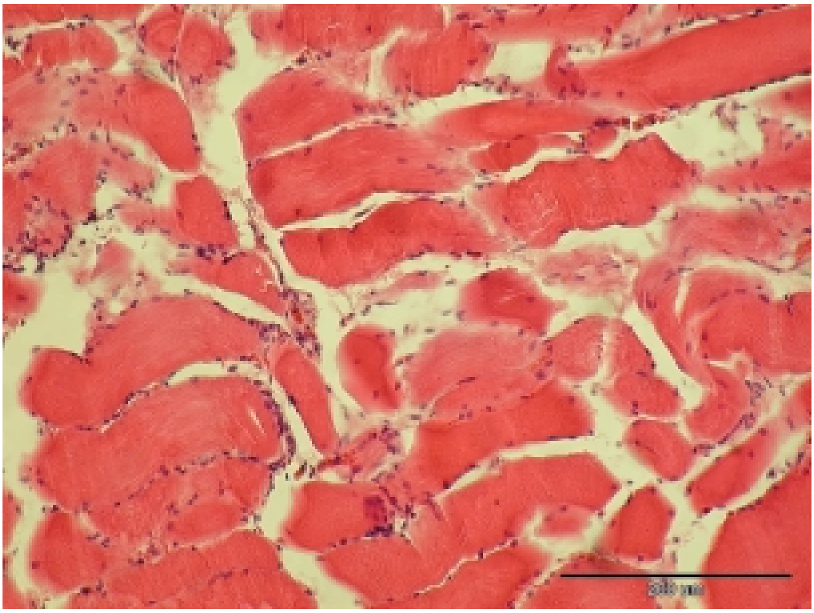


Figure 2

Sarcocysts and degeneration of cardiac muscle

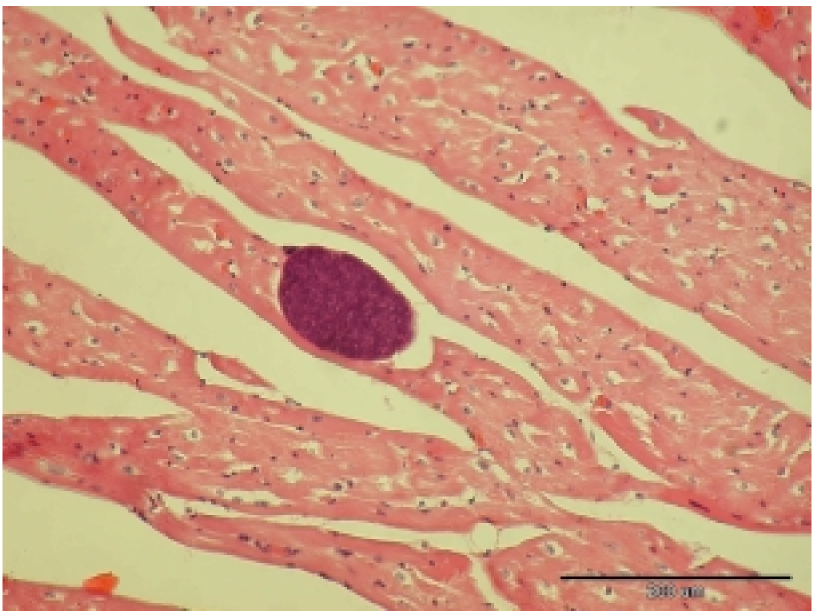


Figure 3

Sarcocysts and degeneration of sceletal muscle

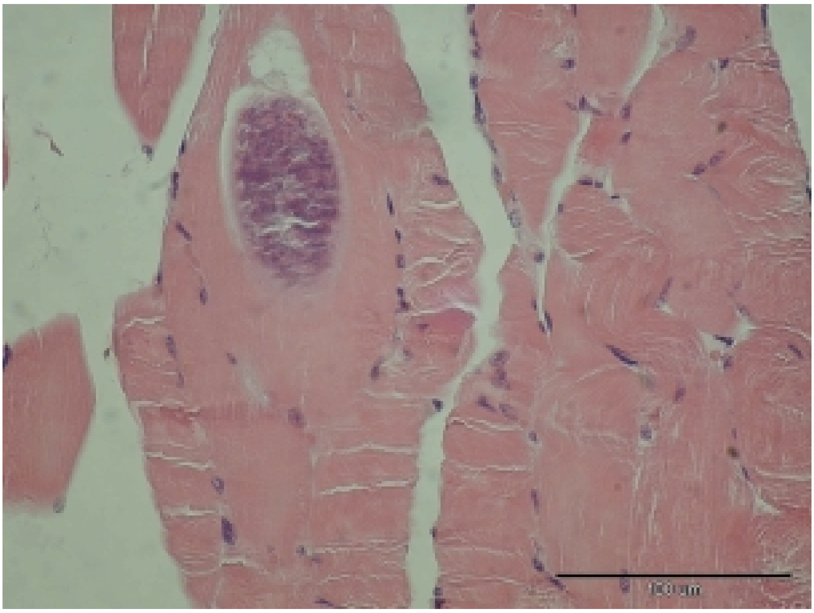


Figure 4

Fat deposition and thickening of blood wessel walls in sceletal muscle

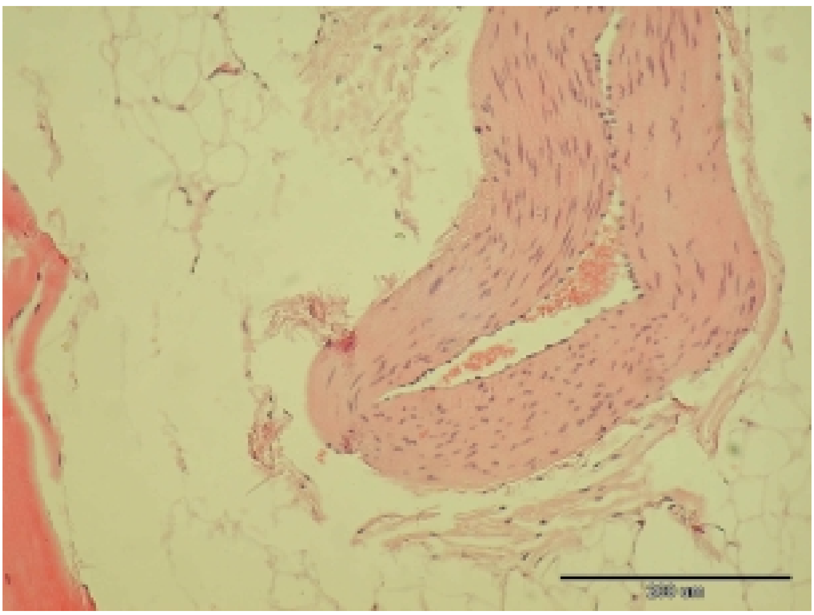


Figure 5

Hydropic and vacuolar changes and mononuclear cells proliferation in liver interstitium

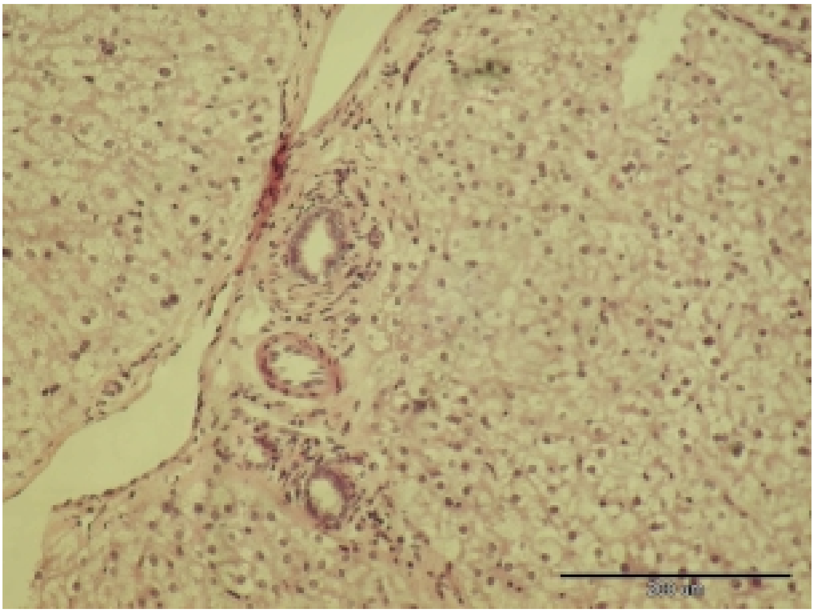


Figure 6

Parasite granuloma in lungs

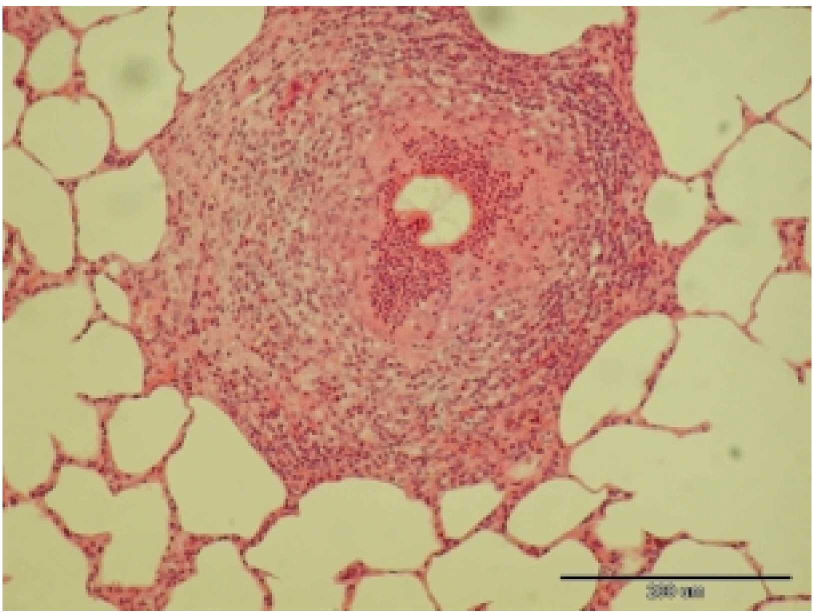


Figure 7

Cross section through two parasites and abundant eosinophile infiltration in lungs

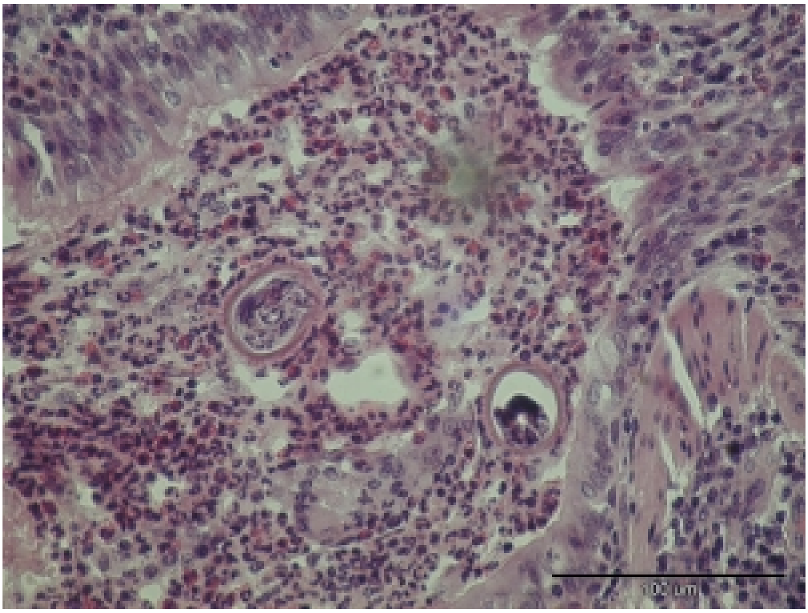
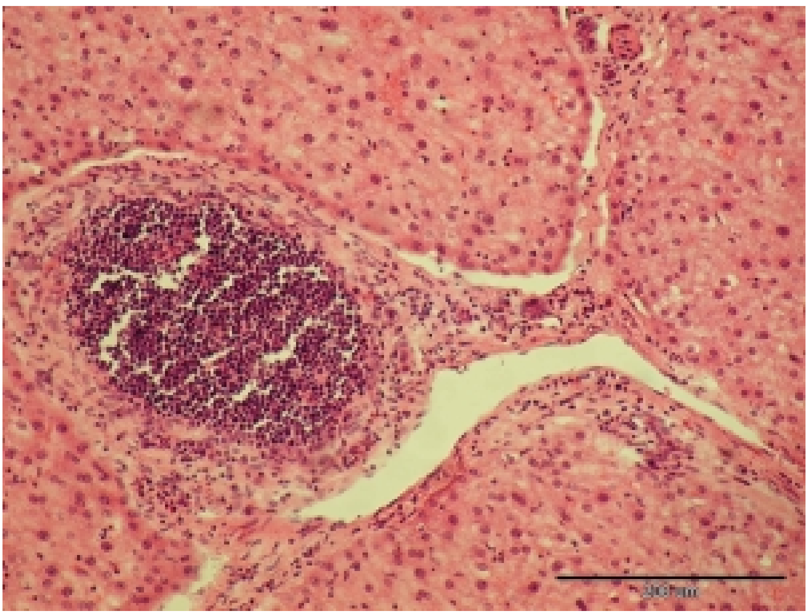


Figure 8

Lymphadenoid hyperplasia in liver



CONCLUSIONS

Based on the above mentioned facts we can conclude:

- Turopolje pigs which live in free nature are subjected to nutritive deficiencies and toxic compounds as well as pigs which are in intensive breeding
- In those pigs vitamin-mineral deficiencies are of oscillatory nature, leading to degenerative reparatory changes of chronic character
- More often than intensively bred pigs, those animals are subjected to parasitic invasions which are reflected as chronic pathological processes
- Aniparasitic therapy and vitamin-mineral supplementation are to be added (as possible) to those animals
- Also, environmental stress factors and noise should be reduced, since adaptive syndrome has often-serious consequences and leads to serious illness (decreased general resistance, infections).

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Corresponding author:

Ruža Sabočanec
University of Zagreb, Faculty of Veterinary Medicine
HR-10000 Zagreb, Heinzelova 55., Croatia
Tel.: 385 1 24 41 390, Fax: 385 1 24 41 390
e-mail: ruza.sabocanec@vef.hr

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Influence of the beehive types on the development of some diseases at apiaries

Z. Tucak, M. [1]Periškić, M. [1]Krznarić, V. [2]Feher-Belaj, S. [3]Ozimec, I. [4]Tucak

University of J.J. Strossmayer in Osijek, Faculty of Agriculture, Osijek, HR-31000 Trg Sv. Trojstva 3.,Croatia
[1]Croatian Veterinary Institute Zagreb, Veterinary Department in Vinkovci, Vinkovci, HR-32000 J. Kozarca 24., Croatia
[2]Medical School, Osijek, HR-31000 Vukovarska 209., Croatia
[3]University of J.J. Strossmayer in Osijek, Faculty of Education, Department of Biology, Osijek, HR-31000 L. Jaegera 25., Croatia
[4]University of Josip Juraj Strossmayer in Osijek, Faculty of Low, Osijek, HR-31000 Radićeva 13., Croatia

ABSTRACT

Recently we become aware of the increased presence of disease at various members of honeybee brood (queen, workers, drones), settled in the beehive. It is already known that various factors, specifically environmental factors, determines development of disease. The aim of study was to find which diseases at apiaries corresponds with similar ecological conditions at different types of beehives. The results showed a connection of some disease presence with type of beehive.
(Keywords: beehive type, disease, ecological conditions)

INTRODUCTION

According to Decree regulating the animal protection from the infectious and parasitic diseases, all apiarists, holders of the beehives have an obligation of delivering samples for the analyses to the Veterinary Institute. From the samples brought by various types of beehives the connection of some honey-bee disease with beehive type, under similar ecological conditions, has been established.

MATERIALS AND METHODS

The material for analyses was sampled at following beehive types: Alberti-Žnideršič (AŽ), Langstroth-Root (LR) and Dadant-Blatt (DB). The honeybee brood obtained food and nutrients by visiting various species of the honey vegetables: Oil-seed Rape (*Brassica oleracea* subsp. *Oleifera*), False-acacia (*Robinia pseudacacia*), Lime tree (*Tilia* spp.), Horse-chestnut (*Aesculus hippocastanum*), Sunflower (*Helianthus annuus*), Goldenrod (*Solidago* spp.), Mint (Mentha spp.), False indigo (Amorpha fruticosa), Meadow Sage (Salvia pratensis) and other meadow plants.

For the Nosema disease detection, sampled material (30 dead honeybees from the beehive's floor – winter mortality), was crushed in the mortar, adding 1 ml of water. A drop of the suspension was transferred by the pipette on a microscopic slide, covered by a cover glass and analysed under microscope magnification. The spores of *Nosema apis* have elongate and oval shape with thick mantle disrupting the light intensity.

Fort the confirmation of *Varroa mite* honeybee parasite, samples consisting the waste from the beehive's floor were dried overnight in the thermostat. After that, the material was sieved - first with a sieve which holes are 2 mm^2 in diameter, then with a sieve with 1 mm^2 diameter holes.

A small portion of the material remained after the second sieving was put on the microscopic slide and analysed under the microscope searching for the presence of parasite. All analyses were carried out by the kindness of the Veterinary Department in Vinkovci.

RESULTS AND DISCUSSION

Long-term investigations indicated the presence of various diseases at different types of beehives. The results of the analyses are shown in *Table 1* and seasonal dynamics of average temperatures and quantity of rainfall in *Vukovar-Srijem county* is shown in *Figure 1*.

The microscopic *Nosema apis* is the causative agent of the European *honeybee* nosema disease. Epozootiological situations in the surveyed area of Vukovar-Srijem County, in the 10-15 km surround from the apiaries that have been examined, is characterised by the diminutive presence of other apiary disease. Registrated abundance of the American Foulbrood disease is 0.001% while for the Chalkbrood disease is 0.01%. Sporadically incidents of the honeybee broods intoxication during the incautiously treatment of weeds with herbicides have been noticed.

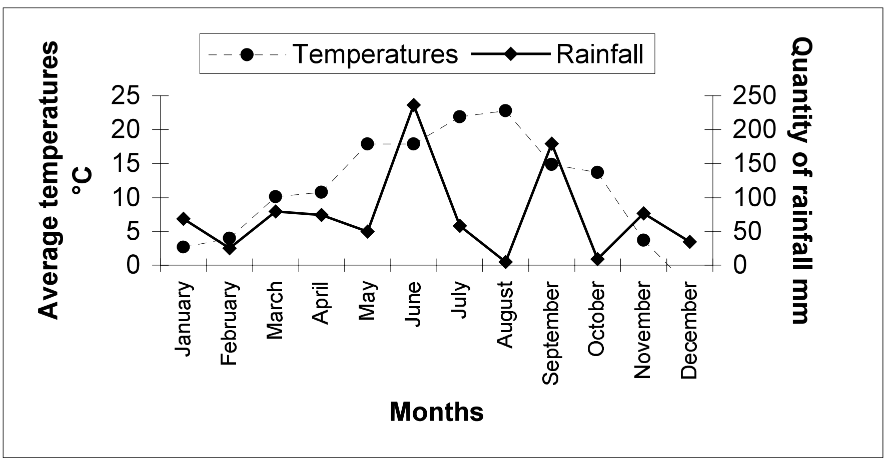
Table 1

The honeybee illness detected at different types of beehive

Beehive type	Number of examined samples	Honeybee illness			
		Nosema disease		Varroa disease	
		Number	%	Number	%
AŽ	567	219	38.62	67	11.02
LR	137	10	7.29	37	27.01
DB	20	10	50.0	8	40.0

Figure 1

Seasonal dynamics of average temperatures and precipitacion



The apiarists strongly habituates with specified type of beehive, excluding the possibilities of composing different types in their apiaries. One of the reason is a great experience in manual operating with the same beehive, and foreseeable behaviour of the honeybees.

CONCLUSIONS

Statistical data analyses by testing the warrantableness of differences between two samples clearly confirms the following:

- Significant differences ($P<0.01$) have been established between AŽ and DB beehives in connection to the presence of nosemosis
- Significant differences ($P<0.01$) have been established between AŽ and DB, and AŽ and LR beehives in the connection to the presence of varosis.

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Corresponding author:

Zvonimir Tucak
University of Josip Juraj Strossmayer in Osijek, Faculty of Agriculture
HR-31000 Osijek, Trg Svetog Trojstva 3., Croatia
T.: 385 31 224 200, Fax: 385 31 207 017

SECTION 3

BODY AND PRODUCT COMPOSITION

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Fatty acid composition of tissues of Turopolje hogs and crossbreeds

M. Đikić, I. Jurić, S. Mužic
University of Zagreb, Faculty of Agriculture, Zagreb, HR-10000 Svetošimunska c. 25., Croatia

ABSTRACT

Purpose of this research is to investigate the proportion and composition of intramuscular fat (IMF) in MLD and fat in backfat (BF) by analyzing saturated (SFA), monounsaturated (MUFA) and polysaturated (PUFA) fatty acids at hogs of Turopolje breed (T) and crossbreeds CLT (♀CL modern genotype×♂T). The pigs were produced in the outdoor system of the forest biocoenosis (Quercus robur, Fraxinus excelsior and Fagus silvatica) and marsh meadows (Deschamsietum caespitosa) in Turopolje region, which is a part of Lonjsko polje, a world known Croatian nature park. Modified traditional Croatian technology of low input of feed in ecosystem (0.5 kg of corn seed/animal/day) was implemented in the extensive management. Slaughter weight and cold carcass weight for T (86.5 kg and 69.5 kg) and CLT (126 kg and 106.1 kg) was analyzed on the slaughtering line. Sample of MLD and belonging BF were taken from the left side for fatty acid analyses. IMF in MLD and fat in fat tissue was analyzed by the Soxlet method. Fatty acids were analyzed by gas chromatography (ISO 5505/1990 method). Share of IMF in MLD in T and CLT groups of fattened pigs was 3.03% and 3.96%, respectively, while fat in BF was 92.98% and 90.8%. Following proportions of fatty acids were established for IMF in MLD and fat in BF:SFA 39.68% and 37.05%; MUFA 54.84% and 50.7% and PUFA 5.67% and 12.18%, respectively. Quality of IMF in MLD, when analyzed through UFA:SFA ratio, in both research groups was satisfactory from the aspect of human nutrition. Established values of C 18:2 and C18:3 in IMF of MLD and fat in BF for T group were 5.46% and 0.21%; and 11.4% and 0.78%, respectively. For CLT group these values were 6.4% and 0.48%; and 10.03% and 0.88%, respectively.
(Keywords: Turopolje pig breed, crossbred, fatty acid, muscle and fat tissue)

INTRODUCTION

Turopolje pig breed is the oldest Croatian autochthonous pig breed and one of the older European ones, too. Based on the historical literature, *Đikić* and *Jurić* (2001) stated that the development of this breed started with Turopolje pig, with the participation of Šiška and some other European breeds of pigs during the XVII. and XIX. century. References on the issue of pig breeds that participated in this process are so diverse that it is not possible to be certain about which of them participated in creation of Turopolje pig. Today, examination of this breed on molecular level is in progress (*Harcet et al.,* 2002). Based on the historical sources, authors set the hypothesis that Turopolje pig is an autochthonous Croatian pig, created in the period of domestication in the area of Turopolje. Turopolje pig was originally created as, and today it still is, a breed for the outdoor system of production in the ecosystem of flood forests of *Quercus robur*, *Fraxinus excelsior*, *Fagus silvatica* and the *Deschamsietum caespitosa* meadows and continental climate. Today and in the past, an old Croatian technology in breeding and production is used in the outdoor system. This technology is of a low feed input, with the possibility of utilization of natural resources of the environment (acorn, grass, soil). Turopolje pig breed has no commercial importance in today's pig meat production in Croatia. However, as Turopolje pig is a part of Croatian and world cultural heritage and biological diversity (*Robić et al.,* 1996), it has been involved in a program of protection and preservation since 1994, according to the principles of Convention on biological diversity. Besides that, research on biological characteristics of the breed are also being carried out (*Đikić et al.,* 1999; *Đikić* and *Jurić,* 2001; *Harcet et al.,* 2002). Carcass composition and meat quality is investigated by *Đikić et al.* (2002), due to the fact that *Sellier* (1998) reported that old pig breeds could be important in future selection of pigs, based on meat quality. In that context, intramuscular fat and fatty acid composition gain on importance (*Walstra et al.,* 2000; *Meadus,* 1998; *Gerbens et al.,* 1998 and *Nechtelberger et al.,* 2001).

Goal of this research was to establish the fatty acid composition of *MLD* intramuscular fat and backfat of Turopolje pig breed and their crossbreeds. Besides that, our intention is to investigate the possibilities of using this breed in meat processing, especially in production of dry-cured products.

MATERIALS AND METHODS

Research was carried out on fattened castrates of Turopolje pig breed (T, n=10) and crossbreeds (CLT, n=6). CLT crossbreeds were produced by mating T boars and CL sows (♂C–Hypor×♀Landrace). The whole productive cycle took place in the outdoor system of forest biocoenosis *(Quercus robur, Fraxinus excelsior and Fagus silvatica)* and marsh meadows *(Deschamsietum caespitosa)* in Turopolje.

Traditional Croatian technology of low feed ecosystem input (0.5 kg of corn seed/animal/day) was implemented in the extensive management. Natural resources (acorn, soil, pasture) were utilized, but having in mind the environmental balance, as well. No industrial feed, vitamin or mineral was used nor in piglet rearing, neither in fattening. Average age of fattened pigs of Turopolje breed was 595±14 days (birth from May 26-June 8, 1999 and slaughtering on January 10, 2001) and of crossbreeds it was 770 days (birth on December 2, 1998, slaughtering on January 10, 2001). Slaughtering weights of fattened pigs were established on slaughtering line, while weight of the halves warm and cold (after 24 hours of cooling on +4°C), were established after the slaughtering. Content of intramuscular fat (IMF) in samples taken from the left side (between the 13th and 14 ribth) of musculus longissimus dorsi (MLD) and fat in samples of belonging back fat (BF) was analyzed by method according to Soxhlet.

Composition of saturated (SFA), mono-unsaturated (MUFA) and polysaturated (PUFA) fatty acids was analyzed by gas chromatography (ISO 5508/1990 Method). Data was processed by GSM procedure SAS (1996).

RESULTS AND DISCUSSION

Table 1 shows carcass weights, percentages of IMF in MLD and fat in back fat tissue, as well as SFA, MUFA and PUFA values.

Table 1

Live and carcass weight of hogs and composition of fatty acid in IMF MLD and fat BF

Trait		Group					
		T			CLT		
		$\overline{x}$	S	min-max	$\overline{x}$	s	min-max
LW	kg	87.0	8.5**		126.0	5.5**	
CW	kg	69.50	8.68**		106.1	8.52**	
IMF	MLD	3.03	0.65	2.28-4.60	3.96	0.54	2.74-6.50
	BF	92.98	3.76	84.08-96.76	90.80	5.63	81.90-95.94
SFA	MLD	39.68	3.74	35.43-46.49	40.15	3.80	35.43-44.45
	BF	37.05	3.37	34.52-41.78	37.96	4.25	34.04-43.95
MUFA	MLD	54.84	2.95	50.07-59.01	52.92	2.85	49.62-56.96
	BF	50.70	1.97	48.18-55.31	51.43	1.34	50.12-53.19
PUFA	MLD	5.67	2.87	3.35-12.76	6.88	4.39	3.09-14.79
	BF	12.18	2.41	7.67-15.88	10.61	2.85	6.05-14.09

$**P<0.01$

Taking into account the age of pigs at slaughtering, results for slaughtering weight and weights of the sides obtained in both groups, as shown in *Table 1*, indicate low weight gain and different feed utilization efficiency of some animals in the outdoor system. Differences in weight are statistically significant, as expected, due to the age of pigs and their different genetic background. Although Turopolje pig is considered to be a late-mature, dual-purpose type of pig for production of both meat and fat, results of its' crossbreeds, due to their economical justification, nevertheless suggest further multidisciplinary examination. Health of the animals, management and technology of low input of feed should be looked into more closely, as well as the ecosystem as a natural source of feed, because the whole process of pig production (from birth till the end of fattening) takes place in the outdoor system of production.

Percent of IMF in MLD established in hogs of Turopolje breed (3.03) is lower than in CLT crossbreeds (3.96), while it was other way around when content of fat in BF is considered (92.98 and 90.80), but differences were not statistically significant, although that was the case in carcass weights and age of hogs.

These results are higher than values (2.53%) reported by *Kolodziej et al.* (2001) and are far above those (0.99%) reported by *Walstra et al.* (2000). Both authors carried out their researches on high meat yielding genotypes from industrial production. *Oliver et al.* (1997) established 3.96% of IMF in ML *thoracis* in Iberian breed hogs and 0.66% in Landrace, but under conditions of intensive production. This is a very interesting information, because older references citated by *Đikić* and *Jurić* (2001) point out that both Turopolje and Iberian breed descend from sus mediterraneus pig. Besides that, literature in past and meat consumers these days say that Turopolje pig has very juicy and tasteful meat, what could be a result of rather high IMF percentage in meat. Percent of IMF in MLD, established in hogs of both groups, coincides with the present picture of importance of IMF percentage for meat quality and it is one of the most recent breeding goals in pig selection.

Latest market demands on the European market, regarding the quality of fresh meat, are on the level of 2-3% of IMF, with no visible marbling. In the same time, on Japanese market pork should have more than 3% IMF, with noticeable marbling, while on the North American market IMF should be below 2% with wide spread opinion that pork is always too fatty for human health (*Maedows,* 1998).

Gerbens et al. (1998) set methods and discover a gene for Duroc pigs (heart and adipocyte fatty acid binding protein H-FAB, A-FAB) responsible for meat marbling, i.e. IMF. Also, pig population analyses in pig selection are implemented in some countries (*Maedows,* 1998; *Nechtelberger et al.,* 2001).

Content of fatty acids in IMF of MLD (Table 1) shows no significant differences in SFA, MUFA and PUFA percentage between the two groups. However, values for MUFA are higher and those for PUFA are lower in T hogs (54.84% and 5.67%, respectively), than in group CLT (52.92% and 6.93%, respectively). This could indicate that those differences are caused by the genetic base of hogs, because halves of CL sows have high meat percentage 54.5% (*Đikić,* 2001). According to data published by *Kolodziej et al.* (2001), there is a positive significant correlation (r=0,44) between percentage of muscles in carcass and PUFA and a negative one between total cholesterol in meat and PUFA (r=-0.59).

Table 2

Fatty acid composition in IMF of MLD

Fatty Acid %	GROUP					
	TUROPOLJE PIG			CROSSBREEDS (CL×T)		
	$\bar{x}$	SD	Min-Max	$\bar{x}$	SD	Min-Max
C<12	0.87	0.73	0.18-2.11	0.95	0.51	0.17-1.57
C12	0.23	0.26	0.08-0.75	0.47	0.22	0.09-0.33
C14	1.30	0.19	0.84-1.49	1.80	0.30	1.32-2.11
C15	0.16	0.18	0.05-0.52	0.13	0.10	0.03-0.26
C15:1	0.20	0.22	0.09-0.71	0.36	0.21	0.06-0.61
C16	25.20	2.30	22.91-29.53	24.78	2.64	22.50-28.34
C16:1	4.01	0.93	1.56-4.85	3.82	0.38	3.28-4.43
C17	0.23	0.03	0.18-0.28	0.22	0.06	0.13-0.29
C17:1	0.20	0.10	0.15-0.44	0.30	0.10	0.19-0.44
C18	11.06	1.28	9.75-13.28	10.68	1.02	9.38-12.12
C18:1	48.70	2.85	43.92-52.92	46.23	3.33	41.46-51.16
C18:2	5.46	2.85	3.14-12.55	6.40	4.36	2.34-14.31
C18:3	0.21	0.10	0.11-0.34	0.48	0.27	0.19-0.75
C20	0.13	0.02	0.12-0.16	0.16	0.07	0.03-0.22
C20:1	0.62	0.21	0.51-1.15	1.33	0.74	0.54-2.57
C22	0.74	0.65	0.16-1.96	0.86	0.66	0.21-2.04
C22:1	0.68	0.31	0.48-1.37	0.55	0.36	0.07-0.96
C24	0.00	0.00	0.00	0.14	0.08	0.06-0.21
C24:1	0.00	0.00	0.00	0.34	0.40	0.06-0.80

SFA was high in both experimental groups (39.68% and 40.15%), while PUFA content was low (5.67% and 6.88%). This indicates a poor meat quality, especially having in mind the most recent data reported by *Newton* (2001) and *Hayes* (2001) regarding the role of PUFA in human nutrition connected to prevention of cardiovascular diseases, autoimmune disorders, diabetes and arthritis. But when the relation between UFA and SFA is analyzed in both of the experimental groups, it could be concluded that, due to high content of MUFA, meat is of somewhat higher quality and similar to meat of meat-type pig genotypes in which *Kolodziej et al*. (2001) found 61.63% UFA. Nevertheless, quality of meat of our experimental groups is below the quality of the Iberian breed and Landrace for which Oliver established UFA content of 65.23% and 67.77%, respectively.

Fatty acid composition of fat in BF of both experimental groups, if analyzed as total UFA and SFA, shows more favorable relation than established by *Barton–Gade* (1987) in different genotypes of high meat yielding pigs, where UFA was 57.26-59.52% and SFA 40.48-43.21%. In the same time, values for UFA and SFA established by *Oliver et al.* (1997) for Iberian breed and Landrace are much higher - 65.23% and 34.64% for Iberian breed and 67.77% and 32.14% for Landrace, respectively.

Tables 2 and *3* show fatty acid composition of IMF in MLD and fat in BF.

Table 3

Fatty acid composition in fat tissue of BF

Fatty Acid %	GROUP					
	TUROPOLJE PIG			CROSSBREEDS (CL×T)		
	$\overline{x}$	SD	Min-Max	$\overline{x}$	SD	Min-Max
C<12	0.12	0.10	0.05-0.38	0.20	0.17	0.05-0.52
C12	0.09	0.04	0.06-0.17	0.13	0.07	0.06-0.24
C14	1.20	0.11	1.05-1.35	1.30	0.21	1.17-1.80
C15	0.08	0.06	0.05-0.24	0.07	0.04	0.04-0.14
C15:1	0.07	0.04	0.01-0.14	0.11	0.11	0.03-0.29
C16	22.50	1.63	20.77-25.31	23.70	2.75	19.81-27.73
C16:1	2.60	0.54	1.79-3.82	2.26	0.38	1.89-2.74
C17	0.40	0.03	0.37-0.47	0.36	0.066	0.30-0.48
C17:1	0.30	0.07	0.25-0.51	0.28	0.047	0.23-0.35
C18	11.80	2.06	7.04-14.35	11.71	1.644	10.45-14.92
C18:1	46.55	1.66	43.56-49.65	47.52	1.25	45.83-48.88
C18:2	11.40	1.95	7.34-13.17	10.03	2.55	5.64-12.89
C18:3	0.78	0.24	0.33-1.09	0.88	0.30	0.41-1.20
C20	0.15	0.04	0.10-0.24	0.17	0.06	0.10-0.28
C20:1	0.87	0.14	0.71-1.20	1.17	0.32	0.90-1.72
C22	0.62	0.27	0.31-1.22	0.77	0.49	0.40-1.71
C22:1	0.32	0.18	0.08-0.71	0.24	0.09	0.11-0.36
C24	0.09	0.04	0.06-0.14	0.10	0.03	0.08-0.13
C24:1	0.06	0.02	0.05-0.08	0.00	0.00	0.00

However, it has to be (*Table 1*) stated hereby that PUFA content in IMF of MLD in Turopolje breed and CLT crossbreeds is very low (5.55% and 6.93%, respectively), related to significance given to PUFA. Among them, without doubt, the most imported are C18:2 and C18:3 as precursors of omega-3 and omega-6 fatty acids that are recently of particular interest in human diet formulation (*Lawrie,* 1998; *Newton,* 2001; *Hayes,* 2001). It is just the analysis of the results (*Table 2* and *3*) that show very low C18:2 and C18:3 content in IMF of MLD and fat in BF of both research groups, when compared to results of *Oliver et al.* (1997), *Kolodziej et al.* (2001), *Barton-Gade* (1987) and *Cameron et al.* (1989).

However, data referred by *Cameron et al.* (2000) and *Horberg et al.* (2001) suggest that nutrition and management could change these relations in pig fat and meat. But, it has to be added that in IMF of MLD and BF of both groups of hogs, the C18:1 content in UFA shows very high values in relation to C18:2 and C18:3. That is one of properties needed for production of quality dry-cured meat products, for which it is intended in future to use meat of Turopolje pig and its' crossbreeds.

CONCLUSIONS

Content of IMF in MLD established in Turopolje pig (3.03%) and CLT crossbreeds (3.96%) correspond with recent standards of modern pig meat market.

Quality of IMF in MLD and fat in BF of both experimental groups, analyzed through SFA, MUFA and PUFA content, show especially low PUFA values, raising the question of analysis and, perhaps, change of technology of hogs feeding in the outdoor system.

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Corresponding author:

Marija Đikić
Faculty of Agriculture, University of Zagreb
HR-10000 Zagreb, Svetošimunska c. 25., Croatia
Tel.: 385 1 239 3799, Fax: 385 1 239 3947
e-mail: mdikic@agr.hr

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Fatty acid composition and cholesterol content of the fat of pigs of various genotypes

J. Csapó, É. Varga-Visi, Zs. Csapó-Kiss, É. Csokona
University of Kaposvár, Faculty of Animal Science, Kaposvár, H-7400 Guba Sándor u. 40., Hungary

ABSTRACT

The authors determined the fatty acid composition and the fat cholesterol content of the fat of Mangalica, Hungarian Large White×Hungarian Landrace and Mangalica×Duroc pigs. It was established that no significant difference among the three genotypes could be detected with respect to saturated, unsaturated, or the essential fatty acids, nor in regard to cholesterol content. The findings of these investigations indicate that in the three pig genotypes studied fat cholesterol content varies between 71 and 109 mg/100 g. Attention is also drawn to the high oleic acid content (relative% age 43.57-44.81) and linoleic acid content (relative% age 10.63-11.47) of pig fat.
(Keywords: fatty acids, cholesterol content, fat, pig, various genotypes)

INTRODUCTION

The fatty acid composition of the fat content of foodstuffs is of extremely great importance with respect to healthy human nutrition. A number of studies have reported on the substantial effect which different ratios of saturated and unsaturated fatty acids may exert on the health of those consuming them. While saturated fatty acids are considered a risk factor for cardiovascular diseases (*Burr et al*., 1989; *Hrboticky* and *Weber*, 1993), polyunsaturated fatty acids are regarded as assisting in the prevention of disease (*Simopoulos*, 1991; *Weber et al*., 1993; *Willett*, 1994). Since it was revealed that the fat contained by foodstuffs of animal origin is very rich in saturated fatty acids, the popularity of pig and cattle meat products for human consumption has recently suffered a decline, while that of poultry, fish and various sea foods, which contain high levels of unsaturated fatty acids, has increased.

The task of improving the fatty acid composition of foods of animal origin constitutes a great challenge both for livestock producers and for those involved in the production of foodstuffs. In the case of monogastrics, such as the pig, there is a reasonably good possibility for the breeder to influence, by varying the composition of the diet, the body composition of the pigs produced and the composition of foodstuffs derived from them (*Bee* and *Wenk*, 1994; *Klingenberg et al*., 1995; *Overland et al*., 1996). Despite the fact that the fatty acid composition of the fat of the various regions of the body is relatively constant, when different diets are fed significant differences between the individual tissues are observed, in relation to the fatty acid composition of the diet. In addition, genotype-dependent differences have also been detected in pigs (*Nurnberg et al*., 1994), in cattle (*May et al*., 1994) and in poultry (*Reidy et al*., 1994). According to the findings of *Sather et al.* (1996) there exists a relation of inverse proportionality between the degree of leanness and the hardness of the fat of Lacombe, Landrace and Yorkshire pigs.

In recent years zoologists and livestock breeders worldwide have joined forces in the interest of saving indigenous and introduced domestic livestock breeds from extermination. The best strategy for preventing the disappearance of such breeds is to strive to maintain genetic diversity, for which it is precisely the indigenous breeds which can prove useful.

The future of the Mangalica breed, indigenous to Hungary, is largely dependent on how its products can be utilised and how long-term market opportunities for these can be ensured. The Mangalica pig is now enjoying a renaissance in Hungary: this is due on the one hand to endeavours to return to the traditional breeds, and on the other hand to the new market opportunities presented by the production of Serrano type ham processed by means of specialised Spanish technology. The ham of the Mangalica pig is extremely suitable for the processing of products of this kind, as due to its meat:fat ratio and the distribution of the fat between its muscle fibres, the ham does not dry out even during the long-term maturing process. The meat of this breed is of outstanding quality; it has a high dry matter content and its red colour corresponds to current requirements. Its palatable flavour is derived from the fat surrounding the muscle tissue.

A quantity of information has been published recently in connection with the fatty acid composition and cholesterol content of the back fat and other fat of the Mangalica pig. It has been claimed that the fat of the Mangalica pig is softer and more easily digestible than that of modern pigs. Its softer, granular consistency is attributable to its different, and also healthier, fatty acid composition. Another view expressed is that the cholesterol content of the fat of the Mangalica pig is substantially lower than that of the fat of the new, intensive genotypes. At present the validity of this view can be neither corroborated nor refuted, since, as far as the authors are aware, there are no precise relevant experimental data available. The investigations outlined in this paper were performed for the purpose of providing scientific substantiation or disproval of the above assertions; this study involved the determination of the fatty acid composition and cholesterol content of the fat of Mangalica, Mangalica×Duroc F_1 and Hungarian Large White×Hungarian Landrace F_1 (MNF×ML) pigs. The MNF×ML genotype is one of the most extensively used crosses in Hungary, and was therefore quite suitable to act as the control.

MATERIALS AND METHODS

These investigations were performed with the collaboration of the Hungapig Co. Ltd. and the Animal Breeding and Nutrition Research Institute in Herceghalom, at the new performance testing station established in 1997. The experimental livestock were all housed in the same indoor area, with 6 pigs to a cage and 2.5 m^2 ground area per animal. Throughout the study both the Mangalica pigs and those of the other genotype constructions were fed ad libitum diets of identical composition, provided from self-feeders. The composition of the diets used and their content are shown in *Tables 1* and 2. Diet I. was fed in the live weight range of 30-70 kg, diet II. when the weight of the pigs exceeded 70 kg.

Table 1

Composition of fattening diets I. and II.

Component	Fattening diet I. (%)	Fattening diet II. (%)
Barley	15.00	15.00
Maize	59.72	57.00
Soybean meal, CP 46%	13.83	14.10
Full-fat soya (heat-treated)	5.00	-
Sunflower meal, CP 40%	-	3.53
Wheat bran	4.00	8.00
MCP (monocalcium phosphate)	0.29	0.20
Lime meal	0.05	0.06
Salt	0.11	0.11
Complete premix I for fattening pigs 2%	2.00	2.00

At live weight between 120 and 130 kg the pigs were slaughtered and their meat classified at the slaughterhouse of the Animal Breeding and Nutrition Research Institute in Herceghalom. After narcosis and slaughter, hanging to drain off the blood, boiling at 60-64°C and manual singeing away of the hair the carcasses were divided into parts. During the routine splitting and cutting into pieces of the carcasses 100 g back fat samples were taken from the region of the withers. These samples were stored in a freezer prior to laboratory analysis.

Table 2

Energy content, crude protein and amino acid composition, micro- and macroelement content and vitamin content of fattening diets I. and II.

Diet	DEs	Crude protein	Lys	Met+Cys	Ca	P	Na	Vit. A	Vit. D_3	Vit. E
	MJ/kg	%	%	%	%	%	%	NE/kg	NE/kg	mg/kg
Diet I.	13.90	16.15	0.92	0.32	0.49	0.54	0.12	11.004.0	1.650.6	34.96
Diet II.	13.57	16.34	0.89	0.63	0.48	0.56	0.12	11.004.0	1.650.6	34.96

Examination of fatty acid composition and cholesterol content
Determination of fatty acid composition

A 1 g quantity of adequately homogenised back fat was measured into a 100 cm^3 Erlenmeyer flask, to which 8 cm^3 concentrated hydrochloric acid was added; the flask was then covered and heated on a steam bath for 60-90 minutes. After cooling 7 cm^3 ethanol and 25 cm^3 ether were added and the flask was shaken for 1 minute. The ether phase was then poured off into a flask, and 25 cm^3 petrol ether of boiling point 40-60°C was added to the remainder of the sample; this was shaken for 1 minute, and after separation the petrol ether phase was poured into the ether phase, followed by homogenisation. A quantity of the resultant extract known to contain 150-200 mg fat was then transferred to a round-bottomed flask with a ground glass neck. Subsequent to evaporation the extract was boiled for 3 minutes with 4 cm^3 of a solution of boron trifluoride in methanol, and after cooling mixed with saturated aqueous saline solution.

The organic phase was dried on sodium sulphate and then injected into the gas chromatograph.

Conditions applied for gas chromatography:

Equipment:	Chrompack CP 9000 gas chromatograph
Column:	50 m×0.25 mm quartz capillary, humidifying phase CP Sil-88 (FAME)
Detector:	FID
Injector:	splitter
Gases:	carrier gas helium, 150 kPa, rate of flow 30 cm^3/min.; at the detector: air 250 cm^3/min., hydrogen 30 cm^3/min.

Temperatures: injector 220°C, detector 220°C, column initially 100°C, then increasing by 6°C/min. to 210°C, and subsequently isothermal until the process was completed

Volume injected: 0.5-2 μl

Cholesterol determination

The pure fat contained by 5 g back fat was extracted in Soxhlet extraction equipment with n-hexane; the fatty extract was evaporated, and 10 cm^3 60% potassium hydroxide and 40 cm^3 methanol were added to the residue. The flask was heated for 30 minutes on a water bath with a reflux condenser. After saponification had been completed the flask was cooled, its contents were washed into a separating funnel with 3×40 cm^3 water, and the cholesterol was extracted with 3×40 cm^3 ether. The unified ether phase was evaporated, after which the residue was dissolved in 4 cm^3 hexane and 0.5 cm^3 methanol and then injected into the gas chromatograph.

The conditions applied for the gas chromatography procedure were the following:

Equipment:	Chrompack CP 9000 gas chromatograph
Column:	10 m×0.25 mm quartz capillary, humidifying phase CP Sil-5 CB
Carrier gas:	helium, pressure 30 kPa
Flow ratio:	50:1
Temperatures:	injector 275°C, detector 300°C, column 270°C
Detector:	flame ionisation detector; hydrogen 30 cm^3/min., air 300 cm^3/ min., nitrogen 20 cm^3/ min.
Volume injected:	0.5-2 μl

Statistical evaluation of results

The Student t-test was applied for the statistical evaluation of the experimental data. The analysis of the basic statistics and the correlation analyses were performed by means of the SPSS for Windows (1996) software package, version 7.5.

RESULTS AND DISCUSSION

Table 3 contains the fatty acid composition of the fat of the pigs of different genotypes in terms of relative mass percentages of the fatty acid methyl esters, while *Table 4* shows the cholesterol content of the fat of the pigs of the various breeds.

No significant difference (at P=0.05 level) between the individual genotypes was detected either for unsaturated essential fatty acids or for unsaturated non-essential fatty acids, with the exception of eicosanoic acid. With respect to saturated fatty acids, with the exception of capric, lauric and palmitic acid, difference between the genotypes proved significant at P=0.05 level. Of these saturated fatty acids, in the case of stearic, margaric, pentadecanoic and nonadecanoic acid the MNF×ML genotype contained the higher proportion, only myristic acid being determined in higher quantities in the Mangalica pig. This signifies that the ratio of saturated fatty acids in comparison with the unsaturated fatty acids was the highest in the MNF×ML pigs (41.12:58.88), although the difference was not significant (this ratio proving to be 39.87:60.13 for the Mangalica). The value for the Mangalica×Duroc genotype was found to be closer to that obtained for the MNF×ML group. For every fatty acid under examination the control group differed non-significantly from the Mangalica pigs.

All of the three genotypes included in this study were found to deviate greatly from the hypothetically ideal ratio with respect to fatty acid composition (HIF), ratios for saturated fatty acids being calculated at only approximately 40% instead of 53-62%, while those for unsaturated fatty acids proved to be around 60% rather than 38-47%. The values for oleic acid (43-44%) were substantially higher than those reported in the literature, while those for linoleic acid (10-11%) and those for linolenic acid (0.5-0.7%) were found to correspond to the literature data.

Table 3

Fatty acid composition of the fat of the pigs of various genotypes (relative percentage of fatty acid methyl esters)

Fatty acid	Genotype		
	Mangalica, n=5	**MNF×ML, n=5**	**Mangalica×Duroc, n=5**
	Mean±SD	Mean±SD(6)	Mean±SD(6)
Capric acid	0.071±0.0087	0.08±0.011	0.082±0.0103
Lauric acid	0.09±0.0081	0.084±0.010	0.086±0.0068
Myristic acid	1.64±0.12	1.458±0.116	1.53±0.083
Pentadecanoic acid	0.04±0.0081	0.058±0.012	0.038±0.0062
Palmitic acid	25.97±0.81	25.04±1.01	26.15±0.978
Palmitoleic acid	2.65±0.47	2.27±0.32	2.49±0.424
Margaric acid	0.28±0.034	0.45±0.098	0.262±0.034
Stearic acid	11.56±1.01	13.63±0.698	12.71±1.633
Oleic acid	44.81±1.71	44.34±1.282	43.57±2.155
Nonadecanoic acid	0.059±0.012	0.074±0.019	0.054±0.0049
Linoleic acid	11.47±1.92	10.63±1.609	11.15±0.724
Arachidic acid	0.17±0.017	0.23±0.022	0.2±0.034
Eicosenoic acid	1.02±0.208	0.75±0.095	0.84±0.139
Linolenic acid	0.57±0.042	0.62±0.081	0.63±0.046
Eicosatrienoic acid	0.074±0.0106	0.084±0.022	0.068±0.0091
Arachidonic acid	0.156±0.027	0.196±0.045	0.15±0.021

Table 4

Cholesterol content of the fat of the pigs of various genotypes

Genotype	Cholesterol content (mg/100 g)
	Mean±SD
Mangalica, n=5	88.4 0±10.08
Hungarian Large White×Hungarian Landrace, n=5	83.60±11.77
Mangalica×Duroc, n=5	92.00±8.72

On the basis of these investigations it may be established that no substantial difference was ascertained with respect to either the monounsaturated, or the polyunsaturated, or the saturated fatty acids (stearic acid being the exception among the fatty acids present in concentrations above 10%) on examination of the fatty acid composition of the fat of these three pig genotypes. In the case of palmitic acid, oleic acid and linoleic acid, which together amount to more than 80% of fatty acid content, the mean values obtained practically concur. Thus, from these investigations it is possible to draw the conclusion that the fatty acid composition of the fat of the Mangalica pig is, practically speaking, totally identical in value to that of the fat of the Hungarian Large White×Hungarian Landrace and the Mangalica×Duroc genotype constructions. There are therefore no grounds for any assumption that the fat of the Mangalica breed has a more favourable fatty acid composition which would render it more easily digestible and healthier for humans than that of the intensive breeds.

A similar conclusion can be drawn with regard to the cholesterol content of the fat of these genotypes. On the basis of the average for nine animals the cholesterol content of the fat of the Mangalica was measured at 88.44 mg/100 g, that of the Hungarian Large White×Hungarian Landrace at 83.60 mg/100 g, and that of the Mangalica×Duroc F1 genotype at 92.00 mg/100 g. No significant difference at $P<0.05$ level was detected between the three genotypes with respect to fat cholesterol content; variance within the genotypes proved greater than that between genotypes. Thus, there is no truth in the reports indicating that the fat of the Mangalica pig contains less cholesterol than that of the more generally produced types of fattening pig.

However, on the basis of the findings of these investigations the authors wish to draw attention to the observation that the fat of all three genotypes examined proved to contain 43-45% oleic acid and 10-12% linoleic acid, and is thus extremely rich in unsaturated fatty acids and the essential linoleic acid when pigs are kept on a fattening diet based on one of the feed mixes currently in widespread use. The linolenic acid content (0.57-0.63%) and arachidonic acid content (0.15-0.20%) of the fat of the pigs examined proved low, while in comparison with the other fats studied stearic acid content was observed to be extremely low (11.56-13.63%).

The measurements made in this study indicate that the cholesterol content of pig fat varies between 71 and 109 mg/100g. This cholesterol content is substantially lower than that of kidney, liver, egg yolk, bone marrow or cod liver oil.

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Corresponding author:

János Csapó
University of Kaposvár, Faculty of Animal Science
H-7401 Kaposvár, P.O.Box 16., Hungary
Tel.: 36 82 314 155, Fax: 36 82 320 175
e-mail: csapo@mail.atk.u-kaposvar.hu

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

A CT-based examination of first-class meat parts in different sheep genotypes

T. Kupai, A. Lengyel, Gy. Toldi
University of Kaposvár, Faculty of Animal Science, Department of Sheep Breeding and Genetics
Kaposvár, H-7400 Guba Sándor u. 40., Hungary

ABSTRACT

The tissue components of first-class meat parts of ram and ewe lambs of four genotypes (Ile de France, Hungarian Merino, Suffolk and Pannon Meat Sheep) in 30±3 kg live weight were compared (10 animals per categories, altogether 80 animals). We demarcated the area of the tissue of first-class meats on that images, which are included these meat parts. The examinations were carried out with the help of statistical tests that were made on the basis of CT images. Concerning the fat deposition of each first class meat part, the order of the breeds was the same (Merino, Ile de France, Pannon Meat Sheep and Suffolk), which can be proven statistically. The Merino deposed three times more fat than the Suffolk. The fat deposition of the ewes is more intensive than that of the rams, however, there is a slim difference between the two sexes in meat types. We did not observe significant differences in meat area of the different breeds. The Suffolk was prominent among the others because of its small quantity of water-like materials. In order to use better the growth potential of the meat type sheeps and their F1 lambs, the increased utilisation of the advantages provided by the slaughter weight over 30 kg is advisable.
(Keywords: CT, examination, first class meat parts, sheep genotypes)

INTRODUCTION

Nowadays, the natural conditions of the world's Great Powers in sheep breeding (Australia, New Zealand and China) favour the extensive way of animal husbandry, which gives the opportunity for producing cheap but high quality wool. Due to the facts mentioned before, the price of wool has fallen significantly for the last decade. As a consequence, the 85–90% of total income of sheep enterprises that do not deal with milking at the moment derives from meat production.

The domestic breed market consists of 25 genotypes (MJSZ – Hungarian Sheep Breeder's Association's offer) in which the Merino is still dominant. To improve the amount of production, two tendencies developed in the world, and this way in Hungarian sheep branch, too: improving reproductive capacity on the one hand and slaughter value and meat quality on the other. In the Association Agreement signed in October, 1991, the EU and Hungary agreed on the export quota of mutton and live sheep. According to this the introduction of S/EUROP system validated in the EU to qualify carcasses and the reaching of 1.5 million ewes (but minimum 1.3) is planned by the time of accession. To fulfil the latter requirement, the improvement of reproductive capacity can be a solution. To improve the S/EUROP qualification of lamb carcasses of domestic production, sheep breeding researches tend towards the examination of measure of such traits that are influential in meat production. The h^2 value of the proportion of daily weight gain, live weight, slaughtering percentage and certain body components can be regarded proper.

To improve the measure of traits of meat production, no other option has existed recently but test slaughtering. The great disadvantage of this method is that the genetic development, and this way the improvement of slaughter value, is slower than expected. For the last few decades, researchers have set out to develop such methods that give opportunity for the in vivo estimation of body composition. The common development of computer technology and X-ray imaging created the method of Computer Tomography. Researches of animal breeding have proven that this technology is suitable for the determination of tissue composition, for the quantity of them *(Vangen,* 1992*)* and for the more efficient and precise in vivo estimation of the meat-fat-bone ratio than before (eg., ultrasound) (*Parrat* and *Simm*, 1987). It was proven by Australian researchers that it is worth applying in breeding value estimations (*Jopson et al*., 1997). Since 1992, several CT experiments have been performed upon different kinds of animals at the University of Kaposvár.

These examinations also prove that the performance tests (STV) which are indispensable during the selecting process can be made more efficient and precise with the help of X-ray diagnostic procedure (*Vangen*, 1992).

There is a difference in quality and price between the different kinds of meat concerning lambs put on the market of heavier slaughter weight. As regards consuming preferences, costumers prefer roast meat. Thus we concentrated on the examination of first class meats (short and long loin, thighs) during the experiment. We settled our experimenting objectives accordingly, as follows:

- Classification of fat, meat and water dense materials - according to their quantity – in the first class meat of sheep of different genotypes in the same live weight,
- and how the same measures of traits are influenced by sexes.

MATERIALS AND METHODS

The ram and ewe lambs of four genotypes (Ile de France, Hungarian Merinó, Suffolk and Pannon Meat Sheep) were evaluated in 30±3 kg live weight in the examination. The keeping and feeding of lambs performed according to the regulations of the Sheep Performance Testing Code (OMMI, 1997).

The animals involved in the experiment were examined in the Diagnostic Institute of Kaposvár University with the help of an HRCT device by observing the CT examination protocol and the animal hygienic regulations (12-24 hours starvation of animals, narcotism, fixation, weighing, imaging, relaxation before transportation).

HRCT provides the possibility of a new testing methodology, namely, the new Australian procedure of imaging (that is: data are not recorded on determined anatomical points but images were taken of all over the body in normal mode with 10 mm slice thickness and 20 mm step, 1.4 zoom factor, kv: 120, mAs: 210). Depending on live weight, 50-60 images can be taken of an animal weighing 30-35 kg from the first cervical vertebra to the hock.

The images stored on CD were processed with CTPC (*Kövér*, 1994) software. From the measuring possibilities provided by this programme, we recorded the demarcated area and its tissue division according to the density measures of *Table 1*.

11 images of each animal were used during the examination: 4-4 images to determine the sectional surface of short and long loin – every second image from the meeting point of the last dorsal vertebra towards the head and tail and 3 serial images to determine the sectional surface of the thighs from the joint of the femur head. The shoulders were not examined.

Table 1

Hounsfield variables relating to certain tissues

Values relating to different tissue types	Hounsfield variables
Fatty tissue	-200 – -20
Water dense tissue	-20 – 20
Muscle tissue	20 – 200
Bony tissue	200 – 1500

Data gained after the examinations were evaluated with different statistic procedures and tests. First, the values of the certain parts of the body were averaged. (This way we gained 1-1 value for the data of tissue varieties of the 4-4 short and long loin images and of the 3 thigh images.) Data outside the double standard deviation distance were excluded from the statistical analysis. Then the basic statistic values (average, standard deviation, minimum, maximum) were accomplished with Excel software of Microsoft Office 97® programme package. Further analyses were performed with the help of SPSS® for Windows™ 9.0 software. To compare the four groups, we used a variance analysis of variable (oneway ANOVA). The statistic tests were carried out at $P \leq 0.05(*)$, $P \leq 0.01(**)$ and $P \leq 0.001(***)$ levels.

RESULTS

Examination of fatty tissue

During the examination of fat content of the long loin, it was stated that the order of genotypes (Merino, Ile de France, Pannon Meat Sheep, Suffolk) could be proven statistically, too. However there were not any considerable differences that could have been proven between Suffolk and Pannon Meat Sheep in the case of ewes and between Pannon Meat Sheep and Ile de France rams *(Figure 1).*

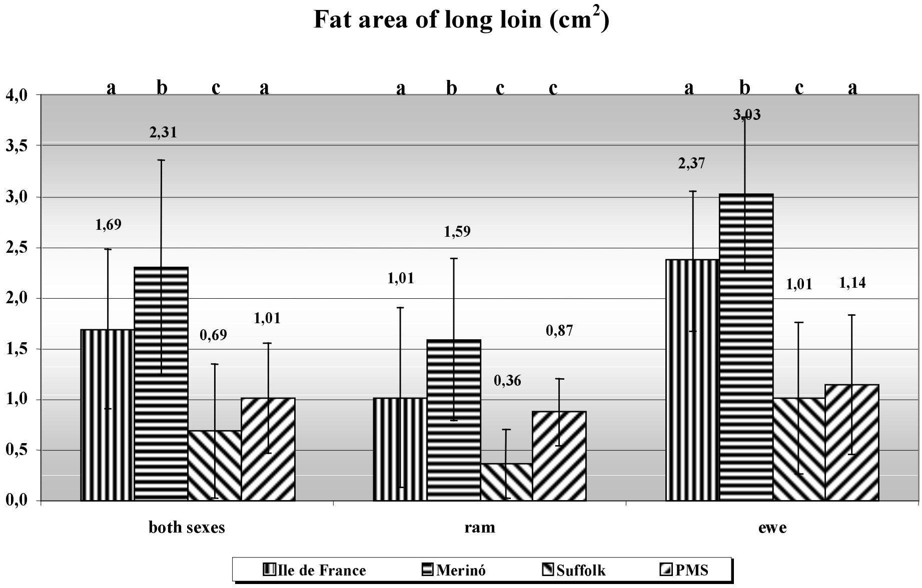
The results gained in the case of short loin can be evaluated similarly. As a result, Merino lambs depose more fat in this live weight, too, than the lambs of the other 3 breeds examined. We did not find any significant difference, either, between Suffolk and Pannon Meat Sheep in female sex and between Pannon Meat Sheep and Ile de France in male sex. The difference measured between the average fat content of the short loin of Suffolk and Pannon Meat Sheep rams is not significant.

It is worth observing the differences caused by sex: Merino ewes deposed much more fat around the meat of both loins than their breed brothers did. However there are not such differences between the meat types.

We got the same Merino, Ile de Frances, Pannon Meat Sheep and Suffolk order, when the thighs were examined. These are the only differences that are not so considerable in the group of rams, as we observed a significant differences only between Merino –Suffolk ($P \leq 0.001$) and Merino-Pannon Meat Sheep ($P \leq 0.01$).

As there are clear differences between meats, the result of the summed fat area evaluation was not surprising. As regards significance levels, the results are equal to those of the short loin in the case of the ewes and rams either. Without sexual distinction, the significant interdependencies that exist between the breeds are the same as those experienced in the case of ewes concerning the three first class meats examined, and their total fat area.

Figure 1



The letters can be seen in the graphs: variance at P≤0.05 significance level, they are different from each other.

Examination of muscle tissue

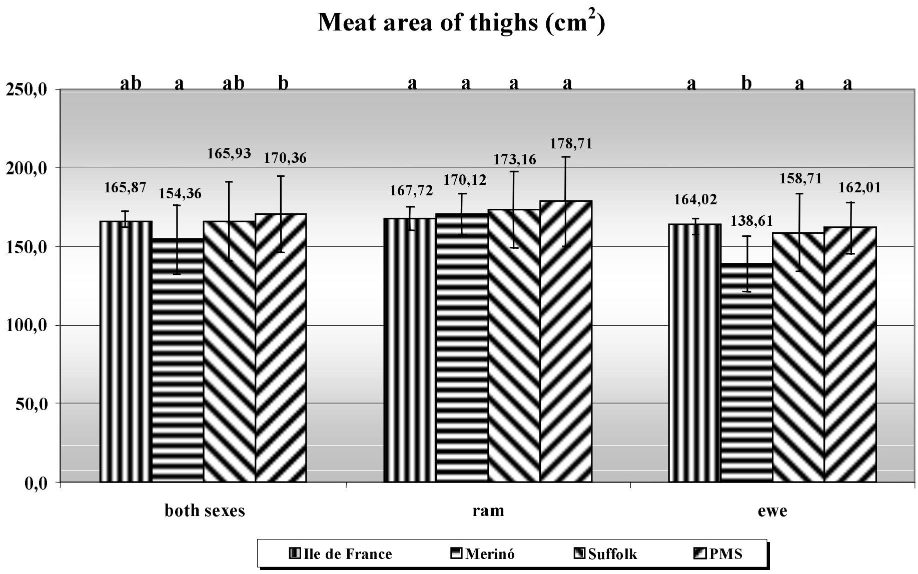
The differences observed in the quantity of muscle tissue of the long loin are rather small, they could not been proven statistically in male sex. In the case of ewes, we only found a significant difference between the highest (Ile de France) and the lowest (Suffolk) value. (P≤0.05). Examining the short loin, we found more prominent differences between the breeds though in the order of the ram group (Merino, Ile de France, Pannon Meat Sheep, Suffolk) only the advantage of the Merino over the others could be proven statistically. However, Ile de France ewes were superior to the other two meat types (Pannon Meat Sheep and Suffolk) than had smaller area.

The graph on meat area of thighs shows completely other order *(Figure 2).* Pannon Meat Sheep in male sex and Ile de France in female sex represented the highest value. The other three types just followed them closely. That is why we did not find significant difference in the case of rams. Though in the case of ewes it can be seen clearly that the meat deposition of Merino falls behind the meat types (at P≤0.01 significance level, between Merino-Pannon Meat Sheep and Merino-Ile de France; and P≤0.05 between Merino- Suffolk).

When comparing the total meat area of the three roast meats, we found a verifiable difference only in female sex with the totally same results described in connection with thighs. This can be explained with the fact that the area of thighs amounts to the biggest proportion of the sum.

If we consider both sexes, only the order observed at the short loin – except the differences of Ile de France-Merino and Pannon Meat Sheep-Suffolk – and the advantage of Pannon Meat Sheep that has the biggest meat area in thighs over Merino (at P≤0.05 level) can be proven statistically.

Figure 2



The letters can be seen in the graphs: variance at P≤0.05 significance level, they are different from each other.

Examination of water dense materials

During the evaluation of the images taken of water dense tissue-like materials, it was verified that the first class meats of Suffolk contain less interstitial tissue-like materials. It is demonstrated by the values observed in certain meats where the order was verifiable statistically in most cases of my research work (*Figure 3*).

In male sex, according to the results of water-like materials of both short and long loins, Suffolk contains significantly ($P \leq 0.001$) less interstitial tissue materials. On the contrary, there was not a significant difference between the breeds concerning water dense materials of thighs. Though there are clear differences in the case of ewes, only the difference between Ile de France and Suffolk can be proven statistically for sure in each meat.

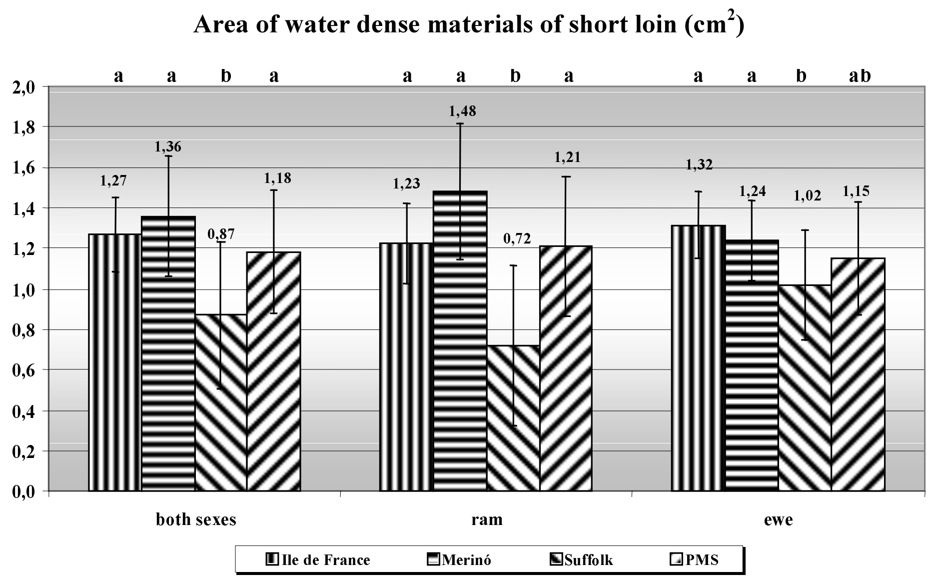
Concerning the total of water-like materials, it is Suffolk again which contains verifiably less as opposed to Ile de France being examined whether separately by sex or collectively.

CONCLUSIONS

As a summary, it can be stated that Merino deposed prominently more fat in this live weight (preceding Ile de France) than Suffolk and Pannon Meat Sheep if we take all three first-class meats into consideration (in the case of the two loins, nearly 3 cm^2 that is more than three times more, while in the case of thighs, 20 cm^2, approximately 1.5-2 times more). Our results are fortified by the fact that lambs reach their slaughtering maturity at the 50-55% of matured weight *(Veress* and *Jávor,* 1990*)*. Merino has reached this weight and hereby, beside the decline of meat deposition intensity, the increase of fat deposition has started. The low values relating to fat area in the case of Pannon Meat

Sheep can be traced back to the genetic background of the breed (influence of Suffolk and Texel). Comparing the lambs by sex, a prominent difference can be observed in the case of both Ile de France and Merino. The fat content of the ewes and rams of Pannon Meat Sheep and Suffolk differed slightly because of the endeavour to decrease sex dimorphism during their breeding. On the other hand, significant dimorphism is peculiar to Merino.

Figure 3



The letters can be seen in the graphs: variance at P≤0.05 significance level, they are different from each other.

Concerning the meat area of loins, we experienced the leading position of Merino in more cases, however, it is an advantage of approximately 1-2 cm^2, which – except the short loin of rams – can not be proven statistically. Though the method applied in my research represents an average loin and thigh area well. The weight of the loin and slaughtering capacity can not be estimated from the data relating to meat area. The reason for this is that we did not deal with the length of the spine and thighs. Thus we are not given a picture of the well-known facts that Suffolk has long trunk, Ile de France has long and wide back, and the legs of Pannon Meat Sheep are close to the four-ham type, due to the influence of Texel. Merino is mature for slaughtering in the examined 30±3 kg live weight but the growth capacity of the other breeds would not be utilised if their lambs were slaughtered at this stage or earlier. Several experiments have proven that (*Mucsi,* 1997) rams from the same breed show developed forms 20-30 days and 4-9 kg later than ewes. This is particularly true about Merino. However, it is worth observing how low standard deviation values are shown by Ile de France, and that the two sexes have nearly the same size of meat area. It can be traced back to the fact that this breed is quite a balanced one in character.

The major parts of water-like materials are interstitial tissues that give place to fat deposition in the farther stage of development. From the small amount of water-like materials of Suffolk we can conclude to a lower level of fat deposition at an older age, too. The bigger area of interstitial tissue material at ewes fortifies the evidence that ewes depose fat earlier (at a younger age) and in a bigger amount than their breed brothers.

The different breeds and cross-breedings produce the most favourable meat-bone-fat ratio at different age and development stage. Texel and F1 lambs represent developed forms at earliest time. Then come Ile de France and meat merinos in order. As opposed to this, Suffolk and Pannon Meat sheep lambs can be fattened to a heavy weight *(Mucsi,* 1997*)*.

We settled the tissue type order of the slaughter value of the breeds examined. Furthermore, we referred to the influence of sex on the amount of fat, meat and water-dense materials. In support of a better exploitation of the potential growth of meat types and their F1 lambs, it is advisable to exploit the advantages provided by the slaughter weight over 30 kg in an increased degree.

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Corresponding author:

Tímea Kupai
University of Kaposvár
Faculty of Animal Science, Department of Sheep Breeding and Genetics
H-7401 Kaposvár, P.O.Box 16., Hungary
Tel.: 36 82 314 155, Fax: 36 82 321 175
e-mail: kuti0723@freemail.hu

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Alterations in the fatty acid composition of rabbit longissimus dorsi muscle after electrical stimulation

A. Szabó, F. [1]Husvéth, [2]Zs. Szendrő, R. Romvári
University of Kaposvár, Faculty of Animal Science, Institute of Diagnostic Imaging and Radiation Oncology
Kaposvár, H-7400 Guba Sándor u. 40., Hungary
[1]University of Veszprém, Georgikon Faculty of Agricultural Sciences, Department of Animal Physiology and Nutrition
Keszthely, H-8360 Deák Ferenc u. 16., Hungary
[2]University of Kaposvár, Faculty of Animal Science, Department of Small Livestock Sciences
Kaposvár, H-7400 Guba Sándor u. 40., Hungary

ABSTRACT

The experiment was performed to investigate whether transcutaneous electrical nerve stimulation (TENS) of the longissimus dorsi muscle (MLD) of rabbits induces specific changes in the muscle fatty acid profile. Ten four-week old Pannon White rabbits were treated with TENS two times a day, with the settings: 30 Hz, 20 μs impulse length, 10 mA, 2×20 minutes. After a treatment of 50 days rabbits were experimentally slaughtered and the fatty acid composition of the MLD was measured by gas chromatography. TENS treatment increased the proportions of linoleic (C18:2 n-6), linolenic (C18:3 n-3) and gondoic acids (C20:1 n-9), compared to the control group. However, the level of palmitic (C16:0), stearic (C18:0), oleic (C18:1 n-9) and eicosapentaenoic (C20:5 n-3) acids significantly decreased. The proportion of total unsaturated fatty acids significantly increased. On the basis of the obtained results TENS may have similar effects in a specific regard on the muscle fatty acid profile like physical load. Based on the suggesion that the composition of the membranes was also affected, the electrical stimulation of muscles may have further consequences, e.g on the membrane properties and meat quality.
(Keywords: fatty acid composition, rabbit, longissimus dorsi muscle, electrical stimulation

Corresponding author:

András Szabó
University of Kaposvár, Faculty of Animal Science
Institute of Diagnostic Imaging and Radiation Oncology
H-7401 Kaposvár, P.O.Box 16., Hungary
Tel.: 36 82 314 155, Fax: 36 82 316 705
e-mail: szan1125@freemail.hu

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Body measures and indexes of the Holstein horses reared in Križevci

D. Alagić, J. Seleš, I. Seleš, M. Meštrović
College of Agriculture at Križevci, Križevci, HR-48260 M. Demerca 1., Croatia

ABSTRACT

Breading of the Holstein horses in Križevci started in 1980 by importing initial breeding material from domicile area in Germany. The aim of these studies was to establish body measures and indexes of the Holstein horses bred in Križevci, separately for stallions and mares fully grown. The investigation was carried out on forty grown-up animals that were measured with standard aids. The body indexes were calculated on the basis of the obtained values which will serve as initial values for the future Holstein breed follow-up in Croatia and its impact on breeding of the Croatian sport horse.
(Keywords: body measures, body indexes, horse breeding, Holstein horse, stud-farm)

INTRODUCTION

Breeding of the Holstein horse in Croatia started in 1980 by importing animals from a domicile area in Germany. The horses were imported by the stud-farm of the Križevci Agricultural Insitute which later developed into the Centre for Horse Breeding and Equestrian Sport. The breeding was immediately spread into the country production on the territory of Croatia and Slovenia. In 1985 the Association of the Holstein Horse Breeders in Croatia was established and today there are about 300 Holstein horses in private breeding. In the period of 22 years of the Križevci Holstein horse breeding programme three generations of animals were obtained out of the initially imported material. The aim of this paper is to analyse body characteristics of the Holstein horses reared in Križevci after becoming fully grown-up. *Rastia et al.* (2000) investigated the correlation of withers height, chest volume and cannon bone circumference among different age groups of these horses, aged up to three years. Here are presented the results of our research.

MATERIALS AND METHODS

The object of the research are the Holstein horses reared at the stud-farm in Križevci, aged four years. The investigated animals were measured with Lydtin s stick and cattle string, namely, withers height, trunk length, depth and width of the chest, chest volume and cannon bone circumference. The chest depth and width and trunk length were correlated with withers height. Based on the measurements, body indexes were calculated as follows: trunk size, compactness, rib cage and bony frame. The obtained results were analysed statistically. Forty animals in total were investigated and analysed: 14 stallions and 26 mares. A part of the investigated animals served as the basis for the research «IMPACT OF WITHERS HEIGHT, CHEST VOLUME AND CANNON BONE

CIRCUMFERENCE AFTER BIRTH ON DIFFERENT HOLSTEIN FOALS» (*Rastija et al.*, 2000). The body indexes were measured after the following formulas:

$$\text{Format indeks} = \frac{\text{trunk length}}{\text{withers height}} \times 100$$

$$\text{Trunk indeks} = \frac{\text{trunk length}}{\text{chest volume}} \times 100$$

$$\text{Compactness indeks (Eurosomy)} = \frac{\text{chest volume}}{\text{trunk length}} \times 100$$

$$\text{Rib cage indeks} = \frac{\text{chest width}}{\text{chest depth}} \times 100$$

$$\text{Bony frame} = \frac{\text{cannon bone circumference}}{\text{chest volume}} \times 100$$

RESULTS AND DISCUSSION

Body measurements and body indexes of the Holstein horses reared at the stud-farm in Križevci have been analysed for the first time in a paper and can be considered as preliminary results. These results will serve for further follow-up of the Holstein horse breeding at the Križevci stud-farm and they can be used for comparison with other breeding investigations of the Holstein horse in Croatia. The following tables show the results for stallions and mares separately.

Table 1

Body measurements of the stallions

No.	Withers height		Chest depth			Chest width			Body length			Chest volume		Cannon bone circum-ference	
	x	x-$\bar{x}$	x	x-$\bar{x}$	%V.G.	x	x-$\bar{x}$	%V.G.	x	x-$\bar{x}$	%V.G.	x	x-$\bar{x}$	x	x-$\bar{x}$
1.	175	5	79	4.65	45.14	51	3.50	29.14	172	-1.14	98.28	202	6.58	23	1.22
2.	173	3	72	-2.35	41.61	45	-2.50	26.01	170	-3.14	98.26	200	4.58	22	0.22
3.	182	12	80	5.65	43.95	47	-0.50	25.82	182.5	9.86	100.27	202	6.58	22	0.22
4.	165	-5	71	-3.35	43.03	50	2.50	30.30	173	-0.14	104.84	190	-5.42	21	-0.78
5.	171	1	77	2.65	45.03	47	-0.50	27.48	163	-10.14	95.32	195	-0.42	21.5	-0.28
6.	172	2	72	-2.35	41.86	45.5	-2.00	26.45	184	10.86	106.97	194	-1.42	22	0.22
7.	167	-3	68	-6.35	40.71	50	2.50	29.94	172.5	0.14	103.29	189	-6.42	21	-0.78
8.	177	7	75	0.65	42.37	48	0.50	27.11	180	6.86	101.69	198	2.58	23	1.22
9.	171	1	79	4.65	46.19	47	-0.50	27.48	170	-3.14	99.41	200	4.58	22	0.22
10.	167	-3	70	-4.35	41.91	49	1.50	29.34	172	-1.14	102.99	190	-5.42	21	-0.78
11.	163	-7	77	-2.65	47.23	45	-2.50	27.60	169	-4.14	103.68	195	-0.42	21	-0.78
12.	166	-4	71	-3.35	42.77	46	-1.50	27.71	176	2.86	106.02	187	-8.42	22	0.22
13.	164	-6	68	-6.35	41.46	48	0.50	29.26	171	-2.14	104.26	189	-6.42	21	-0.78
14.	168	-2	82	7.65	48.80	46	-1.50	27.38	169	-4.14	100.59	205	9.58	22	0.22
	170.07		74.35			47.5			173.14			195.42		21.78	
s	5.41		4.64			1.94			5.77			5.82		0.69	

Table 2

Body indexes of the stallions

No.	Format index	Compactness index	Trunk index	Bony frame	Rib cage index
1.	98.28	117.44	85.14	11.38	64.55
2.	98.26	117.64	85.00	11.00	62.50
3.	100.27	110.68	90.34	10.89	58.75
4.	104.84	109.82	91.05	11.05	70.42
5.	95.32	119.63	83.58	11.02	61.03
6.	106.97	105.43	94.84	11.34	63.19
7.	103.29	109.56	91.26	11.11	73.52
8.	101.69	110.00	90.90	11.61	64.00
9.	99.41	117.64	85.00	11.00	59.49
10.	102.99	110.46	90.52	11.05	70.00
11.	103.68	115.38	86.66	10.76	58.44
12.	106.02	106.25	94.11	11.76	64.78
13.	104.26	110.52	90.47	11.11	70.58
14.	100.59	121.30	82.43	10.73	56.09
	101.84	112.98	88.66	11.12	64.09
m	95.32	106.25	82.43	10.73	56.09
M	104.84	121.30	94.11	11.76	73.52

Table 3

Body measurements of the mares

No.	Withers height		Chest depth			Chest width			Body length			Chest volume		Cannon bone circum-ference	
	x	x- $\bar{x}$	x	x- $\bar{x}$	%V.G.	x	x- $\bar{x}$	%V.G.	x	x- $\bar{x}$	%V.G.	x	x- $\bar{x}$	x	x- $\bar{x}$
1.	166	1.74	72	-1.50	43.37	55	7.24	33.13	170	-2.32	102.40	200	4.89	19	-1.96
2.	156	-8.26	71	-2.50	45.51	39.5	-8.26	25.32	171	-1.32	109.61	186	9.11	20	-0.96
3.	164	-0.26	74	0.50	45.12	41.5	-6.26	25.30	170	-2.32	103.65	193	-2.11	20	-0.96
4.	166.5	2.24	72.5	-1.00	43.54	50	2.24	30.03	176.5	4.18	106.00	198	2.89	21	0.04
5.	164	-0.26	72	-1.50	43.90	47	-0.76	28.65	177	4.68	107.92	190	-5.11	20	-0.96
6.	164	-0.26	71	-2.50	43.29	49	1.24	28.87	176.5	4.18	107.62	191	-4.11	21	0.04
7.	166	1.74	74.5	1.00	44.87	48	0.24	28.91	178	5.68	107.22	200	4.89	22	1.04
8.	166	1.74	74	0.50	44.57	52.5	4.74	31.62	164	-8.32	98.79	202	6.89	22	1.04
9.	160	-4.2	74	0.50	46.25	44	-3.76	27.50	162	-10.32	101.25	192	-3.11	19	-1.96
10.	169	4.74	73.5	0.0	43.49	49	1.24	28.99	178	5.68	105.32	200	4.89	21	0.04
11.	168	3.74	74	0.50	44.04	50	2.24	29.76	177	4.68	105.35	198	2.89	23	2.04
12.	164.5	0.24	74	0.50	44.98	56	8.24	34.04	170	-2.32	103.34	202	6.89	22	1.04
13.	159	-5.26	70	-3.50	44.02	44	-3.76	27.67	171	-1.32	107.54	193	-2.11	21	0.04
14.	156.5	-7.76	72	-1.50	46.00	47.5	-0.26	30.35	162	-10.32	103.51	192	-3.11	20	-0.96
15.	162	-2.26	75.5	2.00	47.00	61.5	13.74	38.00	177	4.68	109.25	200	4.89	21	0.04
16.	163	-1.26	71.5	-2.00	43.86	43.5	-4.26	26.68	174.5	2.18	107.05	192	-3.11	20.5	-0.46
17.	160	-4.26	72	-1.50	45.00	49	1.24	30.62	169	-3.32	105.62	195	-0.11	22	1.04
18.	165	0.74	70	-3.50	42.42	48	0.24	29.09	175	0.68	106.06	195	-0.11	22	1.04
19.	168.5	4.24	74	0.50	43.91	46	-1.76	27.29	181	8.68	107.41	190	-5.11	22	1.04
20.	167	2.74	76	2.50	45.50	40	-7.76	23.95	168	-4.32	100.59	183	-12.11	20	-0.96

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21.	170.5	6.24	78	4.50	45.74	46	-1.76	26.97	186	13.68	109.09	208	12.89	22	1.04
22.	160	-4.26	76	2.50	47.50	42	-5.76	26.25	154	-18.32	96.25	195	0.11	20.5	-0.46
23.	163	-1.26	73	-0.50	44.78	47	0.76	28.83	174	1.68	106.74	194	-1.11	21	0.04
24.	163	-1.26	77	3.50	47.23	43	-4.76	26.38	166	-6.32	101.84	198	2.89	20	-0.96
25.	167.5	3.24	73	-0.50	43.58	52	4.24	31.04	175	2.68	104.47	188	-7.11	20	-0.96
26.	170	5.74	74	0.50	43.52	47.5	-2.66	27.94	178	5.68	104.70	198	2.89	21.5	0.54
	164.26		73.5			47.76			172.32			195.11		20.96	
s	3.89		2.03			5.06			6.89			5.58		1.02	

Table 4

Body indexes of the mares

No.	Format index	Compactness index	Trunk index	Bony frame	Rib cage index
1.	102.40	117.64	85.00	9.50	76.38
2.	109.61	108.87	91.93	10.75	55.63
3.	103.65	113.52	88.08	10.36	56.08
4.	106.00	112.18	88.88	10.60	68.96
5.	107.92	107.34	93.15	10.52	65.27
6.	107.62	108.21	92.40	10.99	69.01
7.	107.22	112.35	89.00	11.00	64.42
8.	98.79	123.17	81.18	10.89	70.24
9.	101.25	118.51	84.37	9.89	59.45
10.	105.32	112.35	89.00	10.50	66.66
11.	105.35	111.86	89.39	11.61	67.56
12.	103.34	118.82	84.15	10.89	75.67
13.	107.54	112.86	88.60	10.88	62.85
14.	103.51	118.51	84.37	10.41	65.97
15.	109.25	112.99	88.50	10.50	81.45
16.	107.05	110.00	90.88	10.67	60.83
17.	105.62	115.38	86.66	11.28	68.00
18.	106.06	111.42	89.74	11.28	68.57
19.	107.00	104.00	95.00	11.57	62.16
20.	100.59	108.92	91.80	10.92	52.63
21.	109.09	118.82	89.42	10.57	58.97
22.	96.25	126.62	78.97	10.50	55.26
23.	106.74	111.49	89.69	10.82	64.38
24.	101.84	119.27	83.83	10.10	55.84
25.	104.47	107.42	93.05	10.63	71.23
26.	104.70	111.23	89.89	10.85	64.18
	104.93	113.60	88.34	10.71	64.93
m M	96.25 113.25	99.47 126.62	78.97 100.52	9.50 11.61	52.63 81.45

A survey of relative measurements in relation to withers height

	Withers height	Chest depth		Chest width		Body lenght	
Stallions - 14	170.07	74.35	43.71%	47.50	27.93%	173.14	101.84%
Mares - 26	164.26	73.50	44.73%	47.76	28.96%	172.32	104.94%

A survey of body indexes in stallions and mares

	Format index	Compactness index	Trunk index	Bony frame	Rib cage index
Stallions - 14	101,84	112,98	88,66	11,12	64,09
Mares - 26	104,93	113,60	88,34	10,71	64,93

By comparing the obtained results of the withers height in stallions reared in Križevci with the wither height of the licensed stallions in domicile breeding area in Germany we can see that the average withers height of the Križevci stallions is 170.07 and that of the original stallions 167.62. The difference is that German data are applied to withers height of stallions upon licence at the age between 2.5 and three years, while the Križevci stallions were measured following the age of four and later.

CONCLUSIONS

Preliminary results of the investigations of the body measures and body indexes of the Holstein horses reared at the stud-farm of the Centre for Horse Breeding and Equestrian Sport in Križevci make the basis for further investigations and analyses of the Holstein horse population in Croatia.

The obtained data are the result of 22 year long work with the Holstein horse breeding at the stud-farm in Križevci and they can serve for similar investigation of the Holstein horse population around Croatia, as the breeding has lasted for the same period of time.

Horse breeding at the stud-farm in Križevci served as the basis for several investigations and it will continue in the future. The stud-farm i serves as the education practicum for students at the College of Agriculture in Križevci.

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Corresponding author:

Damir Alagić
College of Agriculture at Križevci
HR-48260 Križevci, M. Demerca 1., Croatia
Tel.: 48 681 622, Fax: 48 682 615

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

In vivo investigation of fatty goose liver by means of CT

G. Andrássy-Baka, R. Romvári, F. Bogenfürst, M. Molnár, L. Locsmándi
University of Kaposvár, Faculty of Animal Science, Kaposvár, H-7400 Guba Sándor u . 40., Hungary

ABSTRACT

Commercial geese (Gray Landes) were examined by means of high resolution spiral computer tomography. Three ganders were scanned six times before (1), within (2-5) and after (6) the force-feeding period. 25-40 serial CT images were taken depending on the liver size. The changes in the volume of the liver and also the characteristic Hounsfield values were determined. The mean values of volume (cm^3) were 149, 156, 234, 424, 625, 180 at the 1, 2, 3, 4, 5, 6 measuring times respectively. The characteristic X-ray density values of the liver (75-85, 80, 80, -20, –50 and 55 at the 1, 2, 3, 4, 5, and 6 period respectively) were given in Hounsfield units. The applied in vivo method may be a suitable way to study the quantitative changes of the liver and also to describe the qualitative changes of tissue composition during the force-feeding period.
(Keywords: goose liver, computer tomography)

INTRODUCTION

One of the main objectives of goose breeders is to maximize the accesible liver volume during the force-feeding period and also keep its fat content at the optimum level for the further processing industry and the consumers. Under natural conditions some degree of hepatic steatosis occurs in the wild waterfowl, as a consequence of energy storage before the migration. In poultry production, this specific capacity is utilised for the production of commercial fat liver. The excess of triglicerides is normally stored in the cytoplasmic storage vesicles of the liver. When overproduction of triglicerides occurs, which is the case during force feeding, the liver responds in two ways: the secretion of triglycerides into plasma as VLDL increases and since the force feeding does not allow the birds to be fasted, the liver continues to accumulate triglicerides (*Scahaw*, 1998).

It is well known that geese breeds differ in their susceptibility to liver steatosis considering that the response to force-feeding is partly under genetic control (*Hermier et al*., 1991). According to *Rouvier et al.* (1992) the direct genetic effects due to autosomal and sex linked genes were high and positive for fatty liver weight in selected strains of geese. It is notable that the liver weight could be increased by selection without a great effect on "paletot" weight as *Larzul et al*. (2000) established. The Landes goose – used in the present study – is among the best in response to overfeeding as described by *Mourot et al.* (2000). To a certain extent the high susceptibility of the breed is explainable with the high activity of malic enzyme and also with the fact that hepatic lipogenesis remains very active until the end of the overfeeding period to be used to improve the quality and quantity of the liver produced by geese.

At present our experiments are focusing on the preliminary step (preparation) of the force-feeding and the development of new selection methods (*Bogenfürst*, 1992). In such research it is often required to measure the body composition, exact volume and composition of organs or tissues before and during the course of the experiment. It would be ideal if these measurements could be taken on the same individuals repeatedly, using non invasive in vivo methods. Conventionally the lipid content of the liver can be measured by direct chemical analysis. According to *Guy* (2000) the total lipid content of the fatty goose liver is around 50-55%. Storage lipids are predominante, with 95% triglycerides and 1-2% cholesteryl esters. Structural membrane lipids, such as phospholipids and free cholesterol, account for only 1-2 and <1%, respectively (*Fournier et al.,* 1997). The force-feeding induces a large hypertrophy of hepatic cells in relation to the accumulation of the triglycerids. In spite of the highest liver weight, geese provide the best technological liver quality with a fat loss limited to 13.9% during autoclaving astablished *Guy* (2000).

Regarding to *Molette et al.* (2001) the near infrared reflectance spectroscopy can be a new instrumental method in the prediction of the chemical composition of goose fatty liver. There is no data in the literature about the application of *in vivo* methods in this regard of goose research.

In studies with chicken (*Bentsen* and *Sehested*, 1989; *Svihus* and *Katle*, 1993), turkey (*Brenoe* and *Kolstad*, 2000) it has been shown that computer tomography (CT) is a suitable non-invasive technique to measure the volume or mass of the Pectoralis muscle and the abdominal fat permitting single or repetitive measurements. *Romvári et al.* (2000) published a new in vivo 3D method to estimate the breast muscle of broiler chickens by computer tomography.

In the present study different in vivo CT methods were tested to follow the liver development of geese and analyse the liver composition during the force-feeding period.

MATERIALS AND METHODS

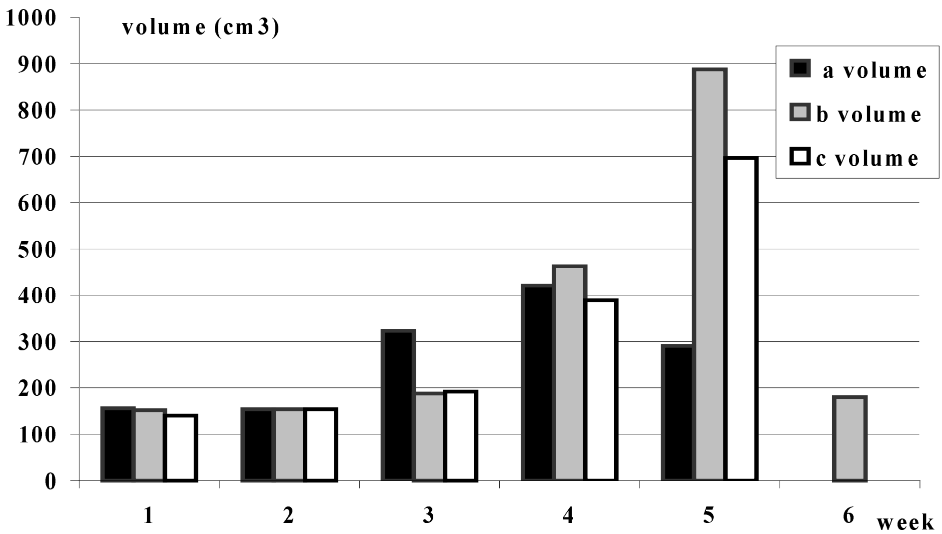
Commercial type Landes ganders were examined at 11, 15, 16, 17, 18, 20 weeks of age (altogether six times) four weeks before (1), within (2-5) and two weeks after (6) the force-feeding period. The three repeatedly examined animals (A, B, C) were selected from a larger population representing the average weight of the given age. The rearing conditions and the nutrition procedure corresponded to the common intensive management technology widely practiced in Hungary. A commercial pelleted goose feed was fed ad libitum. Twenty-eight days before the force-feeding a preparation period was started. During that interval the total daily feeding time was decreased continuously, from twice 60 minutes to twice 30 minutes. At the end of the preparation period birds had only twice 30 minutes acces to feed per day. Later on, as a result of this technological process the gullets of geese were expanded and they were able to consume the same amount of feed during half time for fatty liver production. The ganders were scanned in vivo by means of a Siemens Somatom Plus S40 spiral CT scanner at the Institute of Diagnostic and Oncological Radiation of Kaposvár University. The high resolution CT scans were taken from the geese using a zoom factor of 3.4. During the examination animals were fixed with belts in a plastic cradle without using anaesthetics. Depending on the size of the birds *25* to *40* pictures - with five mm slice thickness - covered the region of the liver. The CT scans were adjusted to take 5 mm thick imaginary slices from the liver. The picture-forming pixels are in fact small prisms with a definite volume. We are able, therefore, to determine the part of the total volume of the examined scan that falls into the Hounsfield (HU) interval of interest. Two kinds of picture evaluation method were applied. As a first approach the liver volume data were determined from the series of cross sectional images. Parallel to this the average Hounsfield value of the liver tissue was also measured. The crude fat content of the liver was determined by direct chemical analysis from „A" and „C" birds following the force feeding period.

RESULTS AND DISCUSSION

There was no negative effect of CT scanning on the liver development, as the final liver volume at the end of the force feeding (period 5) was similar to the rest of the geese from the original stock. Substantial changes were observed in the liver volume within the examined period (*Figure 1).*

Figure 1

Changes of the liver volume



At the time of the preparation (1) and the beginnig of force-feeding (2) the measured values were similar. At the end of the 21-day period (5) the volume data became three times higher compared to the starting point. Two weeks later, as a consequence of feed withdrawal „B" bird approached its starting weight. Similar observation was done by *Prehn* (1996) monitored the fate of birds which returned to basic conditions within an approx. four weeks after reaching the terminal stage of force feeding. After the early rapid increase (3) the "A" bird showed a fallback in liver tissue development (5) caused by its individual susceptibility for the force feeding, which resulted in a fatal gastro enteritis.

In addition to the quantitative evaluations a certain qualitative analysis of the liver was also performed. The goose liver tissue has a characteristic X-ray density value (around 80 HU) in its normal, physiological status. Substantial changes can be seen on *Figure 2, 3* and *4* in the HU values throughout the period.

Figure 2

Changes of the characteristic HU values of the liver within the examined period in C bird

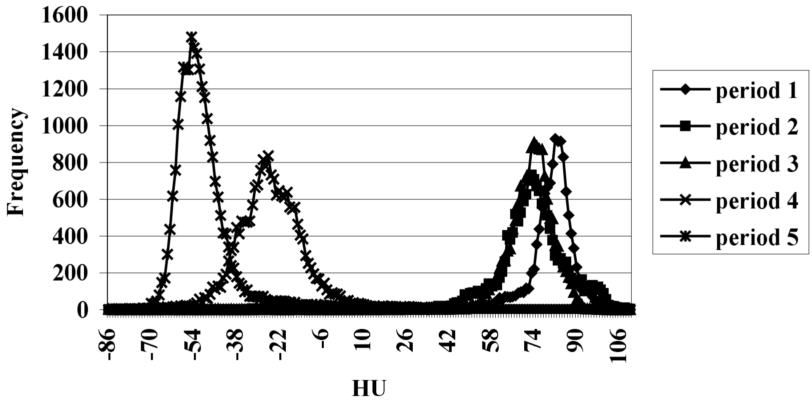


Figure 3

Changes of the characteristic HU values of the liver within the examined period in B bird

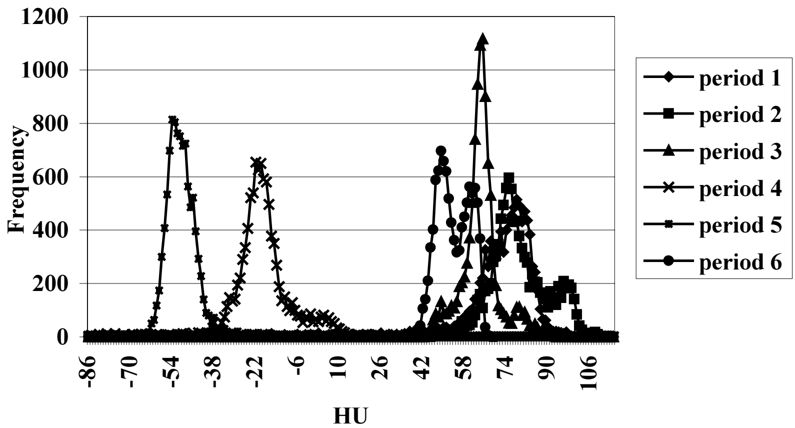
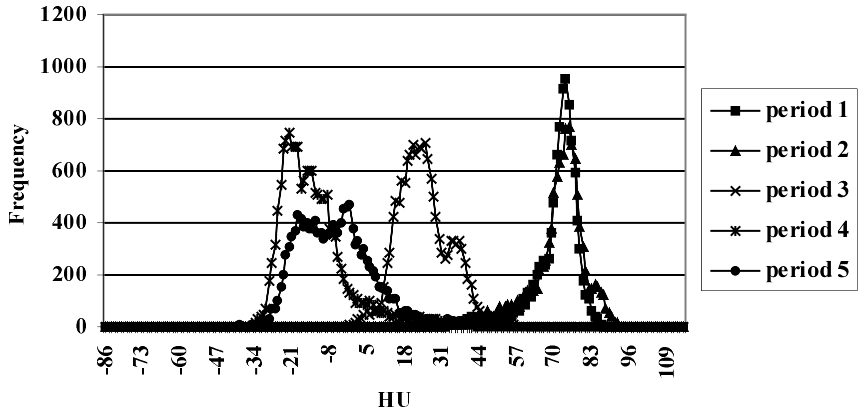


Figure 4

Changes of the characteristic HU values of the liver within the examined period in A bird



Similarly with the volumetric changes the measured density values sensitively follow the force feeding process. The average characteristic HU values of the three examined goose are nearly similar within the period of preparation (1-2) and post force-feeding (6) (55-80 HU). In the course of force feeding (2, 3, 4 and 5) the density values were 80, 80, -20 and -50 HU respectively. The latter value approximates the typical fat tissue density, referring to the high fat content of the fatty liver.

At the end of the force feeding the crude fat content of the liver was determined in bird „A” and „C”. The measured 37 and 52% fat content coupled with 0 és -50 HU respectively. In certain cases the fat deposition becomes irreversible together with the depreciation of the product. According to *Bogin et al.* (cit SCAHAW, 1998) if the force feeding is continued after three to four days, the level of cell damage rises significantly. In Hungary 6-10% of the processed fatty livers show the so called extreme fatty liver syndrome.

While the liver substance is relatively constant, a few CT scans seem to be sufficient to grade the fatty liver. The large variation in the characteristic HU values corresponding to the different liver tissue composition encourage the development of direct *in vivo* evaluation methods. Based on this fact experiments are in progress to calibrate our CT method to predict the fat content of the liver. As a complementation MR spectroscopic procedure can be applied to define the final step of the liver cell degradation, are under way. Liver tissue samples taken with biopsy from the living animals provide the examination of cell wall damage, finding the point where the process turns into an irreversible one.

CONCLUSIONS

The applied in vivo CT examination method seems to be suitable to follow the liver development and analyse the liver composition of geese during the force feeding period. It seems wortwhile to incorporate this non- invasive method in the selection procedures, or screening of top breeder candidates at least to get own performance data on liver development. These non-invasive procedures harmonize well with animal examination regulations and animal welfare phylosophy.

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Corresponding author:

Gabriella Andrássy-Baka
University of Kaposvár, Faculty of Animal Science
H-7401 Kaposvár, P.O.Box 16., Hungary
Tel.: 36 82 314 155, Fax: 36 82 320 175
e-mail: bakagabriella@CT1.atk.u-kaposvar.hu

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Content of some mineral elements in eggs from farms and free range

V. Stibilj, D. [1]Terčič, A. [1]Holcman
Jožef Stefan Institute, Ljubljana, SI-1000 Jamova cesta 39., Slovenia
[1]University of Ljubljana, Biotechnical Faculty, Zootechnical Department, Domžale, SI-1230 Groblje 3., Slovenia

ABSTRACT

The aim of our work was to investigate the relationship between different laying hens housing systems and content of some minerals in their eggs. Samples of eggs were collected from four commercial farms with intensive rearing systems (cage and deep litter eggs) and from four family farms with extensive rearing system (village hens – free range eggs). From each farm two samples, each consisted of three eggs, were randomly taken on a bi-weekly basis. Composited samples from three whites and three yolks respectively were formed in order to determine the minerals content. Exception was one family farm where ten eggs represented a sample. So 24 samples were collected from commercial farms and 24 from family farms. For the potassium, sodium, magnesium, calcium and zinc, the analysis was performed with atomic absorption spectrometry after dry ashing at 520°C and dissolving in HCl acid. Phosphorus was analysed by spectrophotometer. The accuracy of the methods was validated by analysing the standard reference materials (SRM) of whole egg powder SRM 8415. Different housing systems had statistically significant effect ($P<0.05$) on potassium and magnesium levels in whites and yolks. Significant differences ($P<0.05$) between intensive and extensive rearing systems were also observed for sodium content in whites and for phosporus and zinc content in yolks. Levels of calcium did not statistically differ between the groups and were generally consistent. Concentrations of Zn in whites as well as in yolks were low and did not exceed of the maximum permitted concentration.
(Keywords: eggs, mineral elements, free range, battery cages, deep litter)

INTRODUCTION

Many modern consumers are interested in the provenance and nutritional value of their food. In the case of eggs there has been much interest in housing systems (*Charles,* 2002). During the traditional period in the history of egg production (up to 1950s), birds were generally kept on free range or in semi-intensive systems. The need for more efficient production methods saw the introduction of cage systems (*Duncan,* 2000) . The method worked well, but since the 1980s there has been increasing concern expressed by consumer and animal welfare groups about intensive systems. Although the cost of production is lowest in cage systems, in response to consumer demand, the past 20 years or so have seen a major revival of the free range method, as well as the development of the other non-cage systems (deep litter, perforated floor systems, aviaries, percheries etc.) (*Charles,* 2002). Since a significant number of consumers seek eggs from alternative systems there is a need to put together the egg quality and the quality of life of the hens (*Verga,* 1999). Determination of the ash and mineral content of eggs is important for a number of reasons including nutritional labeling, quality, microbiological stability, nutrition and processing. In spite of the great amount of literature actually at disposal on this issue, little is known about the minerals content in eggs, deriving from different housing systems.

In Slovenia free range poultry has been run with other farm enterprises historically and most households used to keep a few hens for egg production in free range conditions. Within this context the main objective of our research was to examine the differences/similarities in minerals content between the free range eggs and eggs coming from commercial farms.

MATERIALS AND METHODS

In the experiment there were two trials:

Trial 1

Battery cage/deep litter - hens housed on two farms in conventional battery cages and on two farms in deep litter system. The hens in this trial were fed only with complete feed mixtures for laying hens. Experimental design for trial 1 is shown in *Table 1*.

Table 1

Basic informations about the origin of the eggs from battery/deep litter system

Sampling site (commercial farm)	Housing system	Sampling period	Number of samples	Number of eggs per sample	Age of hens (weeks)	Provenance of hens
A	Battery cages	I.	2	3	45	Hisex
		II.	2	3	47	
		III.	2	3	49	
B	Battery cages	I.	2	3	60	ISA
		II.	2	3	62	
		III.	2	3	64	
C	Deep litter	I.	2	3	45	Hisex
		II.	2	3	47	
		III.	2	3	49	
D	Deep litter	I.	2	3	50	Hisex
		II.	2	3	52	
		III.	2	3	54	

Trial 2

Village hens in four family farms of a free range system. Free range eggs were produced by village hens with daily access to the outdoors. The village hens were free to run around, but in event of bad weather they were kept inside. They were fed with feed produced in surrounding countryside (barley, wheat, maize, beet, potato) and pasture was also available. Experimental design for trial 2 is shown in *Table 2*.

Table 2

Basic informations about the origin of the eggs from village hens

Sampling site (family farm)	Sampling period	Number of samples	Number of eggs per sample	Age of hens	Provenance (breed) of hens	Composition of daily ration
E	I.	2	3	1-3 years	Brown commercials	barley, wheat, maize, pasture
	II.	2	3			
	III.	2	3			
F	I.	2	3	1, 2, 3 years	Styrian hen, Hisex, ISA-Brown	wheat, maize, pasture
	II.	2	3			
	III.	2	3			
G	I.	2	3	2 years	Hisex	barley, maize, beet, complete mixture for laying hens, pasture
	II.	2	3			
	III.	2	3			
H	I.[1]	3	10	1,5 year	Prelux-R	wheat, potatoes in their skins, pasture
	II.[1]	3	10			

[1]*Sample composed of ten eggs from one hen*

Sample preparation
As with all food analysis procedures it is crucial to carefully handle a sample to ensure that its composition does not change significantly prior to analysis. In our case the eggs were first wiped with dry paper towels and weighed. After the egg breaking on the flat surface, the whites and yolks were manually separated. Thereupon two composite samples of whites and yolks respectively were placed into upright freezer for 24 hours and then lyophilised for 24 hours at low pressure and at temperature of -30°C.

Dry ashing (AOAC, 1998)
Prior to analysis the minerals in egg samples the dry ashing method was used.

Determination of Ca, Na, K, Mg and Zn content (AOAC, 1998)
Levels of Ca, Na, K, Mg and Zn in egg whites and yolks were determined by atomic absorption spectrometry using Opton and Perkin-Elmer 1100 B atomic absorption spectrometers. A calibration curve was prepared with standards of known concentration using the same reagents as used to prepare the sample. Samples were analyzed in duplicate.

Determination of P content (AOAC, 1998)
The phosphorus content of a sample was determined by adding a vandate-molybdate reagent to the sample. This formed a colored complex (yellow-orange) with the prosphorus which was quantified by measuring the absorbance of the solution at 420 nm, and comparing with a calibration curve. To take into account any impurities in the reagents that might interfere with the analysis we also run a blank sample. The accuracy and reliability of analysing procedure was assessed by analysis of reference sample of Standard Reference Materials (SRM) Whole Egg Powder 8415 (SRM catalog 1998). The results of these SRMs in this study were satisfactory and in close agreement with the certified values.

RESULTS AND DISCUSSION

Tables 3 and *4* give the concentrations of the six elements in egg whites and yolks collected from four commercial and four family farms.

Table 3

Mean values and standard deviations for concentrations of K, Na, Mg, P, Ca and Zn in whites and yolks of eggs from four commercial farms (all mg/100 g of sample)

Ele-ments	White (W) / Yolk (Y)	Commercial farms				Mean value ± Standard deviation
		A (battery cages)	B (battery cages)	C (deep litter)	D (deep litter)	
K	W	146.7±6.3	142.8±25.2	148.2±4.8	157.4±9.2	161.4±14.1
	Y	118.2±6.3	120.0±10.7	120.0±4.9	111.3±5.1	117.4±7.6
Na	W	173.6±10.4	166.4±31.0	184.3±5.8	179.2±15.2	175.9±18.4
	Y	55.7±3.4	60.4±3.8	60.5±4.4	52.5±2.8	57.3±4.9
Mg	W	12.6±1.0	12.1±1.8	11.6±1.3	12.4±1.0	12.2±1.3
	Y	12.3±0.8	13.5±1.8	13.5±1.0	13.7±1.4	13.2±1.2
P	W	11.5±1.0	16.4±5.0	12.7±1.2	15.4±2.3	14.0±3.4
	Y	542.9±52.7	517.2±35.8	528.4±24.3	491.0±18.8	519.9±38.3
Ca	W	7.5±0.9	11.7±3.6	9.2±5.9	9.2±2.0	9.2±3.6
	Y	140.9±6.2	149.5±15.4	140.8±8.1	148.0±5.9	144.8±9.9
Zn	W	0.04±0.01	0.04±0.01	0.04±0.01	0.05±0.02	0.04±0.01
	Y	4.1±0.2	4.0±0.5	4.1±0.2	3.8±0.1	4.0±0.3

Table 4

Mean values and standard deviations for concentrations of K, Na, Mg, P, Ca and Zn in whites and yolks of eggs obtained from four family farms (all mg/100 g of sample)

Ele-ments	White (W) / Yolk (Y)	Family farms (village hens)				Mean value ± Standard deviation
		E[2]	F	G	H	
K	W	128.0±9.2	122.0±13.8	120.0±16.4	165.2±26.6	133.8±24.9
	Y	121.7±22.1	101.3±12.6	111.2±14.8	102.7±7.2	109.2±16.4
Na	W	183.2±10.9	186.8±12.1	187.0±17.2	207.3±30.4	191.1±20.4
	Y	51.7±4.8	54.7±7.6	54.0±5.5	63.5±2.9	56.0±6.9
Mg	W	14.3±2.4	12.2±0.8	13.2±1.2	15.7±4.8	13.8±2.9
	Y	15.3±1.5	13.5±1.4	14.5±1.0	15.0±2.3	14.6±1.7
P	W	13.3±1.2	12.3±1.9	12.2±3.5	22.8±7.8	15.2±6.1
	Y	501.5±48.5	491.0±71.6	483.5±31.4	427.0±23.6	477.8±53.1
Ca	W	9.7±2.5	8.0±1.7	6.3±1.4	7.2±1.9	7.8±2.2
	Y	126.0±5.0	117.7±13.3	115.2±6.8	195.0±55.1	138.5±42.9
Zn*	W*	0.04±0.01*	0.03±0.01	0.05±0.08	0.11±0.02*	0.06±0.03
	Y	3.6±0.3	4.0±0.6	3.5±0.2	3.5±0.3	3.6±0.04

**Due to large deviation one sample was not taking into account; [2]Sample composed of ten eggs from one hen*

Tables 5 and *6* show the average content of K, Na, Mg, P, Ca and Zn in egg whites and yolks sampled from both type of farms. For the differences in mean values we performed statistical analysis using t-test.

Table 5

Average content of K, Na, Mg, P, Ca and Zn in whites as related with the rearing system (in mg/100 g of sample)

Elements	Egg whites			
	Commercial farms		Family farms (village hens)	
	Number of samples	$x^1 \pm SD^2$	Number of samples	x±SD
K	24	161.4±14.1^a	24	133.8±24.9^b
Na	24	175.9±18.4^a	24	191.1±20.4^b
Mg	24	12.2±1.3^a	24	13.8±2.9^b
P	24	14.0±3.4	24	15.2±6.1
Ca	24	9.2±3.6	24	7.8±2.2
Zn	24	0.04±0.01	**22**	0.06±0.03

[1]Mean value; [2]Standard deviation; [a,b]Statistically significant (P<0.05)

Table 6

Average content of K, Na, Mg, P, Ca and Zn in yolks as related with the rearing system (in mg/100 g of sample)

Elements	Egg yolks			
	Commercial farms		Family farms (village hens)	
	Number of samples	$x^1 \pm SD^2$	Number of samples	x±SD
K	24	117.4±7.61^a	24	109.2±16.4^b
Na	24	57.3±4.85	24	56.0±6.9
Mg	24	13.2±1.22^a	24	14.6±1.7^b
P	24	519.9±38.28^a	24	477.8±53.1^b
Ca	24	144.8±9.92	24	138.5±42.9
Zn	24	4.0±0.29^a	24	3.6±0.4^b

[1]Mean value; [2]Standard deviation; [a,b]Statistically significant (P<0.05)

On the basis of the data presented in *Tables 3,4,5* and *6* the following observations can be made:

Whites from family farm H contained the highest K levels among the whites sampled from the village hens, whereas on the commercial farms site, the whites from D farm had the highest K levels (*Tables 3* and *4*). Yolks from family farm E contained the highest levels of K among the yolks analyzed from both management systems (*Tables 3* and *4*). There were statistically significant differences (P<0.05) in potassium content between whites and yolks coming from commercial farms on one hand and whites and yolks coming from family farms on the other hand. The differences were in favour of eggs from commercial farms (*Tables 5* and *6*). *Dobrzanski et al*., 1999 have reported similar findings.

The mean Mg content of whites ranged from 11.6±1.3 mg per 100 g of fresh sample in whites from the C deep litter system to 15.7±4.8 mg per 100 g of fresh sample in free range whites from H family farm (*Tables 3* and *4*). The lowest value for Mg content in yolks was detected in yolks from A battery cage system (12.3±0.8 mg per 100 g of fresh sample) whereas the highest Mg content was noticed in yolks from E farm free range eggs.

As compared with whites and yolks from commercial farms, whites and yolks from family farms contained significantlly ($P<0.05$) higher amounts of magnesium (*Tables 5* and *6*). Results for magnesium are in close agreement to those reported by *Dobrzanski et al*. (1999).

Sodium content of whites significantly ($P<0.05$) differ among whites sampled from both types of farms (*Table 5*). Whites from family farms were better supplied with sodium than whites from commercial farms. This result is in the contrast with findings of *Dobrzanski et al*. (1999) who found greater amounts of sodium in free range eggs. The yolks taken from two different types of farms did not show any significant difference in sodium levels (*Table 6*).

Higher amounts of P and Zn were detected in yolks collected from commercial farms compared to those samples of family farms (*Table 6*). Regarding P and Zn levels in whites from both systems, t-test revealed no significant differences (*Table 5*).

Calcium levels of whites and yolks showed no relation to rearing system (*Table 5* and *6*).

Zinc, phosphorus and calcium are to be found primarily in yolks. On the contrary the sodium can be find mainly in whites. The same holds for potassium. Magnesium is loaded in approximately equal amounts in whites and yolks.

Notwithstanding the above findings, caution is required in interpreting the data, since it is well known that minerals content of the eggs is mainly related to the diet (*Naber*, 1979; *Verga*, 1999). Little effects have so far been found due to the housing system (*Verga*, 1999). Regarding obtained results for minerals content are our results consistent with results published elsewhere (*Dobrzanski et al*., 1999; *Cook* and *Briggs*, 1990; *Scherz* and *Senser*, 1994; *Holland et al*., 1992) although the latter five authors specified neither origin of eggs nor the system of rearing, number of analysed samples and methods of determination the elements.

CONCLUSIONS

In the past a couple of experiments have been conducted to estimate content of some elements in eggs coming from free range and commercial farms respectively. Different housing systems did have statistically significant influence on potassium and magnesium content in whites and yolks, on sodium content in whites and on phosphorus and zinc content in yolks. Free range eggs were normally very similar in terms of calcium content to those from birds kept in indoor systems.

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Corresponding author:

Dušan Terčič
University of Ljubljana, Biotechnical Faculty
Zootechnical Department
SI-1230 Domžale, Groblje 3., Slovenia
Tel: 386 1 7217 915
e-mail: dusan.tercic@bfro.uni-lj.si

SECTION 4

MILK PRODUCTION AND MILK QUALITY

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Free D amino acid content of milk from mastitic udder

G. Pohn, J. Csapó
University of Kaposvár, Faculty of Animal Science, Kaposvár, H-7400 Guba Sándor u. 40., Hungary

ABSTRACT

The California Mastitis Test was used as an indicator of mastitis. Five cows were chosen for each of the five scores from 0 to 4. Milk samples were analysed for free AA and free D-AA. The contents of free AA, free D-AA and the ratio of free D-AA to free AA increased significantly as score increased. The free D-AA content of foremilk (first milk jets) from nonmastitic cows (score=0) was approximately five times that of samples drawn later from the same udders. Contents of free AA and free D-AA were highly associated with score and udder inflammation. Very low concentrations of free D-AA are normal for raw milk. Higher concentrations of free D-AA could be attributed to inclusion of foremilk and milk from cows having subclinical mastitis in the bulk tank milk.
(Keywords**:** free amino acids, D-amino acids, mastitis, milk)

INTRODUCTION

Foods have recently been shown to contain considerable quantities of D-AA (*Boehm* and *Bada,* 1984*; Bunjapamai et al.,* 1982; *Friedman et al.,* 1981; *Fuse et al.,* 1984; *Hayashi* and *Kameda*, 1980; *Liardon* and *Lederman*, 1986; *Lubec et al*., 1990; *Man* and *Bada,* 1987; *Masters* and *Friedman*, 1980) attributed to both processing technology and microbiological status of the foods. Milk and milk products have been reported (*Brückner* and *Hausch,* 1990a; *Brückner* and *Hausch,* 1990b, *Gandolfi et al.,* 1992; *Palla et al.,* 1989) to contain significant amounts of D-AA, which were generally attributed to biological status rather than to processing technology. The pertinent literature does not reveal an explanation for the presence of D-AA in raw milk from healthy cows.

The presence of D-AA in food products has been shown to cause a decrease in digestibility of protein (*Bunjapamai et al*., 1982; *Friedman et al*., 1989; *Hayashi* and *Kameda, 1980; Man* and *Bada,* 1987) and bioavailability of essential AA. It was suggested (*Friedman et al.,* 1989; *Man* and *Bada*, 1987) that some D-AA may provide the basis for formation of toxic products. Absorption rates of L-AA in the intestine were reported to be greater than those of the respective D-enantiomers (*Finch* and *Hird,* 1960). Milk products produced by bacterial fermentation contained levels of D-AA (*Man* and *Bada,* 1987), and the bacteria were implicated as a biological source of D-AA.

Because D-AA are often products of bacterial metabolism, and mastitis is an inflamation of the udder of bacterial origin, we investigated the influence of mastitis as a possible explanation of D-AA content of raw milk. The cow produces leukocytes to counteract the infection, and, in early studies, direct microscopic count of leukocytes was used to measure the severity of mastitis. *Shalm* and *Noorlander* (1957) utilized a chemical reaction test that could be read in one of five classes (0 to 4) and was highly correlated with leukocyte count (*Luedecke et al.,* 1967; *Smith* and *Schultze*, 1965). The

California Mastitis Test (**CMT**) has been used in many studies. Electronic procedures have been used to count cells, and the SCC has also served as the measure of mastitis.

Harmon (1994) stated that the primary factor influencing SCC or CMT is intramammary bacterial infection. He also reported that cows with mastitis, as indicated by high SCC, produced milk that differed in composition from milk produced by cows with healthy udders. High SCC was associated with reduced casein and increased concentrations of whey protein, albumin, and immunoglobulin (*Harmon, 1994*). Another study (*Csapó et al.,* 1986) reported changes in mineral contents. Mastitic milk contained more sodium, chloride, calcium, iron, and manganese, and normal milk was higher in potassium, phosphorus, zinc, and copper. The protein and mineral contents of mastitic milk were similar to those of colostrum. In related studies (*Forster et al,* 1967; *Luedecke et al.,* 1967), the foremilk from nonmastitic cows was reported to have higher SCC or CMT than milk drawn later in the milking process.

The objectives of this research were 1.) to determine the concentrations of free AA and free D-AA in milk from cows having different CMT scores and 2.) to compare the D-AA contents of foremilk and milk drawn later from cows having a negative CMT.

MATERIALS AND METHODS

Assignment of cows and sampling milk

The CMT, as describes for use in Hungary (*Hungarian Standard No. 12320-85*) was used in a herd of 1020 Holstein-sired cows. For this experiments, 25 individual cows were identified with each having the same CMT score for all four quarters of the udder. There were five cows in each of the five groups based on CMT score: 0, 1, 2, 3, and 4. The CMT reaction (*Schalm* and *Noorlander,* 1957) is disintegration of leukocytes when milk is mixed with the reagent (NaOH and an anionic surface active agent). In a negative sample (0 score), the mixture of milk and reagent remains liquid and produces no precipitate. As score increases, the degree of precipitation increases and, when score=4, a distinct gel with central peak is formed. CMT score is based on number of leukocytes in milk, and mean counts for scores 0, 1, 2, 3, and 4, respectively, were 67, 118, 401, 1737, and 6964×10^3 per ml. (*Luedecke et al.,* 1967).

At the time of sampling, the amount of milk needed to conduct CMT on each quarter was drawn from each cow. For negative (0 score) cows, the sample was drawn from well-mixed complete yield of the udder with the remainder going to the bulk tank. For positive (CMT of 1, 2, 3, or 4) cows, a volume of 1 L was manually milked, mixed and sampled with the remainder being milked and discarded.

The comparison of D-AA contents of foremilk and later milk required the selection of 5 cows, each of which had negative CMT for all quarters. The foremilk sample consisted of two hand-milked jets from each of the four quarters of the udder. The udder was then milked out completely, and a sample was drawn from the well-mixed remainder.

All milk samples for both experiments were cooled immediately in ice-water and, within 2 h, were placed in a deep freeze at -25°C. The samples were stored at -25°C until preparations for AA analysis were initiated.

Preparation of milk samples for analysis

After defrosting and heating to 30°C, the samples were centrifuged at 5000 x g at room temperature for 20 min. to skim the milk and deposit particulate matter at the bottom of the centrifuge tube. To 50 ml of sample, 50 ml of a 25% trichloroacetic acid solution were added and the mixture was allowed to stand for 20 min. The resulting precipitate was centrifuged at room temperature for 30 min at 10000 x g. To determine total AA, pH of the supernatant was adjusted to pH 2.2 with 4 M sodium hydroxide. To conduct D-AA determinations, the pH was adjusted to pH 7. Using a 10°C hot plate, the solutions were lyophilized. For total AA determinations, the resulting solid material was dissolved in 10 ml of citrate buffer at pH 2.2, and, for determinations of D-AA, dissolution was in 1 ml of twice-distilled water. Samples prepared were stored at -25°C until analysis.

HPLC and ion-exchange column chromatography for the determination of D-AA and total free AA

Instruments

The chromatographic system was assembled from ISCO 100 DM syringe pumps (Isco Inc. Lincoln, Nebraska, USA) and a Rheodyne (Berkeley, California, USA) injector equipped with a 20-µl loop. The separation process was monitored and chromatograms stored on an ISCO Chem Research (Isco Inc. Lincoln, Nebraska, USA) system. The derivative formation and sample injection were performed manually. The excitation and observation wavelengths were 325 and 420 nm, respectively.

Reagents

Acetonitrile and methanol were purchased from Rathburn Ltd (Walkeburn, England). The AA standards, the *o*-phthalaldehyde (OPA) and the 2,3,4,6,-tetra-O-acetyl-1-thio-β-glucopyranozide(TATG) were obtained from Sigma Chemical Co., Inc. (St. Louis, MO). The buffers used for elution were prepared from mono- and disodium phosphate. The pH was adjusted with 4M sodium hydroxide.

Synthesis of derivatives

The reaction was carried out in a 120-µl microvial which was placed in another vial (volume, 1.8 ml) that had Teflon® coating, internal cover plate, and a screw cap. The sample (free AA or protein hydrolysate evaporated in a nitrogen atmosphere), dissolved in 90-µl borate buffer (.4M; pH 9.5), was mixed with 15-µl of reagent (8 mg of o-phthalaldehyde and 44 mg of TATG dissolved in 1 ml of methanol). The mixture was then homogenized by bubbling through approximately 100-µl of nitrogen and left standing for 6 min. Then 25-µl of the reaction mixture were injected into the analytical column. After injection, the system was rinsed three times with approximately 100-µl of a 70:30 acetone-water (vol/vol) solution. Synthesis of derivatives was performed manually and mixing of reagent solution was made with the aid of an IKA Vibro Fix instrument (Janke and Kunkel, IKA-WERK, Breisgau, Germany).

Separation and quantitation of the enantiomers

Separation of the enantiomers was made according to the method of *Einarson et al.* (1987), using a reversed-phase analytical column packed with Kromasil octyl C8 (250×5.6 mm internal diameter; 5 µm particle size). To increase the lifetime of the column, a safety column was fitted between the sample injector and the analytical column (RP8, Newguard, 25×3.2 mm internal diameter, 7 µm particle size), and a cleaning column (C18, 36×4.5 mm internal diameter, 20 µm particle size, Rsil) was installed between the pump and the sample injector. In order to separate the enantiomers, the two component gradient system had the following composition: A=40% methanol in phosphate buffer (9.5 mM, pH=7.05) and B=acetonitrile. The flow rate was 1 ml/min, and the elution of the gradient as a function of time was made according to the method of *Folestad et al.* (1994)

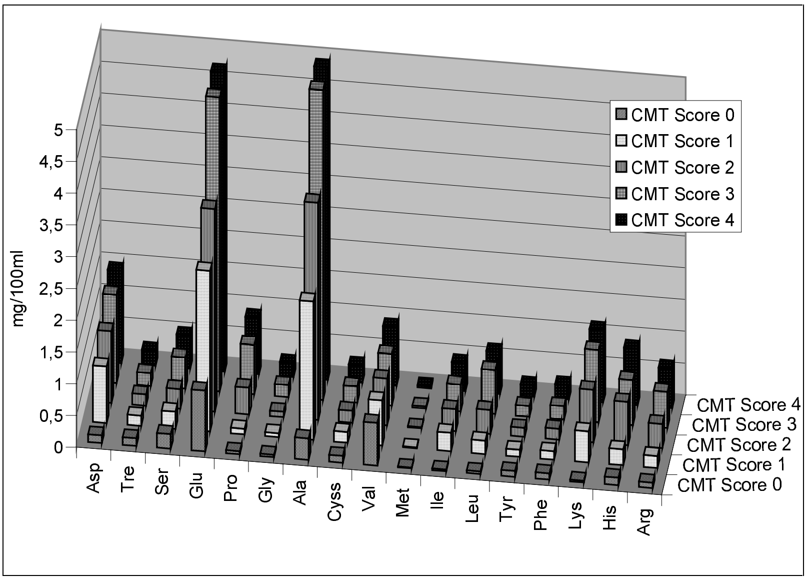
Determination of total free AA
Determination of total free AA was performed with an LKB Model 4101 automatic AA analyzer, following postcolumn derivative synthesis with ninhydrin.

RESULTS AND DISCUSSION

Free AA
Concentrations of total (D- and L-) free AA are shown in Figure 1 for the five CMT scores. Based on analysis of variance and comparison of paired means, differences among the five CMT score groups were significant (P≤0.01) for each of the 17 AA. Variation among cows within CMT class was very small, as indicated by the small standard errors of means. The milk samples with CMT of 2, 3, or 4 had free AA composition similar to that of colostrum. This tendency has also been reported (*Csapó et al.,* 1986; *Harmon,* 1994) for protein components and minerals. Compared with concentrations of normal milk, the most spectacular increases were seen for Ile, Ala, Asp, Pro, and Leu which were more than 10 times the concentrations observed in milk samples scored 0 by the CMT.

Figure 1

Mean free AA (D- plus L-) contents of milk from cows with various California Mastitis Test scores



Five cows were in each group. CMT Score 0=no precipitate, 1=slight precipitate, which disappears, 2=distinct precipitate, but no gel formation, 3=mixture thickens with some suggestion of gel formation and 4=distinct gel with central peak.

The nature of differences among CMT classes was investigated by regression analysis. The significant (P≤.01) linear contrast for each of the 17 free AA and for the sum. The concentration of free AA increased linearly for CMT scores 0 to 3. The differences between CMT scores of 3 and 4 were significant only for Pro and for the sum of all AA. This result tended to cause the quadratic contrast to account for more variation than the cubic contrast. Based on free AA contents, the CMT classifications could be reduced to four: 0 to 3.

A quadratic function of CMT score explained 99% of the variation in the sum of free AA and 97% of the variation in contents of Asp, Glu, and Ala. Conversely, the free AA content could be used as an indicator of severity of mastitis.

Free D-AA

Concentrations of free D-AA are shown in *Figure 2*. Milk samples rated as negative score, CMT of 0, contained free D-Asp, D-Glu, and D-Ala. However, the quantities present (.02, .05, and .04 mg/100 ml, respectively) were almost negligible compared with the quantities occurring in the milk samples that had CMT of 2, 3, or 4. For samples scored 1, D-Val, D-allo-Ile, D-Leu, and D-Lys were also present. D-Ser and D-Pro were identified in samples scored 2, 3 or 4. Not even traces could be identified of the D-enantiomers of other AA, which are the building blocks of proteins.

Free D-AA increased as CMT score increased for all nine free D-AA and for the sum of free D-AA. The nature of the regression pattern was slightly different; the cubic contrast was relatively more important than was the quadratic contrast. California Mastitis Test classes 3 and 4 had similar free D-AA concentrations, as was observed previously. However, differences in free D-AA contents of samples scored 0 and 1 also tended to be small. Therefore, the graphic expression of free D-AA content relative to CMT score tended to be sigmoid in shape. Thus CMT score can be used as an accurate predictor of concentration of free D-AA, but the prediction equation would be a cubic function: $y=a+b_1X+b_2X^2+b_3X^3$.

Figure 2

Mean free D-AA contents of milk from cows with various California Mastitis Test scores

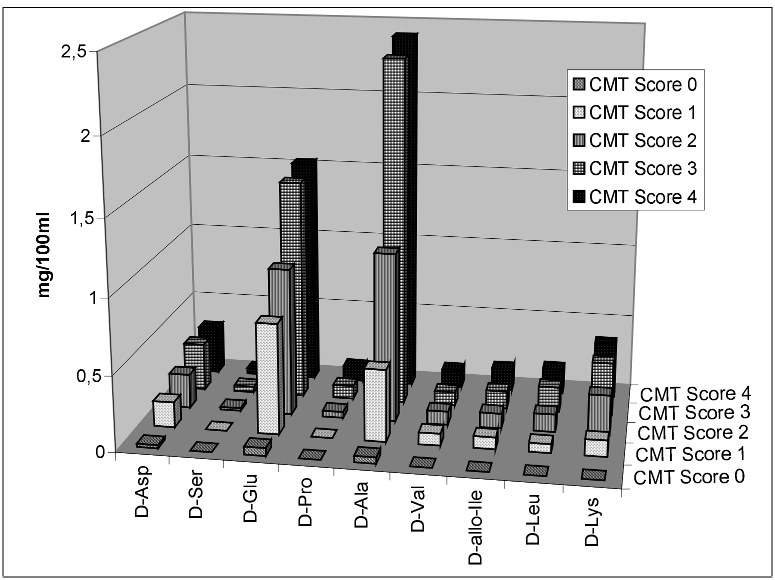


Figure 3

Free D-amino acid concentration as a percentage of free (D and L) amino acid content of milk from cows with various California Mastitis Test scores

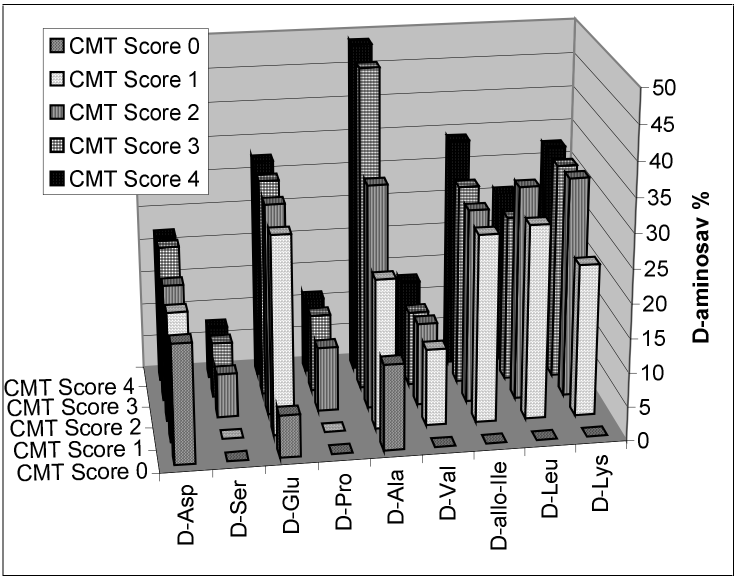
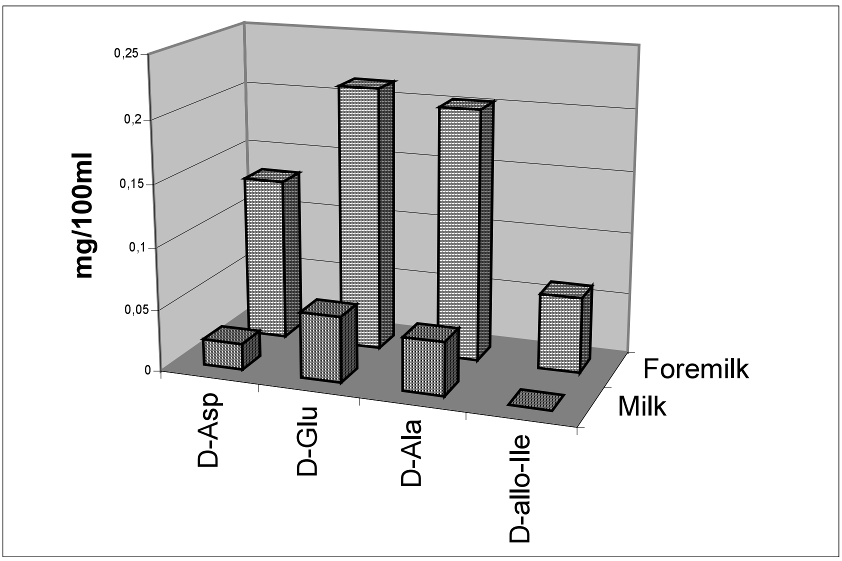


Figure 4

Free D-amino acid content of foremilk and mixed total milk from five cows having negative (zero) California Mastitis Test scores



The increase in free D-AA could be easily attributed to the availability of larger amounts of free AA for conversion to D-AA. However, the concentration of free D-AA relative to free (D- and L-) AA increases as CMT increases (*Figure 3*). Free D-Ala represented almost 50% of the total free Ala when CMT score was 3 or 4. Conversely, the increase in percentage D-Asp (17 to 23%) was small. For the sums of all AA, the percentage D-AA was only 3% for samples scored 0 compared with 28% for these scored 3 or 4 by CMT. Both absolute quantity and percentage (relative to total free) of D-AA increased as CMT increased.

Free D-AA Content of Foremilk

Foremilk has been shown to have higher CMT score and higher SCC (*Forster et al.* 1967; *Luedecke et al.* 1967; *Smith* and *Schultze* 1965) than that of milk drawn later in the milking process. The D-AA concentrations of foremilk and later milk from cows having CMT score of 0 are shown in *Figure 4.* The foremilk was two jets of milk drawn from each quarter at the beginning of milking. Free D-AA contents of foremilk were approximately five times those of later drawn milk (P≤.01). Negative (CMT score of 0) samples had extremely low concentrations of free D-AA in later milk. The free D-AA contents of foremilk from cows whose milk scored 0 was typical of the concentrations reported for milk from cows whose milk scored 1.

CONCLUSIONS

Based on the results, we concluded that very low concentrations of D-AA are normal for raw milk. Higher D-AA can be traced to inclusion of the bacteria-rich foremilk and milk from cows with subclinical mastitis in the bulk tank. Data presented here would support the hypothesis that D-AA content of raw milk is associated with mastitis and, consequently, with bacterial activity in the udder.

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Corresponding author:

Gabriella Pohn
University of Kaposvár, Faculty of Animal Science
H-7401 Kaposvár, P.O.Box 16., Hungary
Tel.: 36 82 314 155, Fax: 36 82 320 175
e-mail: pohng@mail.atk.u-kaposvar.hu

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Introduction of milk quotas in Slovenia: Possibilities, accompanying measures and expected outcomes

S. Kavčič
University of Ljubljana, Biotechnical Faculty, Department of Animal Science, Domžale, SI-1230 Groblje 3., Slovenia

ABSTRACT

Some approaches that seem to be appropriate for milk quota introduction in Slovenia are presented. Empirical work is based on detailed analysis of Slovenian milk production structure. Special emphasis is given to small producers not having real prospects to sustain in milk production. Budgetary costs of different accompanying measures including early retirement scheme, voluntary supply restraint scheme, special promotions for disadvantaged areas (compensatory allowances, environmental programmes, extensification premiums) are projected under basic assumption of not reduced area farmed. Results emphasise necessity of accompanying measures unless rapid and significant stagnation of incomes of people currently involved in dairy farming is permitted.
(Keywords: milk quota, CAP, EU enlargement, income effects, Slovenia)

INTRODUCTION

With approaching Slovenian accession to the European Union (EU) introduction of supply restrictions in milk production is becoming a fact, which will not be possible to avoid. Milk quota, allocated to Slovenian farmers at national level during accession negotiations is at the top of accession questions both for responsible government bodies and for farmers associations. Furthermore, distribution of milk quotas to individual milk producers is a great fear of dairy farmers due to its direct economic consequences as well as due to its psychological impact related to high uncertainty of their likely future in dairy farming.

Data concerning the number of milk cows and milk production of individual dairy farms in Slovenia is still questionable. According to official data from agricultural census carried out in 2000 Slovenian dairy cows population counted 141.6 thousand distributed on more than 28 thousand farms (*SORS*, 2002). However, data for the same year provided by Slovenian dairies (Business association for Slovenian food industry) reported approx. 118 thousand dairy cows on 17 thousand farms included in milk delivering (cit. *Osterc et al.*, 2001). Nearly half of those -mainly family farms - reared 4 dairy cows or less, with additional 30% of dairy farmers with herds of 5-9 cows. Economic or better to say income interesting milk production in Slovenia started in nineties at moderate to high milk yields (more than 5,000 kg per year) in a range of over 20 dairy cows (*Lipovsek*, 2002). This limit is expected to shift even much higher in the foreseen producer price reduction (*Erjavec et al.*, 2002). In these circumstances roughly 10% of farmers - those with herds of more than 15 dairy cows - have real prospects in milk production in the future. Additional 10-15% of currently milk delivering producers can also expect to achieve important share of their income from milk production also in the future. But farmers with less than 10 dairy cows will also claim for as high milk quota as possible. Current Slovenian agricultural policy does not have any efficient program to speed up necessary structural change in direction of herd size improvement, nor idea about adequate system of accompanying measures to release expecting pressure for milk quotas by small farmers not really have any prospects in milk production.

Aim of this paper is to present some opportunities for alleviation of milk quota burden. In this way it could contribute to the discussion of milk quota introduction, which would be best suited to Slovenian circumstances. Approaches described are roughly estimated with emphasis of income effects for producers along with accompanying budgetary implications.

MATERIALS AND METHODS

Possibilities for implementation of milk quota regime are analysed on last data available concerning dairy production in Slovenia. Analysis is mainly based on agricultural census data from 2000 (SORS) and distributional type of data concerning milk, actually delivered to dairies, provided by Slovenian dairies. Approach applied is simplified SWOT scenario analysis supplemented by calculation of crude economic indicators, mostly derived by adapted APAS-PAM sector model of Slovenian agriculture (*Kavčič*, 2001).

The simulation was run using baseline and two policy scenarios. The latter present the possible effects of the *European Commission* proposal (2002) on the Slovenian milk production after accession.

- *Baseline scenario (BS)* assumes continuation of agricultural policy from 2001/2002 and predominantly serves as a comparison tool. It takes into consideration intermediate policy changes, deriving from trade agreements. Like for the policy scenarios, the anticipated price movements are derived from the agricultural outlook for different regions (*OECD*, 2001; *FAPRI*, 2001).
- *Quasi Equal treatment scenario (EUe)* assumes that the candidate countries will apply the same CAP as current Member States with the full level of direct payments at the date of EU enlargement (i.e. in 2004 as the assumed accession and also as the simulated year). Two versions of this scenario are a subject of this study. The first one assumes competitive domestic dairy industry (EUe+) contrary to the scenario of non-competitive dairy industry (EUe-), reflected in lower producer prices.
- *EU negotiating proposal scenario (EUp)* simulates Slovenian accession under framework as proposed by European Commission in its negotiating strategy of 30th January 2002 (*European Commission*, 2002). It assumes direct payments amounting to 25% of the current Member States' level and complemented up to the pre-accession (baseline) level (toping-up approach), and the given proportion of rural development programmes (2.1% of payments for candidate countries from EAGGF-Guarantee Section). Again, the first set of simulation results refers to relatively high level of producer prices (EUp+) and the second one to reduced producer prices (Eup-). The reason behind this distinction is the same as for EUe scenario.

Assumed as accession is the period from 2004 onwards, with the full absorption capacity for the CAP measures (including individual milk quota introduction) starting in the same year. Marketing year 2004/05 is also the period observed in the model. The relevant data for the analysis were provided by the Agricultural Institute of

Slovenia (*Volk*, 2001a and 2001b; *Golez*, 2001) and various published or recalculated sources of the Statistical Office of the Republic of Slovenia (*SORS*).

Current CAP (common agricultural policy of the EU) does not provide any direct payments in milk production sector, although they are brought in indirectly through payments for arable crops (foremost cereals as feed component) and also for beef (particularly slaughter and suckler cows premium). Indirectly milk production is subsidised also through CAP pillar II measures, where the most obvious farmers' revenues are budgetary payments obtained for production in less favoured areas (paid per hectare of area cultivated). Other income support measures involve early retirement scheme, voluntary supply restraint scheme, special promotions for environmental programmes, extensification premiums etc. Although income effect of these measures in individual sector like milk production is less transparent, they could at least mitigate anticipated negative impact of production quota and producer price reduction.

Involvement into early retirement scheme (ERS) is conditioned upon age of farmers. Like in Sweden in nineties (*OECD*, 1997) it could relax pressure on milk quotas also in Slovenia. There is roughly one third of farm holders older than 55 and the same holds also for dairy farmers (*SORS*, 2002). Restricted milk quotas is anticipated to rise their response to ERS eligibility, which could be additionally stimulated by voluntary supply restraint scheme. With such incentives the restructuring process in milk production would be accelerated, where payments for the step out of milk production should be calculated on the basis of the income loss for the next years. In Spain they range between 32.7 and 36.3 €/100 kg (*Rosenwirth* and *Manhardt*, 2002).

Special promotions for environmental programmes in livestock production including dairy farming under current national agricultural policy are most expanded as acreage payments for so called sustainable livestock production. In year 2001 approx. 2.6 million € has been paid in the field of ruminant production, mostly for beef and milk production. One could expect that importance of budgetary incentives for environmental friendly production will rise further after accession. The same holds also for extensification premiums which are not yet feature of Slovenian agricultural policy, but is anticipated to become important source of direct payments after accession, with one third to half of cattle population being eligible for this payment. Predominantly it is intended to beef producers, but it can have important impact also on milk production - particularly when small herd size prevail, what is the case in Slovenia. Budgetary payments for this incentive is forecasted to range between 3.7 and 10 million €, depending on accession negotiations' outcome.

Calculating effects of all measures mentioned above is not an easy task. Therefore combination of sector model and common sense, grounded on the principles of farm management has been applied.

RESULTS AND DISCUSSION

Projection for milk production under EU economic environment with effective production restriction is not favourable. Anticipated price decrease of 2% under EU.+ and additional 15% under EU.- scenario will further deteriorate milk production prospects. Forecasted effect of price changes along with expected policy framework modifications including production quotas as the most transparent one, is presented in *Table 1*.

Table 1

Expected effects of Slovenian EU accession in milk production sector

Scenario	BS	EUe+	EUe-	EUp+	EUp-
Producer price (BS=100)	100	98	83	98	83
Delivery quota (mio t)	not restricted	462.4		422.7	
Direct sale quota (mio t)	not restricted	99.7		40.6	
Supply/Production (BS=100)	100	98.2	90.4	86.0	86.0
Self-sufficieny (%)	120	118	106	103	101
Income (€/hd) (BS=100)	100	101	82	96	78
Sector Income (BS=100)	100	99	74	83	67
No of dairy cows (000)	107.5	93.4	94.9	92.6	93.9
Average milk yield (kg/year)	5015	4961	4884	5005	4934

Contrary to BS milk production after accession will be effectively restricted by national and individual milk quota regime. Current European Commission proposal for milk quotas (EUp scenarios) would result in reduction of milk production for nearly 14%. Taking into account the fact that milk production in Slovenia currently contribute approx. 20% of total value of agricultural output, but more than half of aggregate income, this reduction is even more dramatic. Income per dairy cows will remain relatively high if domestic dairy industry will sustain competitive pressure in the common market (assumed in calculation by higher producer prices), but can fall for as much as approx. 20% if the opposite will happen. With coincidence of reduced total milk production, caused by production quotas, but in the case of lower producer prices foremost by alleviated income position, aggregate income of dairy farmers can fall for a quarter or even a third. As situation stands now, this is much more realistic projection than the one presented by EUe+ scenario, where, among others, very optimistic negotiation outcome along with competitive dairying resulting in high producer prices, are assumed.

Number of dairy cows will fall as well. Even under BS current trends in milk production together with price change effects will result in a fall of dairy cows for milk delivering of approx. 10 to 15 thousand. Milk quota will induce further reduction of national dairy herd of approx. 15 thousand cows. Reduction of dairy cows population for 20 to 25 thousand (approx. 20%) in a period of 3 to 5 years is another moment with tremendous consequences. Taking into account investments in dairy farming during last years, which were in reference year or still are not yet completely utilised, pressure on undistributed national reserve of milk quota is expected to be remarkable. All these problems force dissatisfaction of farmers that are dependent on milk production and lead them to the question: “Is there any rational solution?”

The answer is not straightforward. To achieve satisfactory income in dairy farming, farmers in Slovenia in 2001 had to have at least 30 dairy cows with yields of 5000 kg per year or more. This limit moved up very fast during last years. It is expected that similar economic tendency will be the fact also in the future (*Lipovsek*, 2002). Considering this figures there is room for only 3 thousand professional dairy farmers in Slovenia. As professional dairy farming is not prevailing feature of Slovenian milk production, it is expected that much more than economically justified number of farmers will sustain in milk production, in milk delivery and therefore also in milk quota distribution. Many of them, however, with negative economic results.

Returning back to discussion about possibilities to mitigate income reduction dilemmas - foreseen as Slovenian EU accession effect, but seems to be unavoidable in policy environment of reduced policy intervention as long term trend - there is not much room for any speculations. Even when there is illusion that accompanying measures can have important impact on dairy farmers' income position, many of them are likely to be only dream of farmers in candidate countries (i.e. non-discriminative level of direct payments) or - if they will be eventually applied - they will be of transitional nature and there will be difficult to fulfil eligibility criteria (early retirement scheme). Income assistance measures that seem to have most sustainable nature are those from environment box of CAP, with some characteristics of animal welfare and food safety. Most of them are from technological point of view connected with sufficient agricultural land for manure disposal and therefore require limited number of animals per unit of land cultivated.

Some proxy estimates of budgetary expenditures for accompanying measures, allocated to milk production sector mainly on the basis of land share, utilised by dairy cows, is presented in *Table 2*.

Table 2

Expected vs. required budget expenditures for accompanying measures in Slovenian milk production sector after accession (mio €)

	BS	EUmin	EUmax
Less favoured areas	7.3	13.5	18.2
Environmental programmes	2.5	4.7	6.5
Early retirement scheme	/	/	2.0
Voluntary supply restraint scheme	/	/	up to 19.4
Extensification premiums	/	/	2.4
Total	9.8	18.2	48.5

Under BS scenario milk producers would receive in 2004 roughly 10 mio € revenues from national budget. As negotiation process stands in June 2002, it is expected that this source of dairy farmers' income could almost double, but this should not inspire any enthusiasm about eventually good prospects in the sector. The same EU proposal would effectively reduce sector income for as much as 20 to nearly 40 mio € (the latter refer to lower producer price EUp- scenario).

Under speculation of reduced producer price and current EU proposal for national milk quota, objective of sustained sector income could be achieved only if budgetary expenditure for milk sector (direct transfer to producers) would increase five times. Part of this increase is achievable through substantial growth of already implemented measures (LFA payments and environmental programmes), part from measures which are under discussion to be implemented in the year of accession or a year before (extensification premium and early retirement scheme), but there is still a large black hole with no money foreseen anywhere. Appropriation indicated by budget for voluntary supply restraint scheme in table 2 is likely to be the price that milk producers will have to pay at accession. To be more precise, it is crude estimate of their likely loss of income, derived from reduced milk production and producer price, but not compensated from additional budgetary sources.

Increasing budgetary transfers to milk producers five times is not to be expected, although even that would not be enough to keep current income for many farmers with small scale of milk production. Whatever will EU accession bring to Slovenian milk production sector, structural changes will go on in any case. With this in mind, some producers will grow but will have to pay high price for additional milk quota, and many of them will get out of milk production.

Farmers with increasing milk production scale will, therefore, increase their income from milk production on the account of those ceasing milk production. Even if the latter would have opportunity to participate in voluntary supply restraint scheme, they would not compensate their loss of income completely with funds indicated in *Table 2*. On the other hand one can argue that since structural changes would happen anyway, it should not be attributed to accession effects. This argumentation is correct, but if policy has vision to help prospective dairy farms to be competitive in the near future, it should facilitate changes in a way that no one would feel to be pushed out of production.

With voluntary schemes offering compensation of income loss, advance in the field of competitive production structure would be much easier and faster, and costs for increased scale of milk production on individual farms under quota regime would become manageable again. This would result also in necessary new investment cycle in Slovenian milk production sector, which had been stopped mainly due to uncertainties originated from quota distribution dilemmas, resulted in fear of unchangeable size structure being captured some years ago (i.e. in reference year).

CONCLUSIONS

Crude estimates of likely EU accession effects for Slovenian milk production sector clearly show that expected change of economic environment for dairy farmers in Slovenia is not promising. Although income per dairy cow could remain relatively stable, income in the sector will drop substantially due to very restricted milk quota imposed. Therefore, many of farmers with small dairy herd is expected to get out of production. To mitigate their decision for voluntary quota transfer to those with real prospects in dairy sector, compensation of income loss seems economically justified. Along with expected increase of budget expenditure to those remaining in production (LFA payments, environmental programmes) some additional measures would be of high importance. In addition to early retirement scheme, which is intended to farmers of relatively narrow age group, more targeted voluntary supply restraint scheme in a transition period of 5-10 years would be in Slovenian circumstances of remarkable value to faster necessary structural changes in direction of competitive milk production structure.

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Corresponding author:

Stane Kavčič
University of Ljubljana, Biotechnical Faculty, Dept. of Animal Science
SI-1230 Domžale, Groblje 3., Slovenia
Tel.: 386 1 72 17 810, Fax: 386 1 72 41 005
e-mail: stane.kavcic@bfro.uni-lj.si

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University of Kaposvár, Faculty of Animal Science, Kaposvár

Somatic cells count in milk – indicator of milk quality and health of cows

M. Rajčevič, K. [1]Potočnik, J. [2]Levstek, U. [3]Rajčevič
Poslovni Sistem Mercator, Inc., Ljubljana, SI-1001 Dunajska 107., Slovenia
[1]Biotechnical Faculty, Department of Animal Science, Domžale, SI-1230 Groblje 3., Slovenia
[2]Mesnine dežele Kranjske Ljubljana, Ltd., Ljubljana, SI-1000 Agrokombinatska c. 63., Slovenia
[3]Faculty of Medicine, Institute of Biochemistry, Ljubljana, SI-1000 Vrazov trg 2., Slovenia

ABSTRACT

In years 2000 and 2001 on 4 farms with total number of 1100 cows of the Friesian breed and annual production of approx. 8 thousand tons of market milk in defined region the influence of farm and management factors, year season and studied years on the somatic cells count in stable (tank bulk) milk samples (SCCss) and samples of milk of individual cows (SCCis) was analysed. There were calculated the correlations between the somatic cells count and the number of treated cases of mastitis, between somatic cells and milk quantity and between milk quantity and the number of treated cases of mastitis. In the studied years there was on average SCCss (n=271) 328.2x10^3/ml of milk (LSCCss is 5.51±0.08/ml), and on average SCCis (n=21942) 448.8x10^3/ml of milk (LSCCis is 5.24/ml). On SCCss of milk there was statistically highly significant influence of years (F=41.76, $P\leq0.0001$), farm (F=25.44, $P\leq0.0001$), and not of the season (F=0.36, P=0.547). On SCCis of milk there was, however, statistically highly significant ($P\leq 0.0001$) influence of all three factors, i.e. years (F=904.19), season (F=47.92) and farm (F=20.94). Year and season had no statistically significant influence on manifestation of mastitis (F=0.30, P=0.587 and F=0.91, P=0.344), while statistically highly significant was the influence of the farm (F=26.81, $P\leq0.0001$). Between SCCis of milk and number of treated cases of mastitis there is statistically significant correlation (r=0.275, $P\leq0.008$), between number of cases of mastitis and milk quantity the correlation is r=0.332, $P\leq0.001$, and between milk quantity and SCCss the correlation is r=-0.289, $P\leq0.006$. The correlation between SCCss of milk and SCCis of milk (r=0.608, $P\leq0.0001$) is statistically highly significant.
(Keywords: milk, stable (tank bulk) and individual samples, somatic cells)

INTRODUCTION

Somatic cells in milk are important for the breeder of milk cows from the point of view of the breeding economy. In countries with developed milk production as well as in our country the somatic cells count in stable (tank bulk) is one of the parametres of the milk purchase price (Off. J. of the EC, 1992, No L. 268/17; Regulations on determination of the purchase price of cow milk, Ur.list. RS, 1993/23 and Regulations on elements for formation of the purchase price of cow milk, Ur.list. RS, 107/22.12.2001). The somatic cells are, therefore, indicator of milk quality from the point of view of its hygienic and technological characteristics. They are determined at least once a month. *Schukken* (1992) states that a monthly somatic cells count in delivered milk in ideal conditions should not exceed 200 to 300x10^3/ml.

According to the somatic cells count also the health of cows, especially the health of udders, is evaluated. Milk from healthy udder usually does not exceed $200x10^3$ cells/ml (*Edmondson*,1998), normally it is even lower (*Smith* and *Hogan*, 1999; *Malinovski*, 2001). *Rabold et al*. (1992) states that in milk from healthy udder or in milk form healthy quarter in normal lactation the somatic cells count is even lower than $100x10^3$/ml, and the somatic cells count which is higher than $250x10^3$/ml shows disturbances in one or more udder quarters. The somatic cells count between $200x10^3$ and $300x10^3$/ml milk shows that the cow was infected recently (*Smith*, 1996). The increased somatic cells count in milk of individual cows is, therefore, a reliable indicator of damages of udder tissue. However, *Edmondson* (1998) points out that results of the somatic cells count measurements in individual cows are not the most effective way for solving the mastitis problems, therefore before taking measures we must have more consecutive estimations. In Slovenia the somatic cells in milk of individual cows are being determined monthly for all milk cows only in some herds.

The somatic cells count in milk is also very important for the evaluation of the balance of cow nutrition. Deficiencies in nutrition of cows (deficiency or surplus of determined nutritive substances and mineral, especially trace elements, too great share of concentrates, spoilt fodder, sudden change of ration) influence the too great burdening and irritation of mammary (lacteal) gland and increased somatic cells count in milk. The nutrition influences also on the resisitivity of cows to masititis. *Erskine* (1993) and *Hogan et al.* (1993) report that the deficiency of the vitamin E and selenium in ration is connected with greater frequency of environmental intrammamary infections and clinical cases of mastitis. *Foltys et al*. (2001) attained statistically significant ($P \leq 0.001$) reduction of somatic cells count in milk at addition of 0.2 ppm of organic selenium to fodder mixture for cows and which was given to cows during 8 weeks. Important nutrition components are also vitamin A and beta-carotene, and among minerals copper and zinc (*Hogan et al*., 1996).

The somatic cells in milk can also be used as a selection criterion for increasing resistivity of cows to mastitis. *Philipsson et al*. (1993) have determined for the Scandinavian countries positive correlation ($r=0.10$) between somatic cells count in milk and morbidity rate of cows with mastitis. The same author et al. (1995) quote that in Sweden on sample of 750 thousand cows, daughters of 1462 red-white and 911 Friesian bulls between relative breed value of clinical mastitis and of cells in milk were stated the correlation 0.45 in red-white and 0.41 in Friesian breed, and value of the genetic correlation 0.79 and 0.71 respectively. *Reents* (1997) quotes the genetic connection between somatic cells and manifestation of mastitis about 0.6 to 0.7. The evaluations of authors show that it is possible to increase the resistivity of cows to morbidity rate of mastitis by selection.

Up to now in Slovenia only the selection with regard to milk production is being performed, while the selection with regard to resistivity of cows to mastitis is still not being performed. By increased milkiness also sensitivity of cows to mastitis is being increased. *Solbu* (1989) states that with such one-sided selection the increased share of mastitis cases by 1.3% in a generation. *Pogačar* (1996 a, 1996 b) quotes that the one-sided selection in Slovenia caused greater frequency of cow morbidity rate of mastitis in some lines and bulls which is being yearly increased. Mastitis to many breeders causes great losses since it usually involves the best milk cows. Therefore, mastitis represent not only medical but also economic problem in production of quality milk.

Reents (1997) states that the causes for the increased somatic cells count in milk are most frequently the environmental factors which cannot be eliminated. Consequetly, the measures in curing mastitis must comprise the environmental factors as also the correction of the made mistakes. And these measures include particularly the zoo-hygienic conditions in the stable and milking place, faultless milking machine, milking procedures, hygienic measures after milking, timely drying of cows, timely elimination of uncurable cows, balanced nutrition. At discovering of causes we must take into consideration also factors suc as age of cows, lactation stage, fertility, calving season, general condition of the herd. On four farms with milk cows from defined region the somatic cells have been defined for many years beside in stable (tank bulk) samples also in milk samples of individual cows within the regulara monthly control (AP). Mastitis remains the greatest economic, technological and sanitary problem on bigger farms. Our research goal was to study the influence of environmental factors: farm, season and studied years on somatic cells count in milk stable samples and milk samples of individual cows. We were also interested in differences among separate influences and correlations among them.

MATERIALS AND METHODS

In years 2000 and 2001 on 4 farms with total number of approx. 1100 cows of the Friesian breed the somatic cells count in samples of milk of individual cows (SCCis) and stable (tank bulk) milk samples (SCCss) was analysed. For the somatic cells count in milk of individual cows were used the data from regular AP control we received from experts (technical service) of the Slovene Agricultural Institute. For determination of the somatic cells count in stable samples the milk samples from tank were taken 1 to 4 times per month on each farm. Only on the farm B the somatic cells in milk of individual cows were not determined from June to September in the year 2000. A the same time the tank milk samples were used for commercial purposes. In two years there were in total analyzed 21942 milk samples of individual cows and 271 stable samples. All samples include evening and morning milking. At sample taking the daily quantity of milk in tank oscillated between 3500 and 9000 kgs. Production of milk for market was 8 288 tons in 2000 and 7 976 tons in 2001.

All 4 studied farms are in the defined region. Technology of breeding and nutrition of cows are the same on all four farms. Breeding is free, and nutrition differs among seasons. In summer (May-September) cows were pastured, and hay, maize and/or grass silage, appropriate fodder mixtures and mineral-vitamin supplement were given to them. Winter ration comprised hay, grass and maize silage, fodder mixtures and mineral-vitamin supplement.

On farms cows sick with mastitis were recorded and cured daily.

Milk analyses were performed in the laboratory of the Dairy Institute of Biotechnical Faculty, Department of Zootechnics. The somatic cells count in millilitre of milk was defined with the instrumental method with apparatus Fossomatic 90 (Foss Electric).

The analysis results were statistically processed with the programme package SAS/STAT (1994). The influence of the farm, years and season on the somatic cells count in milk was analysed with F-test (analysis of variance), while differences among years, seasons and farms were evaluated with Scheffe's test. The correlation between somatic cells count and number of cases of cured mastitis, milk quantity and number of cured cases of mastitis and milk quantity and somatic cells count in milk was calculated. Since the distribution of somatic cells count in milk samples of individual cows strongly deviates from normal, logarithms of basic measurements were calculated (LSCC). Based on these data the analysis of variance was performed afterwards.

RESULTS AND DISCUSSION

In *Tables 1* and *3* are shown the annual mean of the somatic cells count in stable (tank bulk) milk samples and the mean of milk samples of individual cows per farm with some statistical indicators, and in *Tables 2* and *4* the differences of studied influences (Scheffe's test).

Table 1

The mean SCCss (10^3/ml) and LSCCss in years 2000 and 2001 per farm with some statistical indicators

Farm	Year	No. of samples	Mean	Medi-ana	Stand. deviat.	Coef. var. %	Min.	Max.
A	2000	35	385.1	386.0	72.9	18.9	218.0	625.0
	LSCCss		5.58	5.59	0.08		5.34	5.80
	2001	33	364.4	350.0	54.8	15.0	270.0	476.0
	LSCCss		5.56	5.54	0.06		5.43	5.68
B	2000	35	302.8	302.0	52.1	17.2	201.0	406.0
	LSCCss		5.47	5.48	0.08		5.30	5.61
	2001	33	354.8	372.0	43.1	12.1	258.0	436.0
	LSCCss		5.55	5.57	0.06		5.41	5.64
C	2000	34	275.5	272.0	36.4	13.2	190.0	345.0
	LSCCss		5.44	5.43	0.06		5.28	5.54
	2001	34	334.6	332.5	45.9	13.7	226.0	469.0
	LSCCss		5.52	5.52	0.06		5.35	5.67
D	2000	34	275.3	268.0	47.0	17.1	205.0	376.0
	LSCCss		5.43	5.43	0.07		5.31	5.57
	2001	33	334.6	335.0	42.6	12.7	246.0	433.0
	LSSCss		5.52	5.52	0.06		5.39	5.63
A+B + C+D	2000	138	310.2	302.5	69.95	22.55	190.0	625.0
	LSSCss		5.48	5.48	0.09		5.28	5.80
	2001	133	347.0	345.0	48.09	13.86	226.0	476.0
	LSSCss		5.54	5.54	0.06		5.35	5.68
TOTAL	2000 and 2001	271	328.2	327.0	62.87	19.16	190.0	625.0
	LSCCss		5.51	5.51	0.08		5.28	5.80

Farm influence *F-value=25.44* *$P \leq 0.0001$*
Season influence *F-value=0.36* *$P=0.547$*
Year influence *F-value=41.76* *$P \leq 0.0001$*

The somatic cells count in joint (stable, tank bulk) milk samples is, especially in EU, used as indicator of hygienic conditions in milk production (*Heeschen et al.*, 1997).

Numerous researches show that the somatic cells count over $250x10^3$/ml milk represents for the breeder a serious warning that there are more cows with udder inflammation in herd. According to *Edmondson* (1998) in somatic cells count in tank bulk sample between 200 do $400x10^3$/ml of milk in stable the infection is present, and with greater somatic cells count of $400x10^3$/ml there is a problem of infectious mastitis in herd.

From *Table 1* is evident that the somatic cells count in stable sample in studied farms ranges from minimum $190.0x10^3$/ml to maximum $625.0x10^3$/ml of milk. The mean for both years is $328.2x10^3$/ml of milk, and LSCCss is 5.51/ml, while mediana is $327.0x10^3$. In year 2000 they were lower, $310.2x10^3$/ml cells/ml, while the mean for the year 2001 was higher, $347.0x10^3$/ml, being by 11.9% higher. In both years the greatest somatic cells count in stable milk samples was on farm A ($385.0x10^3$ in year 2000, $364.4x10^3$/ml of milk respectively in year 2001), farm B is the following, while farms C and D are practically equal. However, on farm A the somatic cells count/ml of milk was in the year 2001 (abs.) smaller than in the year 2000, while on other three farms it was increased in the year 2001.

Considering the summer (May-September) and winter (October-April) season in the year 2000 there were more somatic cells in milk in the summer season. The mean was $299.6x10^3$ cells/ml, and LSCCss was 5.48/ml, and in winter season $320.5x10^3$/ml, LSCCss was 5.51/ml. In opposition to the year 2000 there were in the year 2001 more somatic cells in milk in summer season, i.e. $354.3x10^3$/ml, LSCCss was 5.75/ml as in winter season where cells were $340.5x10^3$/ml, LSCCss was 5.53/ml. In the year 1995 on studied farms in summer season the somatic cells were $310x10^3$/ml, and in winter season $313.2x10^3$/ml, i.e. without greater difference between seasons (*Rajčevič* and *Jazbec*, 1997). Some sources quote that in summer season there were more somatic cells in milk than in winter, but not on pasture, although also the pasture conditions can contribute to manifestations of environmental mastitis.

In the year 1995 on same farms in stable milk samples (n=104) the somatic cells were $357.0x10^3$/ml (*Rajčevič et al*., 1996), in the year 1996 (geom.mean) $293.9x10^3$/ml (n=96) and in the year 1997 (geom. mean) $318.5x10^3$/ml (n=96) (*Rajčevič et al*.,1998). Presented results show considerable oscillation of somatic cells count in stable milk samples in mentioned years, of which the year 2001 was the worst as there were most cells in millilitre of milk, and the least cells were found in the year 1996.

With regard to the Regulations on elements for formation of purchase price for cow milk (Ur.list. RS 107/22.12.2001), and standard EU of 1.1.1998 on studied farms the 91.7% delivered milk in the year 2000 and 89.5% in the year 2001 contained the somatic cells up to $400x10^3$/ml, and in 8.3% and 10.5% milk the somatic cells were more than $400x10^3$/ml. In 1996 on the same farms in stable samples there was more than $400x10^3$ cells/ml in 7.3% milk, and in 1997 in 21.15% milk. Regarding the share of delivered milk with somatic cells count more than $400x10^3$/ml in years 2000 and 2001 and in comparison with 1997 a great progress was achieved, but the year 2001 was worse than 2000.

In years 2000 and 2001 the influence of farm and years on somatic cells count in stable milk samples was highly statistically significant ($P \leq 0.0001$) as we have found out also for years 1995, 1996 and 1997.

Table 2

Estimate of differences of studied systematic influences on (logarithmic) somatic cells count in stable milk samples (Scheffe's test)

Effect	Difference	Estimate±Std. Error	t-value	P
Year	2000-2001	0.05505±0.008519	6.46	0.0001
Season	Summer-Winter	0.00514±0.008519	0.60	0.5466
Farms	A-D	0.09154±0.01205	7.59	0.0001
	A-B	0.05831±0.01201	4.86	0.0001
	A-C	0.09034±0.01201	7.52	0.0001
	D-B	0.03323±0.01206	2.76	0.0574
	D-C	0.00120±0.01205	0.10	0.9997
	B-C	0.03203±0.01201	2.57	0.0709

From *Table 2* is evident that differences in somatic cells count in stable milk samples are statistically highly significant ($P \leq 0.0001$) between years and farms A and D, A and B, A and C.

Table 3

The mean SCCis (10^3/ml) in milk of individual cows and LSCCis in 2000 and 2001 by individual farm

Farm	Year	No. of samples	Mean	Medi-ana	Mad	SD Mad	Min.	Max.
A	2000	2439	533.9	217.0	166.0	246.1	4.0	5000
	LSCCis		5.36	5.34	5.22	5.39	3.6	6.7
	2001	2417	567.2	214.0	166.0	246.1	4.0	5000
	LSCCis		5.37	5.33	5.22	5.39	3.6	6.7
B	2000	1729	388.3	114.0	84.0	124.5	4.0	5000
	LSCCis		5.11	5.06	4.92	5.09	3.6	6.7
	2001	2641	467.9	162.0	126.0	186.8	4.0	5345
	LSCCis		5.22	5.21	5.10	5.27	3.6	6.73
C	2000	4087	371.2	136.0	91.0	134.9	1.0	5000
	LSCCis		5.17	5.13	4.96	5.13	3.0	6.7
	2001	4120	467.9	175.0	119.5	177.2	1.0	5000
	LSCCis		5.28	5.24	5.08	5.25	3.0	6.7
D	2000	2257	360.4	131.0	83.0	123.0	1.0	5000
	LSCCis		5.17	5.12	4.92	5.09	3.0	6.7
	2001	2252	448.1	157.0	103.0	152.7	1.0	5000
	LSCCis		5.25	5.20	5.01	5.18	3.0	6.7
A+B + C+D	2000	10512	409.3	760.2	100.0	148.3	1.0	5000
	LSCCis		5.20	5.16	5.0	5.17	3.0	6.7
	2001	11430	485.0	855.7	125.0	185.3	1.0	5345
	LSCCis		5.28	5.24	5.10	5.27	3.0	6.73
TOTAL	2000 and 2001	21942	448.8	158.0	112.0	166.1	1.0	5345
	LSCCis		5.24	5.20	5.05	5.22	3.0	6.73

Farm influence F-value=20.94 P≤0.0001
Season influence F-value=47.92 P≤0.0001
Year influence F-value=904.19 P≤0.0001

Since the nature of somatic cells distribution in milk samples of individual cows is different than in stable samples, in statictical processing beside mean values and mediana there were also calculated the mediana of deviations from mediana (Mad). Exceptional extreme values (e.g. $5x10^6$) in stable samples are nullified, and in individual samples they change the distribution (there is no normal distribution any longer). Standard deviation is not quoted as with such sample distribution (measurement) it is not logical.

Table 3 shows that the somatic cells count for both years is on average $448.8x10^3$/ml of milk, LSCCis is 5.24/ml, mediana $158.0x10^3$/ml, and Mad $112.0x10^3$/ml. Also the somatic cells count in milk samples of individual cows is greatest on farm A as the mean is $533.9x10^3$/ml of milk, LSCCis is 5.35/ml in 2000 and $567.2x10^3$/ml, LSCCis is 5.37/ml in 2001.

As evident from *Table 3* there is highly statitistically significant (P≤0.0001) impact of all three studied influences on somatic cells count in milk samples of individual cows.

Table 4

The estimate of differences of studied systematic influences on (logarithmic) somatic cells count in milk samples of individual cows

Effect	Difference	Estimate±Std. Error	t-value	P
Year	2000-2001	0.2001±0.006656	30.07	0.0001
Season	Summer-Winter	0.04316±0.006236	6.92	0.0001
Farms	A-D	0.1664±0.03232	5.15	0.0001
	A-B	0.2302±0.03016	7.63	0.0001
	A-C	0.1539±0.02737	5.62	0.0001
	D-B	0.06376±0.03233	1.97	0.0486
	D-C	0.01252±0.02975	0.42	0.6740
	B-C	0.07628±0.02738	2.79	0.0054

From *Table 4* is evident that in somatic cells count in milk samples of individual cows there are highly statistically significant ($P \leq 0.0001$) differences between years, seasons and between farms, except between farm D and C ($P \leq 0.6740$). Difference between farm D and B is significant on the level $P \leq 0.0486$, and the difference between farm B and C on the level $P \leq 0.0054$.

In our research the somatic cells count in milk samples of individual cows ranged from the minimum 1 thousand to the maximum 5345x10^3/ml of milk. *Sainsbury* (1998) quotes that with cow with 1x10^3- and more somatic cells/ na ml the production of milk is smaller by 900 kgs. According to *Edmondson* (1998) the cow health condition with regard to mastitis should be good if there are less than 100x10^3/ml somatic cells in milk of individual cow, at 100 to 200x10^3/ml the cows are probably not infected, between 200 and 400x10^3/ml there is the possibility of infection, and over 400x10^3/ml of milk there is the problem of subclinical infection.

Statistical indicators in *Tables 1* to *4* show that also in our research environmental factors have a great influence on increased somatic cells count as emphasized also by *Reents* (1997). In our opinion these influences on studied farms are still not being eliminated effectively enough. This is also pointed out by the *Table 5*, from which is evident that in the year 2001 during determination of somatic cells in milk samples of individual cows the number of cows with more 200 to 400x10^3 cells/ml was increased, and there was even more increased (4.65%) the number of those with more than 400x10^3 cells/ml; these were 23.07% in 2000, and 27.72% in 2001.

Table 5

The number and share of milk samples of individual cows categorised in classes according to Edmondson (1998) for all farms together per year

Somatic cells 10^3/ml	**Year 2000**		**Year 2001**	
	No. of samples	%	No. of samples	%
to 100	4073	38.75	3864	33.81
100-200	2314	22.01	2344	20.51
200 - 400	1700	16.17	2053	17.96
over 400	2425	23.07	3169	27.72

Edmondson (1998) states that the determination of somatic cells count in milk of individual cows is a big problem since by this it is determined which quarter and how many quarter were infected, and just as well not the infection type and degree. He also quotes that the somatic cells count of individual cows can be useful for determination of problematic cows, but these findings must be base at least on three consecutive sample takings. If the samples are taken from eachindividual quarter, only then can be determined which and how many quarters are affected, but with this the infection type and degree are not determined (bacteriological analysis).

Table 6

The correlations between somatic cells count and cases of mastitis, between milk quantity and somatic cells count

	SCCis	LSCCis	SCCss	LSCCss	Milk quantity
SCCss	0.608	0.568			
	$P \leq 0.0001$	$P \leq 0.0001$			
LSCCss	0.613	0.569			
	$P \leq 0.0001$	$P \leq 0.0001$			
Milk quantity	-0.328	-0.266	-0.278	-0.269	
	$P \leq 0.001$	$P \leq 0.01$	$P \leq 0.006$	$P \leq 0.008$	
No. of mastitis	0.275	0.102	0.158	0.162	0.332
	$P \leq 0.008$	$P=0.335$	$P= 0.124$	$P=0.114$	$P \leq 0.001$

There were determined statistically significant correlations between somatic cells count in milk samples of individual cows and number of cured cases of mastitis ($r=0.275$, $P \leq 0.008$), between milk quantity and number of cases of mastitis ($r=0.332$, $P \leq 0.001$), between somatic cells count in stable milk samples and milk quantity ($r=-0.278$, $P \leq 0.006$) and SCCis and milk quantity ($r=-0.328$, $P \leq 0.001$). Correlation between somatic cells count in stable milk samples and milk samples of individual cows is highly statistically significant ($r=0.608$, $P \leq 0.0001$).

CONCLUSIONS

Our research shows how numerous and complex are environmental factors that are the most frequent cause for manifestation of mastitis and increased somatic cells count in milk. In stable samples as well as in milk samples of individual cows the somatic cells count in milk oscillated considerably. On their count highly statistically significant ($P \leq 0.0001$) is the influence of farm (and management) and studied years, and on SCCis also the season influence. These influences comprise numerous factors - from zoohygienic conditions, nutriton to management and supervision of all procedures on farm. In our opinion, on studied farms the first place is occupied by zoohygienic conditions in stable, especially in milking place, and supervision. Only cooperation of all expert (veterinary, tehnologist, equipment experts) and leading workers can give long-term success in reduction of cases of mastitis.

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Corresponding author:

Marija Rajčevič
Poslovni sistem Mercator, Inc.
SI-1001 Ljubljana, Dunajska 107., Slovenia
Tel.: 386 1 50 74 286
e-mail: rajcevic@ibmi.mf.uni-lj.si

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Potential use of milk analyses for udder health control in highly productive dairy herd

M. Klinkon, M. [1]Klopčič, J. [1]Osterc

Veterinary Faculty, Ljubljana, SI-1000 Gerbičeva 60., Slovenia
[1]Biotechnical Faculty, Zootechnical Department, Domžale, SI-1230 Groblje 3., Slovenia

ABSTRACT

The differences of milk composition in highly productive dairy herd in milk bulk tank and from individual dairy cows in the frame of referral A4 (AP) and B control were analysed in the paper. During the experiment the oscillations of somatic cells count (SCC), of the content of lactose and enzyme LDH activity were monitored. Significant oscillations of the SCC and enzyme LDH activity in milk tank were noticed. The somatic cell count in milk tank varied between 87 and 770 thousand cells/ml milk, and enzyme LDH activity between 7 and 173 U/l milk. When the SCC in the milk tank exceeded 400 thousand SCC, enzyme LDH activity exceeded 100 U/l milk. Both parameters were used for udder health control. The content of lactose, which also shows udder diseases, lowered only when the SCC in the milk tank exceeded 600 thousand SCC/ml milk. AP and B control were carried out on the farm at the time of no udder disorders reported in the herd.
(Keywords: dairy cows, milk, lactose, somatic cell count, enzyme LDH activity)

INTRODUCTION

Economic milk production requires high milk production per cow, milk with a high nutritive value and excellent hygienic quality as well as healthy cows. Milk composition could show faults in nutrition and management of herd as for example disorders in health and hygienic quality of milk. Hence it is important to perceive the above connections in production of quality milk and healthy cows.

Health and nutritional disorders that result in lower production and clinical diseases can hardly be noticed at the beginning, therefore suitable preventive advisory programmes are necessary. In the first place results of milk tank analyses and from individual dairy cows that are easy to be taken and have several parameters measured will become the basic diagnostic material for detection of udder, metabolic, reproductive diseases, and parasites.

Production and health control in dairy cows have heretofore been proceeded by so called milk profile test. Milk is analysed regularly according to milk recording system. Samples are easy to be taken, and individual animals or the whole herd are recorded. The results of milk analyses are important for the farmer, nutritional experts and veterinarians. Milk samples show health conditions of an animal more quickly, easily and cheaply than blood assays, which is very important from the point of view of production.

Milk analyses indicate several parameters of quality like contents of fat, proteins, lactose, dry matter, somatic cell count, contents of urea, potassium, sodium, chlorine, acetone, the enzyme LDH activity and so on. According to the experiences the results of milk analyses are not adequately used in herd control. We would like to show the dynamics of various milk components on the base of individual and milk tank samples in highly productive dairy herd.

In highly productive dairy cows mastitis and high SCC are very frequent. Farmers whose main income derives from quality milk sale would like to control udder health in dairy cows on the permanent basis. Some milk components like the content of lactose, SCC and the enzyme LDH activity are the most suitable indicators of udder conditions. In practice milk components cannot be measured every day because it would be too expensive. Daily control of milk quality can be achieved by frequent analysis of milk tank samples. We wondered if the results of milk tank gave adequate information on udder health conditions in the herd. Therefore in the farm with the average annual milk production above 10,000 kg milk per cow milk tank sample composition was compared to the results of analysis of milk from individual diary cows at monthly milk recording.

In Slovenia the quality of milk is determined by regulations. Besides the content of fat and proteins in milk the total number of microorganisms (TNM) and somatic cell count (SSC) are of great importance. The above traits significantly affect the selling price on the farm. Farmers look forward to high content of fat and proteins in milk and to a low presence of TNM and SSC in order to achieve the highest price per litre of sold milk. Milk composition is important also because it shows important facts about the supply of energy and proteins (proteins, urea) in animals as well as health conditions, especially of udder and are an important indicator of some diseases.

A high content of milk fat in milk can show ketosis, acidosis and cystic degeneration of ovary. At the beginning of ketosis and energy deficiency in a daily ration the milk contains more milk fat. When ketosis is clinically noticed (no appetite) the content of milk fat is low (*Klinkon et al*., 1999a).

Proteins are the most valuable components of milk. The content of proteins is most often affected by ketosis and hypocalcemia. Visible and invisible udder diseases (mastitis) cause lower content and poor composition of proteins in milk due to increased fermentation of already built milk proteins especially casein in mammary gland (*Klinkon et al.,* 2000).

Lactose in milk is a disaccharide composed of glucose and galactose. Cow milk contains on the average about 4.60% of lactose (*Walstra,* 1984). The content of lactose in milk depends on the breed, stage of lactation, successive lactation, health conditions and other factors (*Miljkovič,* 1984). Lactose in milk is more stable than other components (*Larson* and *Smith,* 1974). Several researches proved the relation between the higher SCC in milk and lower contents of lactose. Milk that contains more than million of SCC/ml usually does not reach 4.40% of lactose. Low concentration of lactose proves a metabolic functional disorder of udder tissue that is not a consequence of udder inflammation but the result of metabolic disorders. Considering the fact that lactose derives from glucose in blood it is obvious that only a suitable nutrition will result in adequate level of glucose in blood (*Klinkon et al.,* 1999b).

Somatic cells in milk are represented by epithelial cells, i.e. cells of gland tissue, leukocytes – white blood cells and lymphocytes – a group of white blood cells. Somatic cell count affects the selling price on the farm, therefore it is very important to have healthy cows in the herd. Somatic cell count is very substantial for each farmer because it reveals cows with visible or invisible mastitis. Milk from healthy udder in the normal lactation contains about 100,000 cells in ml milk. *Klopčič* (1994) reported that SCC was increased during 8 to 14 days after calving, decreased till the 60th day after calving when it reached the lowest values, and is followed by an increase until drying. Somatic cell count is considerably increased in the case of udder inflammation. When the SCC increases above 400,000 cell/ml the danger of acute mastitis is present since the risk factor has been increased by three times. A team work of a farmer, control and selection and veterinary services can result in successful and effective struggle for satisfying udder health and thus a good quality of produced milk, which is very important for the farmer (payments are based on quality of milk) and milk industry that needs good quality milk for production of quality products.

Somatic cell count in milk has been lowered to achieve better quality of milk. Higher somatic cell count (neutrophyl granulocytes, other leukocytes, epithelia cells) in milk is the result of damages in alveolar walls of the udder. Damages could be the outcome of infections, chemical effects (usage of antibiotics), physical effects (traumatic damages, bad function of milking machine) and stress conditions. Somatic cell count in milk depends on the age of dairy cows (milk from older animals contains more somatic cells than milk from younger ones), on the season (in spring SCC is lower than in autumn). Somatic cell count changes during the day as well, morning milk contains less SCC than evening milk; *Mijovič et al.,* 1995).

Klinkon et al. (1999b) found out that higher somatic cell count caused lower percentage of lactose. The content of milk fat is not affected by somatic cell count while milk proteins increase linearly to somatic cell count. Higher SCC affects some biochemical parameters in milk. More somatic cells cause higher enzyme LDH activity, higher concentration of sodium and chlorine while the concentration of potassium decreases.

Only healthy and regularly supplied cows can give milk with normal composition and in regular amounts. Both composition and amount of milk are most affected by mastitis – inflammation of udder. The inflammation of udder causes the following changes in milk composition:

- The ratio of nitrogen fractions is destroyed.
- The amounts of casein and lactose are lowered.
- The amount of calcium is lowered.
- The amount of whey proteins increases (albumins, imunoglobulins).
- The amounts of sodium and chlorine are increased.
- The number of leukocytes and amounts enzyme of catalysis are increased (*Zorko*, 1992).

Zadnik et al. (1993, 2001) studied the content of sodium, potassium, chlorine and somatic cell count, and enzyme LDH activity in milk They found out that the above parameters show health conditions of udder. They found increased amounts of sodium (above 24 mmol/l), chlorine (above 35 mmol/l) and enzyme LDH activity (above 100 U/l) while the content of potassium decreased (below 38 mmol/l) in samples of milk tank with more than 400,000 SC/ml.

Besides mastitis several other diseases and disorders that affect the composition and amounts of milk are known. Most known are metabolic disorders that appear at digestion of carbon hydrates (ketosis, acidosis) and of some mineral matters (parturient paresis).

MATERIALS AND METHODS

Presentation of the family farm

The farm owns 9 ha and hires 6 ha of agricultural lands. Dairy cows (n=20 to 22) were free in stables all the year. Their ambition is to produce high quality fodder (hay, grass and maize silage). Components for feeding mixtures are bought and mixed by themselves. Feeding mixture is fed automatically by computer assistance while grass and maize silage are fed ad libitum. Cows are milked in the milking parlour at passage tandem 2×2 and is computer assisted. They maintain order and cleanness, hence no problems of milk quality are known.

Table 1 indicates the results of control for the period from 1990 to 2001. The highest milk production per cow was achieved in the year 2000 when the average annual milk production per cow exceeded 10,000 kg of milk. Hence the milk production per feeding day and milking day was the highest in the year 2000. The results of milk recording showed that cows produced the richest milk in 1999 and 2001 regarding the contents of fat and proteins. In the last 12 years milk production augmented remarkable; the average milk production per cow was 6.507 kg in 1990 and in 2000 10.226 kg milk per cow per year. It means that the average annual production of milk in the period between 1990 and 2000 increased for 3.719 kg or by 338 kg milk per year. The content of fat was quite high (above 4.0%), while the content of proteins increased especially after 1995 (above 3.33%).

Table 1

Annual milk production of recorded cows in the AP control on the above mentioned farm in the period 1990–2001

Year	No. of cows	Milk yield, kg		Fat	Proteins	Milk yield, kg		Milking days	PTC
		Total	Per cow	%	%	Per FD	Per MD		Days
1990	19.6	127,737	6,507	4.26	-	17.8	19.9	327	388
1991	21.1	143,085	6,784	4.17	-	18.6	20.2	336	366
1992	21.2	162,024	7,646	4.28	-	20.9	22.7	337	404
1993	23.2	209,988	9,069	3.93	3.20	24.9	27.1	335	385
1994	24.1	205,256	8,515	4.01	3.22	23.3	25.1	339	407
1995	25.5	228,050	8,941	4.03	3.15	24.5	27.0	331	389
1996	27.2	243,871	8,964	4.10	3.33	24.5	27.4	328	410
1997	25.3	231,521	9,146	4.29	3.43	25.1	27.4	334	379
1998	25.0	252,244	10,072	4.40	3.35	27.6	29.8	338	391
1999	23.5	227,519	9,696	4.45	3.47	26.6	28.7	338	379
2000	23.8	242,946	10,226	4.47	3.37	27.9	30.1	340	381
2001	23.5	228,326	9,712	4.45	3.47	26.6	28.7	338	379

FD: feeding day; MD: milking day; PTC: period between two calvings

Milk composition in the dairy herd

Between November 2 and December 13 1999 i.e. for six weeks, differences of the amounts and composition of individual dairy cows and milk tank were monitored. After morning milking a daily sample of milk from tank was taken. During the experiment 42 samples of milk were taken.

During the experiment the milk controller recorded production (AP control) twice according to the reference method A4. The milk controller took milk samples from all cows that were milked on the certain day. Basic (contents of fat, proteins, lactose and dry matter and somatic cell count) and biochemical (content of sodium, potassium, chlorine, urea, enzyme LDH activity) parameters of milk were determined in samples of milk from individual cows. The farmer himself recorded milk production three times during the experiment (B control). He took samples of milk from individual cows once a week from both daily milking. We determined basic and biochemical parameters of milk in those samples too.

Milk samples were analysed in two laboratories. In the Laboratory of Institute for Dairy of Biotechnical Faculty, Zootechnical Department the infrared spectrometry with Milko-Scan 133 was used to determine basic composition of milk and Fossomatic 5000 to determine SCC in milk. In the laboratory of Clinics for Ruminants at the Veterinary Faculty the bio-analyser Cobas Mira was used to determine biochemical parameters in milk (urea, Na, K, Cl, LDH).

Data processing

Collected data were processed by SAS (Version 8) at the Centre for expert work in animal breeding at Biotechnical Faculty, Zootechnical Department.

Basic statistical parameters: mean value ($\bar{x}$), standard deviation (SD), coefficient of variability (CV), minimum and maximum for some studied traits of milk tank within the regular milk recording (AP control), and the farmer's milk recording (B control) were estimated.

RESULTS AND DISCUSSION

Table 2 shows basic statistical parameters for the amount and composition of milk tank and for individual cows obtained at the regular milk recording (AP control) and at farmer's recording (B control).

Table 2

Basic statistical parameters ($\bar{x}$, SD, CV) for milk tank (total daily milk production) and results from AP and B control

Trait	Milk Tank			AP milk recording			B milk recording		
	$\bar{x}$	SD	KV	$\bar{x}$	SD	KV	$\bar{x}$	SD	KV
No. of measure.	42	42	42	43	43	43	64	64	64
Milk, kg	-	-	-	25.40	6.99	27.6	24.3	7.25	29.9
Fat, %	4.47	0.16	3.61	4.75	0.69	14.4	4.64	0.87	18.7
Protein, %	3.57	0.04	1.29	3.67	0.47	12.8	3.62	0.46	12.8
Lactose, %	4.58	0.06	1.37	4.61	0.23	5.04	4.58	0.22	4.70
SSBM, %	8.87	0.05	0.60	9.03	0.56	6.20	8.93	0.50	5.62
SSC x 1000/ml	331	178	53.7	160	239	149	236	517	219
LDH, U/l	102	26	26	63	40	64	72	59	82
Urea, mmol/l	5.67	0.73	12.9	5.80	1.20	20.8	5.49	1.23	22.3
Na, mmol/l	20.93	1.85	8.85	19.51	3.98	20.4	21.42	3.21	15.0
K, mmol/l	40.14	1.49	3.71	39.38	3.02	7.68	40.61	3.01	7.40
Cl, mmol/l	36.57	1.62	4.44	38.93	4.55	11.7	37.27	4.29	11.5

The comparison of milk tank analysis and of individual cows within AP control and B control shows that all components and biochemical parameters differ in mean value. Those differences are higher when milk tank analyses are compared to milk analyses of individual cows within AP control. Lower differences are noticed when the results of milk tank are compared to the results from B control. The lowest differences of the mean value are noticed when the results of AP and B control are compared. Also the standard deviation and the coefficient of variability are higher in the composition of milk from individual cows (AP and B control) in comparison to the milk tank results. The basic components of milk tank were lower than in milk from individually recorded cows. On the contrary, somatic cell count and enzyme LDH activity were higher in milk tank, but two parameters indicated lower standard deviation and lower coefficient of variability in AP than in B control.

Considering the fact that no important changes occurred in feeding regime during the experiment standard deviations for milk traits were not high. The highest standard deviation was determined for somatic cell count and the enzyme LDH activity and for sodium, potassium and chlorine. The highest variability was noticed in somatic cell count in milk tank whereas it ranged between 87 and 770 thousand per ml of milk during the observation (six weeks). Within the milk recording (AP) the somatic cell count ranged between 12,000 and 1,498,000 cell/ml milk in individual cow. A high variability was observed in enzyme LDH activity (CV=25.6% in milk tank and 82% in milk from individual cows in B control). For the content of urea in milk was CV 12.9% in milk tank and 22.3% in milk from individual cows in B control. In sodium CV ranged between 8.85% in milk tank and 20.4% in milk from individual cows in AP control. Other components indicated lower coefficients of variability.

Figure 1 shows that the content of lactose in milk tank differences during the experiment. Milk contained a lot of lactose at the beginning of the experiment and much less towards the end of it. The AP control was done on the first and the thirtieth day of the experiment. The average content of lactose in the AP control was 4.63%, and 4.60% in the second one. Milk tank contained 4.62% of lactose in the first AP control, and 4.65% in the second one. The farmer did the B control on the tenth, twenty-first and on the fortieth day of the experiment. The first and third control showed that the average content of lactose in milk from individual cows was 4.58% and 4.59% in the second control. Milk tank contained almost equal amounts of lactose as in B control.

Figure 1

Oscillations of the content of lactose in milk from tank

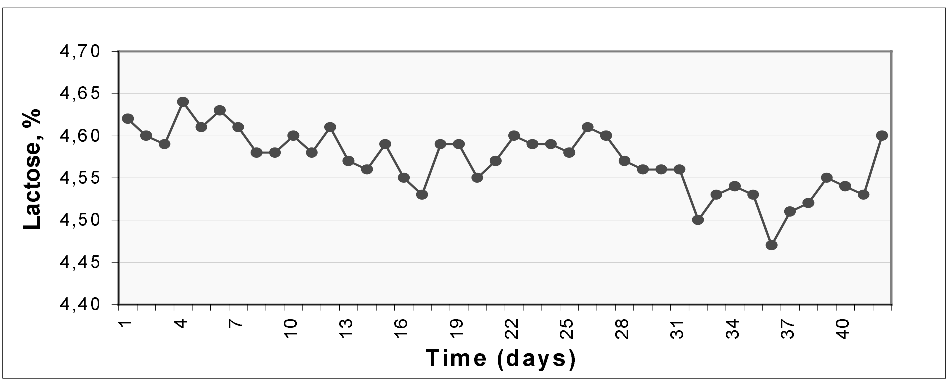

Figure 2

Oscillations of the somatic cell count and enzyme LDH activity in milk from tank

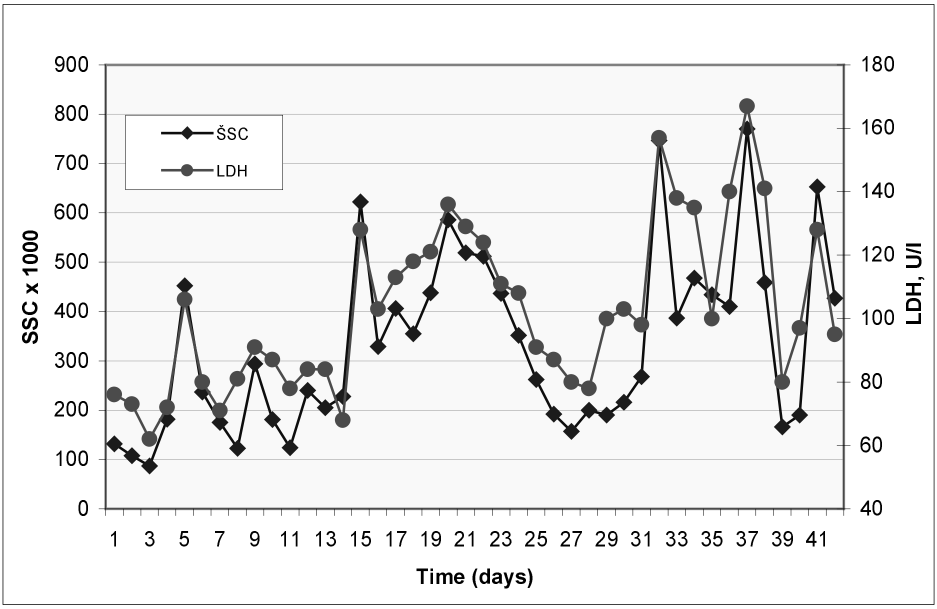

Figure 2 shows that somatic cell count and enzyme LDH activity in milk from tank during the six-week-long experiment varied. During the experiment high oscillations of somatic cell count in milk tank were noticed. Milk tank contained above 400,000 somatic cells/ml milk sixteen times. The AP control was done on those days when milk contained little somatic cells. The average somatic cell count in milk from individual cows was 100,000 in the first AP control (milk tank contained 123,000 somatic cells on that day) and in the second control 223,000 (milk tank contained 216,000 cells). Also B control showed that milk tank did not exceed the allowed limit of 400,000 cell/ml milk. Only in the second control, which was done by the farmer on the 21st day of the experiment, milk tank contained above 500,000 cells while the average SCC in milk from individual cows (B control) was 257,000 somatic cells/ml.

Figure 2 represents also the oscillations of enzyme LDH activity in milk tank. Enzyme LDH belongs to cytoplasmic enzymes and is present in the epithelial cells in milk canals in the udder. During the inflammation process in udder milk producing tissue is affected, therefore enzyme LDH activity increases. Enzyme LDH activity in milk is an important indicator of health condition of mammary gland, especially it shows tissue infections with bacteria and is positively correlated to the somatic cell count and to the content of sodium and chlorine in milk. In our experiment, we have noticed high correlation subsist between the somatic cell count and enzyme LDH activity (r=0.85). During the experiment the enzyme LDH activity exceeded 100 U/l milk eighteen times. Higher values of enzyme LDH were noticed together with higher somatic cell count in milk tank, which is clearly shown in *Figure 2.* When the somatic cell count in milk tank exceeded 400,000 somatic cells/ml milk, the enzyme LDH activity exceeded 100 U/l milk too.

The content of lactose did not change during the experiment as quickly as the enzyme LDH activity did in relation to higher somatic cell count. The analysis of lactose content in milk tank, which is presented in *Figure 1*. and somatic cell count, which is presented in *Figure 2*. showed that the content of lactose lowered when the somatic cell count exceeded 600,000 cell/ml in milk tank.

AP and B control were carried out when no significant udder health troubles were noticed, which is proved by low somatic cell count and low enzyme LDH activity on the milk recording day in milk tank as well as in milk from individual cows. The analysis of lactose content, somatic cell count and enzyme LDH activity in milk tank during the six-week-long experiment showed that the somatic cell count oscillated the most, which is known as an indicator of udder health. Analyses of AP and B control results showed that both controls were carried out in a certain time period (monthly, weekly…) and that they informed farmers on the composition and quality of milk from individual cows only on the day of the milk recording. Milk production is an alive and continuos process that changes, which is shown by oscillations of milk composition.

The farmers will be the happiest if they know the composition of milk tank every day, which could only be enabled by daily analyses of milk tank. If milk tank contains more somatic cells or enzyme LDH activity is increased, a farmer will decide to have milk from individual cows analysed. Due to a narrow correlation between somatic cell count and enzyme LDH activity (*Figure 2*) farmers will be satisfied with the somatic cell count. A more in detail analysis of composition and quality of milk from individual cows will show which cow has an exceeded somatic cell count and is in danger of mastitis. Milk with higher somatic cell count is neither suitable for sale nor for further processing.

CONCLUSIONS

A high production of milk per cow requires the best management system (balanced daily ration, favourable climate and temperature, rearing system and maintenance should enable a high production). Results of milk analyses on the farm that keeps a white-and-black dairy herd show that:

- A six-week-long experiment in which daily oscillations of milk tank composition was studied has shown that somatic cell count in milk tank oscillated the most ranging between 87 and 770 thousand SCC/ml milk.
- The same oscillation curve was noticed in enzyme LDH activity in milk tank. It ranged between 7 and 173 U/l milk.
- When the somatic cell count in milk exceeded 400.000 SCC/ml milk, the enzyme LDH value exceeded 100 U/l milk. Both values represent the critical value that informs the farmer about the mammary gland trouble and of the cases of mastitis in the herd.
- During the experiment the somatic cell count in milk tank exceeded 400.000 cell/ml milk sixteen times, and the enzyme LDH activity exceeded 100 U/l milk eighteen times.
- The content of lactose lowered whenever the somatic cell count exceeded 600.000 cell/ml milk in tank.
- AP and B control were carried out on the days when no serious udder health problems were noticed, which can be proved by the results of milk tank analyses from AP and B control.
- The experiment showed that a once-a-month recording in highly productive dairy herd is not sufficient. A permanent production requires daily observation of milk

composition and quality so that the farmer can take adequate measures in time to prevent serious disorders (better herd monitoring, analysis of changes in the herd, milk analysis per individual cow …).

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Corresponding author:

Martina Klinkon
University of Ljubljana, Veterinary Faculty
SI-1000 Ljubljana, Cesta v Mestni log 47., Slovenia
Tel.: 386 31 635 240, 386 1 47 79 215, Fax: 386 1 2832 308
e-mail: martina.klinkon@vf.uni-lj.si

SECTION 5

GENETICS AND MEAT QUALITY

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Effects of rapid inbreeding on sow fertility traits in a closed herd of Swedish Landrace

T. Belic, I. [1]Jurić, M. [1]Dikić, I. [1]Curik

Agromedimurje, Farma svinja Cakovec, Croatia

[1]University of Zagreb, Faculty of Agriculture, Animal Science Department, Zagreb, HR-10000 Svetošimunska 25., Croatia

ABSTRACT

In this study we analyzed the effects of rapid inbreeding, calculated from three generations long pedigrees, on fertility traits of sows. The analysis was based on 72 inbred (ranging from inbreeding coefficient 3.12% to 31.25%) and 89 non-inbred sows of Swedish Landrace and all fertility traits were related to the first litter. The analysis was done by regressing fertility traits on inbreeding coefficients (univariate models). The effect of the age of sow at the first successful conception (fixed) was also included into regression models. The available data did not let us to consider the effects of litter inbreeding. When dependent variable was litter size (total number born and number born alive) and number at weaning, the linear regression model was applied. Dependent variables that were distributed according to Poisson distribution, as it was case for the number born dead, mortality during weaning and total number of inseminations, were analyzed by generalized linear regression models assuming Poisson distribution. Significant inbreeding depression was obtained for total number born ($b=-0.103$, $P<0.001$), number born alive ($b=-0.0910$, $P<0.01$), number at weaning ($b=-0.078$, $P<0.01$) as well as the number born dead ($P<0.01$). On the other hand, significant inbreeding depression was not present for the total number of inseminations ($P=0.867$) and mortality during weaning ($P=0.068$). Thus, it was shown that higher inbreeding of sows leads to the reduced fertility.

(Keywords: inbreeding depression, litter size, piglet mortality)

INTRODUCTION

Mating of animals with a common ancestor is defined as inbreeding and is unavoidable in closed populations. The reduction of the population mean for fertility and fitness traits such as are litter size, survival, birth weight, weaning weight is one of the consequences of inbreeding and is empirically observed phenomenon in a large number of livestock populations, see *Fredeen* (1956) for pigs, *Lamberson* and *Thomas* (1984) for sheep, *Burrow* (1993) for beef cattle, and *Miglior* (1994) for dairy cattle. However, the genetic basis of inbreeding depression is still unclear (*Lynch* and *Walsh,* 1997) and a number of topics, from genetic models (*Lynch* and *Walsh,* 1997) to statistical design (*Curik et al.,* 2001, 2002), still remain to be answered. In the large number of studies related to the inbreeding depression in pigs (*Dickerson et al.,* 1954; *Bereskin et al.,* 1968; *Toro et al.,* 1988; *Rodriguez et al.,* 1994; *Culberson et al.,* 1998; *Rodriganez et al.,* 1998; *Belic,* 2001), this topic was mostly studied through statistical analysis of the relationship between dam and/or litter inbreeding coefficient and fertility traits (total number born, total number born alive and total number at weaning) as well as of the relationship between dam and/or litter inbreeding coefficient and fitness traits (weight at birth and weaning weight). In this study, we also included the total number born dead, mortality at weaning and total number of inseminations (all related to the first litter) as traits of interest. Thus, the aim of this research was to estimate the effects of rapid inbreeding in sows on a larger number of traits related to the fertility (total number born, number born alive, number born dead, total number of inseminations, number at weaning and mortality during weaning) using a closed Swedish Landrace herd.

MATERIALS AND METHODS

All animals included into analysis were kept at the Agromeđimurje farm in a closed herd of Swedish Landrace. The analysis was based on 72 inbred (ranging from inbreeding coefficient 3.12% to 31.25%) and 89 non-inbred sows and all studied traits were related to the first litter. Inbreeding coefficients of the sows were calculated following the concept of path coefficients as defined by *Wright* (1922) and were related to the three generations long pedigrees. The effects of inbreeding were analyzed by the linear regression (univariate model) of the dependent variables (total number born, number born alive, number born dead, total number of inseminations, number at weaning and mortality during weaning) on the inbreeding coefficients of the sows. The effect of the age of sow at the first successful conception was divided in three classes (from 178 to 223 days, from 224 to 253 days and older then 253 days) and included into regression models as a fixed effect (except for the model with total number of inseminations). The effects of interaction between fixed variable and inbreeding were also analyzed in all models but as being non-significant they were not further presented. The assumptions of the models were explored through descriptive analysis of the residuals (normality and heterogeneity). For the following traits: number born dead, total number of inseminations and mortality during weaning as dependent variables the assumptions of the models (normality) were not satisfied. For that reason, those three variables were analyzed by Poisson regression (generalized linear models). General linear models (PROC GLM) were used when the analysis was related to the variables that were normally distributed. Otherwise, we used generalized linear models (PROC GENMOD) which assume a Poisson distributed error and with log as a link function. Descriptive statistics of the traits included in the analysis is shown in *Table 1*. All analyses were performed with the SAS statistical package (*SAS Institute,* 1996).

Table 1

Descriptive statistics of the traits used in the analysis (n=161)

Variable	Mean	Variance	Minimum	Maximum
Inbreeding coefficient of the sow	4.658	55.681	0	31.250
Total number of inseminations	1.540	0.875	1	5
Age at successful insemination	246.348	1932.840	178	433
Total number born	7.752	7.388	2	16
Number born alive	7.516	7.914	1	16
Number born dead	0.236	0.606	0	6
Number at weaning	7.025	6.124	1	13
Mortality during weaning	0.491	0.514	0	6

RESULTS AND DISCUSSION

The estimated effects of the relationship between sow fertility and inbreeding coefficients of the sow are given in *Table 2* for the total number born, number born alive and number at weaning and in *Table 3* for the number born dead, total number of inseminations and mortality during weaning. All six analyzed effects were negatively related to the increase of inbreeding (mathematically positive relationship between sow inbreeding and total number of inseminations is biologically considered as negative). While significant effects of sow inbreeding were observed for the total number born (P=0.0002), number born alive (P=0.0014), number at weaning (P=0.002) and number born dead (P=0.0069), the effects were not significant for the total number of inseminations (P=0.867) and mortality during weaning (P=0.068).

Table 2

Effects of sow inbreeding on the litter size and number at weaning for the first litter

Variable	Parameter estimate	SE	Lower 95% CL	Upper 95% CL
Total number born	-0.103**	0.027	-0.130	-0.076
Number born alive	-0.091*	0.028	-0.119	-0.063
Number at weaning	-0.078*	0.025	-0.103	-0.053

Parameter estimates are related to linear regression coefficient and 1% change in the inbreeding coefficient of the sow; CL=confidence limit; P values were related to the two sided t-test (P<0.01, ** P<0.001)*

Table 3

Effects of sow inbreeding on the number born dead, total number of inseminations and mortality during weaning for the first litter

Variable	Parameter estimate	Robust SE	Lower 95% CL	Upper 95% CL
Total number of inseminations	0.001	0.008	-0.015	0.018
Number born dead	-0.088*	0.041	-0.168	-0.008
Mortality during weaning	-0.032	0.019	-0.069	0.005

Parameter estimates are obtained by Poisson regression (generalized linear model) and are related to the 1% change in the inbreeding coefficient of the sow; CL=confidence limit; P values were related to the Likelihood ratio statistics for type 3 analysis (P<0.05)*

The biological explanation is that litter size in mammals may be affected by inbreeding of mother, through a decrease in the number of eggs released, mortality caused by lethal genes or through changes in the intrauterine environment. The estimates observed in this study (see *Table 2* and *3*) were around three to fourfold larger then those estimated in other studies (*Dickerson et al.,* 1954; *Bereskin et al.,* 1968; *Toro et al.,* 1988; *Rodriguez et al.,* 1994; *Culberson et al.,* 1998; *Rodriganez et al.,* 1998). There are several speculations why such a strong inbreeding depression has been observed in this study. The simplest explanation is the small sample size. Further, in this study only the effects of inbreeding through three generations were studied and it might happen that the effects of the same level of inbreeding are more detrimental when inbreeding is achieved through close connections (rapid) in comparison to the inbreeding that is achieved through remote connections (slow), as it was hypothesized by *Cothran et al.* (1994) and *Curik et al.* (submitted) and demonstrated by *Wiener et al.* (1992). The fact that the effects of litter inbreeding were not included might also be the potential reason for a higher estimates (more negative). Unfortunately, in this study we were limited by the fact that the whole pedigree and data set was not electronically available and thus we did not consider the effects of litter inbreeding, boar inbreeding as well as the effects of inbreeding coming from the more remote generations (slow inbreeding). How we are currently entering pedigree information and fertility information data into electronic format. Thus, those effects as well as the information from other litters (second and latter litters) will be considered in more details in our future work.

CONCLUSIONS

The obtained results show a consistent negative effect of sow inbreeding on all six analyzed traits. The analyzed effects were significant for total number born, number born alive and number at weaning but were not-significant for total number of inseminations and mortality during weaning. However, the observed indicated trend should be confirmed in a more extensive study taking into account the effects of litter inbreeding as well as the effects of remote versus close inbreeding effects.

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Corresponding author:

Ino Curik
University of Zagreb, Faculty of Agriculture
HR-10000 Zagreb, Svetošimunska 25., Croatia
Tel.: 385 1 239 4010, Fax: 385 1 239 3947
e-mail: icurik@agr.hr

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

The influence of environment enrichment (gnawing stick) on some performance and carcass traits of male rabbits

D. Jordan, I. Štuhec
University of Ljubljana, Biotechnical Faculty, Zootechnical Department, Domžale, SI-1230 Groblje 3., Slovenia

ABSTRACT

Housing of rabbits in individual wire cages enables the animals to satisfy only the basic vital necessities; their environment is much poorer than in the wild. In such poor environment the welfare of animals is questionable. However, the environment can be enriched in different ways. Very simple and inexpensive, but very effective enrichment represents the addition of gnawing wood. This kind of enrichment and the reaction of rabbits was studied in two experiments. Each, spring and summer experiment included 40, seven to thirteen weeks old fattening rabbits. All 80 animals were New Zealand White males line SIKA. In both experiments together rabbits gnawed 5.03±0.91 g of wooden stick, which means that on average each individual rabbit gnawed 0.14±0.02 g of wooden stick daily. Enrichment of environment with wood had no significant influence on weight gain, carcass weight, or weight of gastrointestinal tract. Rabbits fattened in summer experiment had 3.12±1.34 g (P=0.0226) higher average daily weight gain and 21.23±10.17 g (P=0.0408) lighter carcass weight than rabbits fattened in spring experiment. The reason for discrepancy between higher average daily weight gain and lighter carcass weight can be found in heavier gastrointestinal tract of rabbits fattened in summer experiment. The difference in weight of gastrointestinal tract between repetitions was 17.36±10.64 g, but it was not significant (P=0.1078).
(Keywords: rabbits, wire cages, environment enrichment)

INTRODUCTION

Several studies have shown that in spite of many years of selective breeding domesticated rabbits still perform or try to perform behavioural repertoire of wild rabbits. In the wild rabbits spend most of their time and energy on foraging, in contrast with domesticated rabbits, who often receive food in the form, which is easy to consume. The consequence is a lot of remaining time, which has to be filled with other activities. In many housing systems fattening rabbits are housed in traditional wire cages, which often restrict performance of normal behaviour repertoire (*Berthelsen* and *Hansen,* 1999). Rabbits are limited in their natural locomotion pattern of hopping, running, standing and rising on hind legs. Also their social behaviour and gnawing possibilities are very limited (*Maertens* and *Van Oeckel,* 2001*)*. Changes in animal behaviour are the first signs of poor environment. Animals fall into the state of stress, become more restless and frequently change the activities (*Lehmann,* 1987; *Metz*, 1987). Several kinds of abnormal behaviours such as bar biting, excessive grooming and stereotypic activities appear (*Hansen* and *Berthelsen*, 2000). Poor environment can be enriched with objects, which enable animals to perform desired activities. These kinds of objects are hay, straw, grass, gnawing sticks or branches with leaves (*Lidfors,* 1997). Rabbits are rodents and even *Stauffacher* (cit. after *Lidfors,* 1997) found out, that in semi-natural enclosure they spent about 20% of the time chewing on wood and branches. That is why he suggested, that rabbits should have gnawing sticks also in their cages. Wood, as a material for gnawing, serves as environment enrichment, and in the form of sawdust as feed additive, which has a positive influence on rabbit's digestion (*Koritnik* and *Banožić*, 1974).

The aim of this study was to find out if the addition of gnawing stick as a material for environment enrichment influences the performance and carcass traits of fattening rabbits housed in individual wire cages.

MATERIALS AND METHODS

Animals

Each of our two experiments included 40 male New Zealand White rabbits line SIKA. The first experiment took place in spring, that is from 24.04. to 07.06.2001, and the second one in summer, from 14.06. to 26.07.2001. Animals were housed individually in wire cages, measuring 37.5×40×30 cm. Cages were equipped with automatic feeders and nipple drinkers. The duration of lighting was 12 hours (from 6 a.m. to 6 p.m.). Water and food were available ad libitum. Animals were fed in the morning between 7 and 8 a.m. with complete feed mixture for fattening rabbits. In the case of diarrhoea, rabbits were fed with the feed mixture with additional 0.3% of Farmatan (chestnut tannin). In the second experiment in order to prevent diarrhoea all the animals were fed only with Farmatan added to the feed mixture. At the beginning of the first experiment animals were 45 days old and at the first weighing, that is at the age of 47 days, the average weight of 1346.72±17.50 g was recorded. At the beginning of the second experiment rabbits were 44 days old and their average live weight was 1325.85±17.21 g.

After the individual housing in wire cages rabbits were divided into two groups of 20 animals each. Experimental group was treated with fir-wood sticks as a material for gnawing. To control group wooden sticks were not placed into the cages. At the beginning of the experiment there was no significant difference in live weight of animals between the experimental and control group.

Measures

- *Fir-wood sticks* were weighed three times a week, on Monday, Wednesday and Friday, between 8 and 10 a.m.
- *Live weight of animals* was measured once a week, on Thursday, between 8 and 10 a.m.
- *Carcass weight of animals* was measured after the slaughter at the age of 89 and 86 days respectively. We weighed carcass with edible offal, without head and lower parts of extremities.
- *The weight of gastrointestinal tract* was measured without milt.

Statistics

For the statistical analysis of data we used GLM (General Linear Models) procedures of the SAS/STAT (*SAS/STAT User's Guide,* 1990) statistical program package. Basic statistical parameters were calculated with MEANS procedure, the 'estimate' sentence from GLM procedure was used for the estimation of differences between repetitions and treatment.

Weight gain of rabbits is expressed as the average daily weight gain in the entire six-week experimental period. Data were analysed by means of statistical model, which included fixed influences of repetition (R_i) and treatment (T_j), and weight of animals at the beginning of experiment (x_{ijk}) as independent variable. Statistical model used for analysing *carcass weight and weight of gastrointestinal tract* included fixed influences of repetition (R_i) and treatment (T_j), and slaughter weight of animals (x_{ijk}) as independent variable.

MODEL: $y_{ijk}=\mu+R_i+T_j+b_x(x_{ijk}-\bar{x})+e_{ijk}$

RESULTS AND DISCUSSION

The amount of gnawed wood

On average rabbits gnawed only 3.53±0.80 g of fir-wood stick in spring experiment (*Table 1*), compared to summer period, when they gnawed 6.30±1.51 g. In spring the amount of gnawed wood ranged from 0 to 14 g, and in summer from 2 to 32 g. In both repetitions together rabbits gnawed on average 5.03±0.91 g of wooden stick, which means that on average each individual rabbit gnawed 0.14±0.02 g of wooden stick daily. *Maertens* and *Van Oeckel (2001)* also reported the low intake of wood although rabbits gnawed extensively on the wooden sticks. *Huls* et al., *Gunn* and *Brooks* et al. (all cit. after *Lidfors*, 1997) found out that rabbits showed interest for fir–wood sticks over a longer period of time.

Table 1

Basic statistical data for the amount of gnawed wood

Repetition	N	Average	SD	Min	Max
Spring	17	3.53±0.80	3.28	0	14
Summer	20	6.30±1.51	6.78	2	32
TOGETHER	37	5.03±0.91	5.57	0	32

In spring (*Figure 1a*) and in summer experiment (*Figure 1b*) the total amount of gnawed wood most often ranged from 2 to 4 g. This kind of intake of wood was in both repetitions together registered in 43.24% of cases (*Figure 1c*).

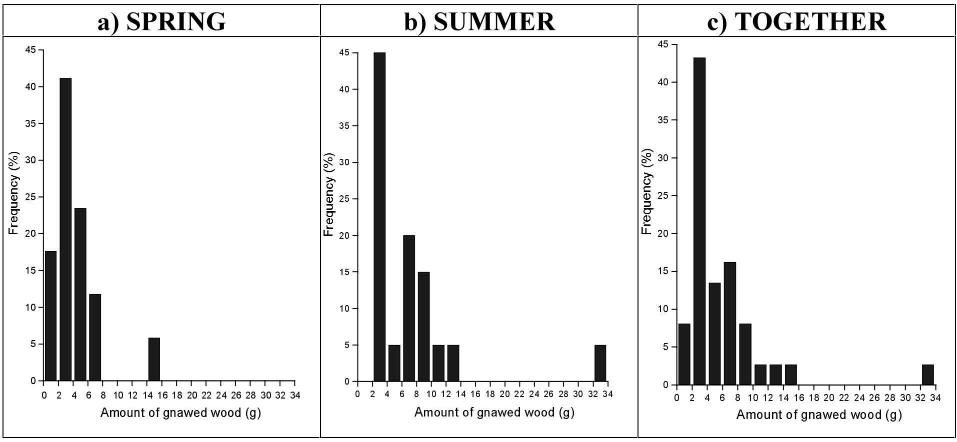
Weight gain

The significant influence (P≤0.05) on the average daily weight gain was exerted by the repetition and the weight of animals at the beginning of experiment. Heavier rabbits grew faster. With each gram of rabbit's body weight at the beginning of experiment, the average daily weight gain increased 0.015 g/day (P=0.0259).

Between the age of 7 and 13 weeks average daily weight gain of rabbits was 34.6 g/day, but between repetitions (*Table 2*) there were some significant differences. Animals had lower weight gain in spring than in summer experiment, namely 3.12±1.34 g/day. These results are in contradiction with the findings of *Cifre et al.* (1999), who reported lower weight gain in summer. Feeding the animals strictly with the addition of Farmatan to the basic feed mixture, could explain the increased weight gain in summer period. After weaning the addition of Farmatan in the concentration of 0.3 and 1% had a positive effect on growth and feed conversion efficiency *(Štruklec* and *Kermauner,* 1994). *Zimmermann* and *Bessei* (2001) also reported similar results with the addition of Farmatan in the concentration of 0.4%.

Figure 1

Distribution of the amount of gnawed wood



Addition of gnawing stick did not influence on daily weight gain of rabbits. In their studies *Lidfors* (1997) and *Maertnes* with *Van Oeckel* (2001) also found no significant differences in average daily weight gain between treatments.

Table 2

The least squares means, estimates and statistical significance of the estimates in the average daily weight gain between repetitions and treatments

	LSM (g)	Estimate±SEE (g)	P - value
Repetition			
Spring	33.0	-3.12±1.34	0.0226
Summer	36.1		
Treatment			
Control	34.5	-0.10±1.34	0.9395
Experimental	34.6		

P≤0.05 statistically significant; LSM: least squares means; SEE: standard error of estimate

Carcass weight and weight of gastrointestinal tract

The repetition and slaughter weight of animals had significant influence ($P \leq 0.05$) on carcass weight. Weight of gastrointestinal tract was significantly influenced only by slaughter weight of animals. The heavier the rabbits were before slaughter, the higher was their carcass weight ($b=0.627$, $P=0.0001$) and the weight of gastrointestinal tract ($b=0.067$, $P=0.0008$).

Treatment had no significant influence on carcass weight and weight of gastrointestinal tract. This kind of result was expected due to low intake of wood. Perhaps the influence of wood addition would be greater at older rabbits.

In spring experiment the average slaughter weight of animals was 2738.47±49.27 g, and in summer experiment 2836.15±46.72 g. The average dressing percentage in spring repetition was 54.26±0.30% and 53.64±0.30% in summer repetition.

The average carcass weight of rabbits fattened in spring period was 1497 g (*Table 3*) and the average carcass weight of animals fattened in summer period was 1476 g. Carcass weights in spring experiment were significantly higher (P=0.0408) 21.23±10.17 g than carcass weights in summer experiment. This is surprising in regard to significantly higher daily weight gain of rabbits in summer experiment (*Table 2*). The reason for discrepancy between higher average daily weight gain and lighter carcass weight can be found in heavier gastrointestinal tract of rabbits fattened in summer experiment. The difference in weight of gastrointestinal tract between repetitions was 17.36±10.64 g, but it was not significant (P=0.1078).

Even between treatments there were some differences in carcass weight and weight of gastrointestinal tract, but they were not significant (P≥0.05). Carcass weights of animals in the control group were on average 3.93±10.14 g lighter than carcass weights of animals in the experimental group. The gastrointestinal tract of animals in the control group was also 15.41±10.63 g lighter than gastrointestinal tract of rabbits in the experimental group.

Table 3

The least squares means, estimates and statistical significance of the estimates in the carcass weight and weight of gastrointestinal tract between repetitions and treatments

	LSM (g)	Estimate±SEE (g)	P - value
Carcass weight (g)			
Repetition			
Spring	1497	21.23±10.17	0.0408
Summer	1476		
Treatment			
Control	1484	-3.93±10.14	0.6998
Experimental	1488		
Weight of gastrointestinal tract (g)			
Repetition			
Spring	405	-17.36±10.64	0.1078
Summer	422		
Treatment			
Control	406	-15.41±10.63	0.1518
Experimental	421		

P≤0.05 statistically significant; LSM: least squares means; SEE: standard error of estimate

CONCLUSIONS

On the base of our results we can conclude, that the addition of wooden stick as a material of environmental enrichment did not significantly influence the weight gain, carcass weight and weight of gastrointestinal tract. Between spring and summer experiment there were significant differences in weight gain and carcass weight. There were great differences between rabbits in the interest of the wooden stick, which is shown in very different amount of wood intake.

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Corresponding author:

Dušanka Jordan
University of Ljubljana, Biotechnical Faculty, Zootechnical Department
SI-1230 Domžale, Groblje 3., Slovenia
Tel.: 386 1 7217 866, Fax: 386 1 7241 005
e-mail: dusanka.jordan@bfro.uni-lj.si

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Growth and carcass traits of two rabbit genotypes: comparison of Slovene SIKA male line with commercial hybrids

A. Kermauner, S. Žgur
University of Ljubljana, Biotechnical Faculty, Zootechnical Department, Domžale, SI-1230 Groblje 3., Slovenia

ABSTRACT

Growth rate and carcass traits of two rabbit genotypes (SIKA male line – Slovenian male line for meat production and commercial hybrid imported from Italy, 50 rabbits per genotype and 50 rabbits of each sex) were as recorded from weaning (41±1 day) to slaughter. Rabbits were fed standard feed mixture Kun/stand ad libitum. Thirty-six rabbits were slaughtered at 77th day and 40 rabbits at 90th day. For carcass evaluation 16 animals per genotype, age and sex were selected. SIKA rabbits reached significantly higher weight at 90 days (2933 vs. 2711 g) and significantly better feed conversion ratio than Italian hybrids (4.085 vs. 4.711 g). SIKA rabbits exhibited significantly lower kidney fat percentage (2.24%) than Italian hybrids (2.90%). There were no differences in percentage of different carcass cuts, pH 24 and meat colour between two genotypes. Increased animal age at slaughter from 77 to 90 days did not change kidney fat percentage.
(Keywords: rabbits, genotypes, growth, carcass quality)

INTRODUCTION

In Slovenia, our own selection line SIKA was formed to meet Slovenian needs for breeding rabbits. In Rabbit centre of Biotechnical Faculty, male SIKA line for meat production exists from 1995. In male line, the factors that influence growth rate, feed conversion ratio, slaughter, carcass and meat characteristics have to be controlled. The genetic origin of the rabbit influence their growth curve, proportions of separate digestive organs and carcass quality (*Pla et al.*, 1996; *Dalle Zotte* and *Ouhayoun,* 1998; *Piles et al.*, 2000). The aim of present study was to find optimal animal age or live weight at slaughter of Slovenian rabbit male line SIKA, so it was compared with commercial Italian hybrids at two different ages.

MATERIALS AND METHODS

Growth rate of 100 rabbits of two genotypes (SIKA male line – Slovenian male line for meat production and commercial hybrid imported from Italy, 50 rabbits per genotype and 50 rabbits of each sex) was recorded from weaning (41±1 day) to slaughter. Rabbits were fed standard feed mixture Kun/stand *ad libitum*, feed intake and weight of rabbits were recorded weekly. Thirty-six (36) rabbits were slaughtered at 77th day and forty (40) rabbits at 90th day. Animals were fasted 2 hours before slaughter. Slaughter weight, warm carcass weight (excluding head and lower parts of legs, including liver and kidneys), weight of liver, kidneys and separate digestive organs (with their contents) were measured at slaughter. The proportions (%) of liver, kidneys and separate digestive organs with respect to the slaughter weight were calculated. For carcass evaluation 16 animals per genotype, age and sex were selected. Cold carcass weight without kidneys and liver was recorded 24 h after slaughter. After that kidney fat was removed, carcass was cut into fore and hind quarter between the 6th and 7th thoracic vertebra. Back was cut between last thorax and first lumbar vertebra. Hind leg was divided from loin between 6th and 7th lumbar vertebra. Hind leg was further dissected into meat and bone. Percentage of cuts was calculated from cuts weight and cold carcass weight. Meat colour and pH were measured 24 hours after slaughter on the cross section between last thorax and first lumbar vertebra.

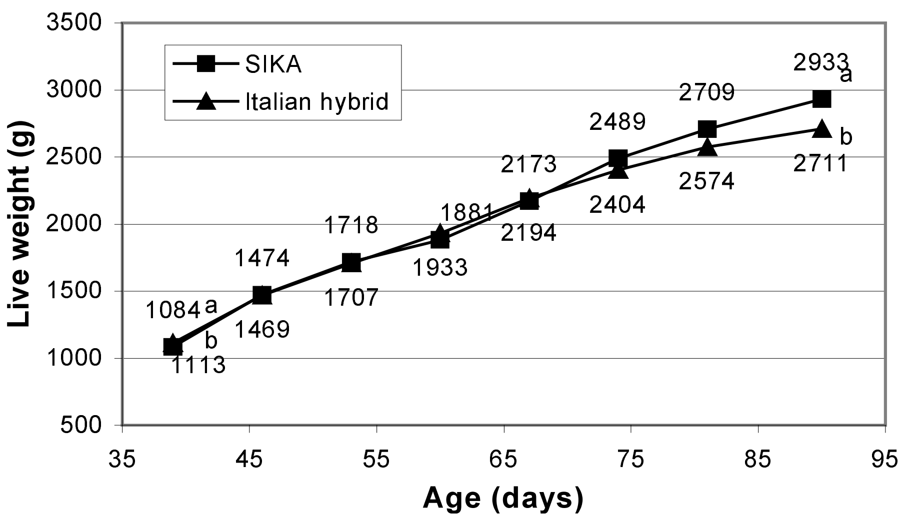
Statistical analysis was performed by SAS statistical package (*SAS*, 1999) with GLM procedure. Effects of genotype, age and sex as fixed effects and interactions between those effects were included in the model (except non significant interaction genotype*age*sex). For the analysis of rabbit's live weights data, the effect of age was excluded and covariate analysis (linear regression on weaning weight) was included in the model.

RESULTS AND DISCUSSION

Despite worse start at 39 days of age (*Figure 1*) SIKA rabbits reached significantly higher weight at the end of the experiment (90 days of age) than Italian hybrids. Live weight of SIKA rabbits at 90 days was comparable with Pannon White rabbits (*Szendrő et al.*, 1998) and INRA 9077 strain (selected on prolificacy) (*Dalle Zotte* and *Ouhayoun*, 1998) and it was higher than Hyla hybrid rabbits (*Nizza* and *Moniello*, 2000), which had almost the same weight (2750 g at 90 days) as Italian hybrids from our experiment. Both our genotypes were heavier than New Zealand rabbits from Burundi (*Anous*, 1999) and Mexico (*Ortiz Hernandez* and *Rubio Lozano*, 2001) and lighter than two hybrid meat lines (synthetic meat line and Hy+), selected for high growth rate (*Dalle Zotte* and *Ouhayoun*, 1998; *Piles et al.*, 2000).

Figure 1

Live weight of two rabbit's genotypes



Average daily weight gain in entire trial was significantly higher in SIKA line with significantly better feed conversion ratio than in Italian hybrids (*Table 1*). Daily weight gains of both genotypes were lower than in two hybrid meat lines, selected for high growth rate, but higher than in INRA 9077 strain (*Dalle Zotte* and *Ouhayoun*, 1998; *Piles et al.*, 2000)

Feed intake and feed conversion of both our genotypes were higher than in Hyla hybrids (*Nizza* and *Moniello*, 2000), where rabbits from 51st to 70th day of age consumed about 110 g of feed per day and feed conversion was from 2.72 to 3.09.

Table 1

Production parameters of two rabbit genotypes at two different ages: LS-means (±SEE) with significance (P) of effects

	Genotype			Age		
	SIKA	Italian hybrid	P	77 days	90 days	P
Average daily weight gain (g/day)	37.50 ±0.940	33.59 ±0.950	**0.0046**	37.26 ±133.636	33.84 ±125.598	**0.0126**
Average daily feed intake (g/day)	150.61 ±2.779	154.37 ±2.807	0.3435	153.07 ±2.878	151.90 ±2.705	0.7680
Consumed feed in entire trial (g)	6714 ±129.0	6846 ±130.3	0.4721	5814 ±133.6	7747 ±125.6	**<.0001**
Average feed conversion ratio	4.085 ±0.123	4.711 ±0.124	**0.0006**	4.191 ±0.128	4.604 ±0.120	**0.0210**
Slaughter weight (g)	2727 ±47.5	2634 ±48.0	0.1771	2534 ±49.2	2828 ±46.2	**<.0001**
Warm carcass weight (g)	1436 ±28.3	1377 ±28.5	0.1474	1322 ±29.3	1492 ±27.5	**<.0001**
Dressing percentage (%)	52.58 ±0.319	52.20 ±0.323	0.4066	52.10 ±0.331	52.69 ±0.311	0.1954
Liver weight (g)	77.22 ±2.336	79.75 ±2.359	0.4491	77.99 ±2.419	78.98 ±2.274	0.7678
%	2.85 ±0.072	3.03 ±0.073	0.0771	3.09 ±0.075	2.79 ±0.070	**0.0044**
Kidney weight (g)	18.00 ±0.411	17.26 ±0.415	0.2115	18.14 ±0.426	17.13 ±0.400	0.0875
%	0.67 ±0.017	0.66 ±0.017	0.8147	0.72 ±0.017	0.61 ±0.016	**<.0001**

Slaughter weight was slightly (P=0.1771) higher and proportion of liver (% of slaughter weight) was lower (P=0.0771) in SIKA line than in Italian hybrids (*Table 1*).

Proportions of liver in our experiment were much lower than in New Zealand from Burundi, Hyla and synthetic meat line, selected for high growth rate (4.0 to 4.6% of slaughter weight) , while proportions of kidneys were comparable (*Anous*, 1999; *Nizza* and *Moniello*, 2000; *Piles et al.*, 2000). Because of different calculation methods it is hard to compare dressing percentage with other authors: in our experiment it was better than in New Zealand in Burundi (*Anous*, 1999) and comparable with *Kermauner* and *Štruklec* (1996).

Table 2

Slaughter parameters of two rabbit genotypes at two different ages: LS-means (±SEE) with significance (P) of effects

	Genotype			Age		
	SIKA	**Italian hybrid**	**P**	**77 days**	**90 days**	**P**
Stomach weight (g)	97.13 ±3.463	97.78 ±3.497	0.8942	88.79 ±3.587	106.13 ±3.371	**0.0008**
(%)	3.56 ±0.126	3.72 ±0.128	0.3616	3.51 ±0.131	3.76 ±0.123	0.1692
Small intestine weight (g)	100.57 ±2.346	92.78 ±2.369	**0.0224**	99.05 ±2.429	94.30 ±2.283	0.1584
(%)	3.72 ±0.074	3.54 ±0.074	0.0819	3.92 ±0.076	3.34 ±0.072	**<.0001**
Large intestine weight (g)	76.56 ±1.764	68.66 ±1.781	**0.0024**	74.07 ±1.827	71.15 ±1.717	0.2479
(%)	2.83 ±0.064	2.63 ±0.064	**0.0305**	2.93 ±0.066	2.53 ±0.062	**<.0001**
Caecum weight (g)	164.41 ±4.002	148.80 ±4.041	**0.0077**	156.81 ±4.144	156.40 ±3.895	0.9432
(%)	6.06 ±0.149	5.71 ±0.151	0.1027	6.21 ±0.155	5.57 ±0.145	**0.0035**
GI tract weight (g)	438.67 ±8.541	408.03 ±8.626	**0.0139**	418.72 ±8.846	427.98 ±8.314	0.4484
(%)	16.17 ±0.287	15.60 ±0.290	0.1656	16.57 ±0.297	15.21 ±0.279	**0.0013**

The small intestine, large intestine, caecum and entire gastrointestinal (GI) tract (with contents) were significantly heavier in SIKA rabbits; similar results were found when proportions of these organs were considered (*Table 2*). These results together with better weight gain and feed conversion ratio indicate that digestive tract was better developed in SIKA rabbits. This resulted in improved digestibility and nutrients utilisation in SIKA line compared with commercial hybrids.

Weights of GI tract and separate digestive organs in both genotypes were higher than reported by *Kermauner* and *Štruklec* (1996). Proportion of GI tract is comparable with Hyla rabbits (*Nizza* and *Moniello*, 2000), but lower than in synthetic line (*Piles et al.*, 2000).

SIKA rabbits exhibited slightly higher cold carcass weight ($P=0.112$) than Italian hybrid line (*Table 3*). They had statistically significant ($P<0.05$) lower kidney fat quantity and percentage from Italian hybrid rabbits. SIKA rabbits had higher ($P<0.05$) weight of loin and hind leg. This was only the consequence of higher carcass weight, because there were no differences in percentage of different carcass parts (fore quarter, back, loin and hind leg) between two lines. Otherwise *Gomez et al.* (1998) reported differences in kidney fat, fore and hind leg percentage between different rabbit lines. *Pla et al.* (1996) also found differences in percentage of carcass cuts and kidney fat between two breeds differing in adult weight. Breeds with higher adult body weight had less fat at the same weight.

Therefore *Dalle Zotte* and *Ouhayoun* (1998) reported the highest kidney fat percentage in line that reached the highest maturity at slaughter. In most experiments the adult weight is not known and so it is difficult to distinguish between effect of genotype and adult weight. Meat content in the hind leg was higher in SIKA rabbits, but there were no differences in meat and bone percentage in hind leg between two genotypes.

The effect of age is quite logical: older animals had lower average daily gain, worse feed conversion ratio, higher slaughter and carcass weight, what agrees with results of *Nizza* and *Moniello* (2000). Older rabbits had lower proportions of liver, kidneys, total GI tract and separate digestive organs (except stomach proportion) than younger rabbits.

Cold carcass weight increased with increased animal age (*Table 3*). At 77 days of age rabbits of SIKA line had 1219 g of cold carcass weight and Italian hybrid line had 1218 g. At 90 days of age SIKA rabbits reached 1468 g of cold carcass weight and Italian hybrid rabbits had 1360 g. The difference between two lines at 90 days of age was statistically significant (P<0.05) and consequently also the interaction between genotype and animal age tended to be statistically important (P=0.117). With increased animal age from 77 to 90 days, the quantity of kidney fat increased for more than 6 g, while the percentage of kidney fat did not change significantly. With increased animal age the percentage of fore quarter did not change, while the percentage of back and hind leg decreased (0.5% and 1%) and the percentage of loin increased (2%). The interaction between genotype and age was statistically significant for percentage of fore quarter (P<0.05). In SIKA rabbits the percentage of fore quarter increased for 0.7% from 77 to 90 days of age while in Italian hybrid rabbits decreased for 0.8%. With increased animal age, meat percentage in hind leg increased and bone percentage decreased (P<0.05).

Table 3

Carcass weight and composition of two rabbit genotypes at two different ages (LSM±SEE) with significance (P) of effects

	Genotype			Age			SEE
	SIKA	Italian hybrid	P	77 days	90 days	P	
Cold carcass weight, g	1343.6	1288.8	0.112	1218.3	1414.1	**<0.001**	±24.03
Kidney fat, g	30.5	39.2	**0.008**	31.7	38.0	**0.051**	±2.2
%	2.24	2.99	**<0.000**	2.58	2.66	0.676	±0.14
Fore quarter, g	361.1	339.7	**0.059**	324.4	376.4	**<0.001**	±7.7
%	26.52	26.61	0.744	26.63	26.49	0.649	±0.22
Back, g	168.6	163.7	0.419	157.1	175.2	**0.005**	±4.2
%	12.42	12.83	0.206	12.88	12.36	0.107	±0.22
Loin, g	293.5	263.3	**0.033**	244.4	312.4	**<0.001**	±9.5
%	21.44	20.48	0.076	19.95	21.96	**0.001**	±0.37
Hind leg, g	492.5	455.9	**0.028**	444.7	503.4	**0.001**	±11.1
%	36.25	35.66	0.094	36.48	35.43	**0.004**	±0.24
Meat content in g	193.2	177.9	**0.048**	170.9	200.1	**<0.001**	±5.2
hind leg, %	84.75	84.58	0.763	83.98	85.34	**0.026**	±0.41
Bone weight in g	34.4	32.1	0.056	32.4	34.1	0.161	±0.80
hind leg, %	15.25	15.43	0.763	16.02	14.66	0.226	±0.41

Animal genotype did not exhibit any effect on meat colour and pH 24 hours after slaughter. *Dalle Zotte* and *Ouhayoun* (1998) reported significant differences in L* and a* values between different genotypes, though the differences were very small. *Pla et al.* (1996) found only the differences in b* value on the surface muscle between different genotypes.

With increased animal age meat tended to be darker (lower L values, $P=0.142$) and less red (lower a values, $P<0.05$). Changes in meat lightness were different in two rabbit lines (P value for interaction between genotype and age was 0.049). In SIKA rabbits L value did not change with animal age while in Italian hybrid rabbits L value decreased from 59.08 at 77 days to 56.54 at 90 days.

Table 4

Meat colour and pH of two rabbit genotypes at two different ages (LSM ± SEE) with significance (P) of effects

	Genotype			Age			SEE
	SIKA	**Italian hybrid**	**P**	**77 days**	**90 days**	**P**	
CIE L value	58.46	57.81	0.371	58.6	57.60	0.142	0.51
a* value	3.9	3.58	0.246	3.42	4.12	**0.035**	0.23
b* value	3.85	3.64	0.493	3.62	3.86	0.441	0.15
pH 24	5.69	5.68	0.861	5.60	5.77	**<0.001**	0.02

Sex had no explicit effect on studied growth, slaughter and carcass traits, except on weight and proportion of large intestine and carcass fat percentage (data not presented). Male rabbits had significantly lower weight (69.8 *vs.* 75.4 g) and proportion of large intestine (2.63 *vs.* 2.83%) than females. *Kermauner* and *Štruklec* (1996) found lower caecum weight in male than in female rabbits, but no influence of sex on large intestine weight was found. Other authors also reported no influence of sex on growth parameters (*Szendrő et al.*, 1998; *Ortiz Hernandez* and *Rubio Lozano*, 2001), on dressing percentage (*Piles et al.*, 2000; *Ortiz Hernandez* and *Rubio Lozano*, 2001), or on GI tract weight and proportions of liver and kidneys (*Piles et al.*, 2000). Male animals also showed lower percentage of kidney fat than female animals (2.22 vs. 3.02%). *Piles et al.* (2000) also reported 0.24% higher total dissectible fat in female than in male animals at 9 weeks of age. But the effect of sex on proportion of different carcass cuts was not observed (*Piles et al.*, 2000).

CONCLUSIONS

In present study, rabbits of SIKA male line demonstrated higher growth rate, better feed conversion ratio and better carcass quality than commercial Italian hybrids. Differences between genotypes were more distinctive in older animals. Kidney fat percentage did not increase with animal age at slaughter, therefore also at 90 days of age growth potential was still not exploited.

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Corresponding author:

Ajda Kermauner
University of Ljubljana, Biotechnical Faculty, Zootechnical Department
SI-1230 Domžale, Groblje 3., Slovenia
Tel.: 386 1 72 17 881, 386 1 72 17 800, Fax: 386 1 72 41 005
e-mail: ajda.kermauner@bfro.uni-lj.si

SECTION 6

ECONOMICS AND FARM MANAGEMENT

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Profitability of livestock farms in Croatia

V. Par, M. Njavro
Faculty of Agriculture, University of Zagreb, Department of Farm Management, Zagreb, HR-10000 Svetošimunska c. 25., Croatia

ABSTRACT

Economic efficiency and competitiveness of the agricultural production is necessary condition in the integration processes. Efficiency, competitiveness and sustainability are difficult to estimate on the complex systems as family farms are. Based on the project "Farm Survey" and according to the EU methodology (standard gross margin), family farm typology in the Croatia is established. Objectives of the paper are to determine basic production and economic characteristics of the livestock farms and economic indicators for business analysis. For that purpose economic indicators (primary profitability) and descriptive statistics methods will be used. Preliminary results showed that livestock farms (general types grazing livestock and granivores) participate with 32% out of total (n=892 farms) and mixed livestock holdings with 23%. Significantly higher agricultural income was recorded in the specialist granivores type. In the general type grazing animals, deeper analysis is necessary because bigger variety of the results between regions as well as between family farms in the same region. Average agricultural income in the general type grazing animals was 3573.90€. In the principal types cattle-dairy, rearing and fattening and sheep, goats and other grazing animals income was 6669.60€ and 9581.10€ respectively. Specialist granivores in average earned 6200€ (the specialist poultry 10121.40€). On the mixed livestock holdings agricultural income was 4567.22€ without significant variation between principal types.
(Keywords: profitability, family farms, livestock production, typology)

INTRODUCTION

Comparing with European Union, livestock production in Croatia is low regarding yield as well as quality (*Par et al.,* 1999). Production is self sufficient with small per cent of commercial, market oriented family farms. And just those farms should be precondition for efficiency and competitiveness on European and World market. Farm Survey project results shows importance of livestock production on family farms in Croatia (*Par, Zimbrek, Juracak,* 1999). Just for illustration, 70% of family farms in sample (n=892) posses cow, 22.9% produce calves and 16.9% fatten calves. Average production per cow is small, 2053 litre (includes sold milk and consumption on households). In the same time family farms typology in Croatia (*Njavro,* 2001) showed that 31.52% of family farms can be insert in animal production (specialist grazing livestock and specialist granivores) while 23.02% are in some kind of mixed livestock holdings. Regarding to economic size classes of holdings, livestock's farms prevails in very small (37%) and small economic size class (32%).

Objective of paper is presentation of production and economic characteristics of family farms and reached level of profitability. Later, results will be compared with results of other family farm types and with other economic sectors in Croatia. Profit is determined on three levels: region, type of farming and economic size of holding. Family farms profitability was analysed by *Par* and *Juracak* (1999). They conclude that profitably is low and strongly influence on sustainability of agricultural production, while sustainability of households is insured through off-farm income. Starting from hypothesis that inefficient and inadequate competitiveness danger sustainability of whole farm, proposals and recommendations are given.

MATERIALS AND METHODS

Data used in this paper are data collected on permanent project "Farm Survey". Project has started in 1998 with the goals for determination of main capable resources on farms, production and development level. Sample was drawn from Census 1991 and according to the following rules: at least four hectare of arable land, at least one family member full-time employ on farm and significant agricultural production. Based on mentioned criteria from total of 525.253 family farms, 75000 family farms were chosen and in sample were drawn 892 of them. Survey takes place on complete Croatian territory, and for the purpose of survey territory is divided on four regions: Pannonia-eastern part, Pannonia-western part, Hilly-mountain region and Mediterranean region. Family farm typology (type of farming and economic size) used in paper has foundation in European Union methodology. Income is determined on two levels: *gross farming income* and *Net household income*.

Scheme 1

Gross farming income

Farming revenues		Farming Expenditures	
		–	Paid labour
+	Sale of agr. products	–	Production costs
+	Household consumption	–	Land rent
+	Subventions	–	Machinery direct costs
+	Other revenues	–	Overheads
		–	Taxes and contributions

Gross farming income=Farming Revenues-Farming Expenditures

Scheme 2

Household income structure

+	Gross farming income
+	Income from other activities inside household
+	Income from activities outside household
+	Other net household revenues
=	**Gross household income**
–	Depreciation
=	**Net household income**

Farm resources value includes all long-term assets for agricultural production (agricultural land, machinery and equipment, permanent crops, buildings and breeding livestock). In the profitability calculations gross farm income was decreased for the depreciation value (*farming income*) while the net household income stay same as in Project. E*ngaged means* are consisted of farm resources value and current assets (Farming Expenditures)

Profitably was determined on two ways (by two indicators):

1) as ratio between farming income and engaged means:

$$r_1 = \frac{DP}{AS}$$

DP=farming income and
AS=engaged means

2) As ratio between net household income and engaged means:

$$r_2 = \frac{NDK}{AS}$$

NDK=net household income

For data analysis descriptive statistic were used while for profit calculations we used farm and enterprise budgeting methods.

Monetary values are expressed in Euro. Average exchange rate (Croatian National Bank) in 1999 was 1€=7.579622 HRK.

RESULTS AND DISCUSSION

Out of total 892 family farms, 652 are placed in some type of farming connected with livestock production. “Specialist granivores” type includes 225 family farms, while mixed holdings (mixed livestock holdings and mixed crops-livestock) includes 203 and 170 family farms. Number of holdings in specialist granivores type (pigs and poultry) is small (n=53). Animal production, in line with tradition, is mostly represented in Pannonian region-west part (n=394), and then in Pannonian region-eastern part (n=165), Hilly-mountain region (n=77) and Mediterranean region (n=15). Livestock farms used, in average, 10.255 hectares of own land while rent makes 17% in the structure of totally used land. Family farms are not heavily indebted, debt-to-asset ration is 5.9%. Index of specialisation for all farm types is 2.3. Demographic picture is very unfavourable. “Head” of household has, in average, 60 years old and in the most of cases only with primary school finished.

Income and farm resources value in livestock farms

Average farm income on surveyed livestock farms was 2404.08€. Highest income was earned in eastern part of Panonian region (2960.03€) and lowest in western part of Panonian region (2126.88€). Analysis according to the types of farming showed that the highest income was on mixed livestock farms (3039€) and the lowest on specialist grazing animals type with only 1130.17€. Average net households income on livestock family farms in the Republic of Croatia in the year 1999 was 5901.00€. The highest net household income was recorded in the Mediterranean region, while the lower average was in eastern part of Panonian region. Lowest net household income had mixed crop-livestock farms. It can also be illustrated that the biggest gap between farm and net household income appeared in specialist grazing animals types and mixed livestock holdings. Average value of engaged means was 53404.35€. Very high value in Mediterranean region (112671.50€) is results of high land value in that region. As it was expected, the highest value is recorded on specialist granivores types (pigs and poultry) 60535.83€.

Table 1

Farm Income, Net Household Income and Engaged means (€)

Region	Number of family farms	Farm income	Net household income	Engaged means
Croatia	651	2404.08	5901.27	53404.35
Panonia-eastern part	165	2960.03	5171.18	61437.76
Panonia-west part	394	2126.88	5627.84	45479.29
Hilly-mountain region	77	2671.95	7761.98	63705.50
Mediterranean region	15	2194.62	11562.71	120322.60

Table 2

Farm Income, Net Household Income and Engaged means of General Type of Farming (€)

General type	Number of family farms	Farm income	Net household income	Engaged means
Specialist grazing livestock	225	1130.17	5800.14	57286.75
Specialist granivores	53	2784.71	7703.77	60535.83
Mixed livestock holdings	203	3093.30	6178.57	45409.27
Mixed crops-livestock	170	3148.47	5142.03	55589.60

Table 3

Farm Income, Net Household Income and Engaged means due to Economic Size Classes (€)

Economic size classes	Limits in european size units	Nuber of family farms	Farm income	Net household income	Engaged means
Very small	2	114	2848.73	4522.07	29532.00
	4	192	1347.07	4750.12	40978.52
Small	6	132	2035.33	6160.32	46201.83
	8	74	2995.56	5771.00	68287.97
Medium low	12	77	4544.91	8296.40	75724.07
	16	22	1957.86	7206.61	82470.58
Medium high	40	30	3147.94	9981.53	112613.99
Large	100	10	385.90	7715.51	135623.33

Profitability
Conducted research showed higher profitability on farms with mixed productions as the result of lower farm resources value. Average profitability indicator r1 on family farms with livestock production was 6.58% and average r2 was 17.32%. The fact that profitability indicator r1 on family farms with mixed production (mixed livestock holdings: 8.47% and mixed crop-livestock:7.58%) is higher then the same indicator on specialist farms (specialist grazing animals: 4.05% and specialist granivores: 6.51) could be explained with insufficient production efficiency and insufficient capacities use. In the same time indicator r2 is higher on specialised livestock farms. It is result of incomes from other activities inside and outside of household. The fact that resources are not optimally used illustrates the r1 and r2 indicators in very small and small economic size classes. Namely, they are higher then those in upper economic size classes.

Table 4

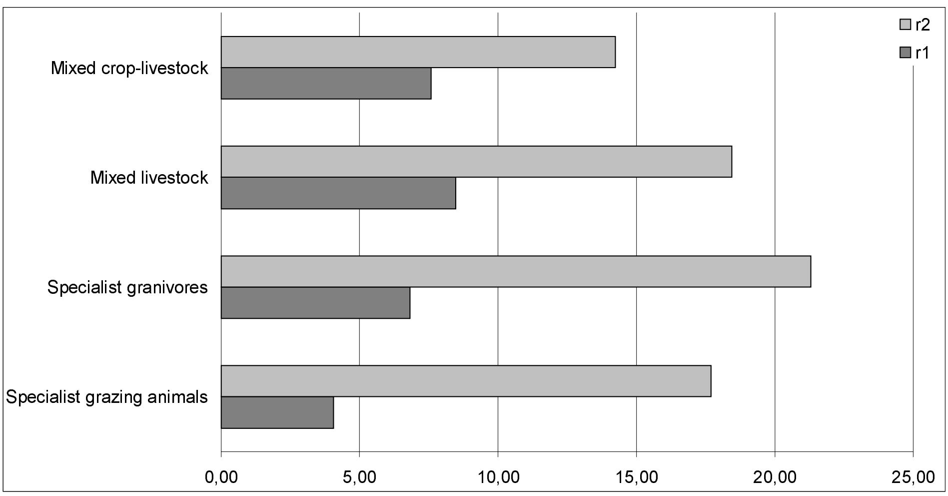
Family farms profitability (1999)

	Farm income	Net household income	Engaged means	r1	r2
Croatia-all types	2273.12	6046.32	61095.98	5.94	16.73
Livestock production	2404.08	5901.27	53404.35	6.58	17.32

Extremely low profitability indicator r1 in specialist grazing animal's type is result of negative profitability in fattening calves production and low r1 in sheep, goats and other grazing animals types (r1=0.17%). Profitability in the specialist granivores type is mainly due to results in special pigs type (r1=7.63%) but in specialist poultry (r1=2.22%)

Figure 1

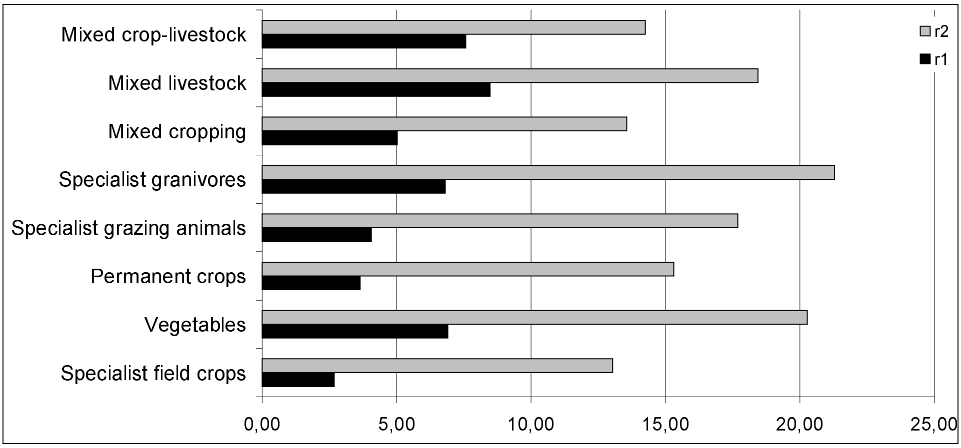
Profitability indicators r1 and r2 on livestock farms



ANOVA analysis showed statistically significant difference between profitability indicator r1 regarding regions (F=0.259, Sig.:0.855) and regarding general type of farming (F=2.202, Sig.=0.087). Profitability indicator r2 is statistically significant regarding general type of farming (F=1.963, Sig.=0.118). Significance level was 0.05. Mentioned results put agricultural production and sustainability of livestock farm in question while the households sustainability must be insured through other source of income outside agriculture. In the year 1999 credit rates of business banks were, in average, 15% and deposit rates of business banks, 4.13% to 4.31%. With this credit rates level it is obvious that livestock production can't be competitive. Research also showed that more specialised production is not necessary more profitable.

Figure 2

Family farm profitability by types of farming



CONCLUSIONS

Profitability on the family farms with livestock production is low. Profitability on the household level is important for the survival of household. Despite selection criteria in the sampling procedure that tried to select commercial, market oriented farms, results showed that agriculture, in many of cases, is not main source of income.

Reasons for such results (we take in consideration only internal factors) can be listed as follows: low productivity by hectare and by livestock unit, inappropriate organization of production as well as organization of farm, slow adoption of modern technology. With current level of profitability any serious investment cannot be done. Existing problems in livestock production in Croatia can be solved with coordinated cooperation between farmers, scientists, agribusiness industry, banks and governments institutions (ministries, extension service etc.).

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Corresponding author:

Vjekoslav Par
Faculty of Agriculture, University of Zagreb
Department of Farm Management
HR-10000 Zagreb, Svetošimunska c. 25., Croatia
Tel.: 385 1 23 93 790, Fax: 385 1 23 93 745
e-mail: vpar@agr.hr

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Financial problems in the Hungarian broiler sector

A. Keszi, A. Csorbai, P. Jankovics, K. Tóth, I. Marton
University of Kaposvár, Faculty of Animal Sciences, Department of Farm Economics
Kaposvár, H-7401 Guba Sándor u. 40., Hungary

ABSTRACT

On the eve of the accession to the European Union, the broiler sector is not in an easy situation in Hungary as regards competitiveness. Though the conditions of the sector meet the requirements the capital shortage intensifying year by year hinders the development of the entire sector. The buildings and machines are obsolete, most of them would need to be replaced or upgraded, the sector is at a serious disadvantage compared the EU countries also in the field of the specific utilisation of fodder, not to mention the backlogs in respect of the other factors affecting profitability. Under these circumstances the chance that the Hungarian broiler sector can preserve its competitiveness is narrowing.
(Keywords: financial problems, Hungarian broiler sector)

INTRODUCTION

In Hungary, poultry consumption per capita reached 25 kg in 1998 which is outstanding also in European relations. Poultry was the only meat type the consumption of which continued to increase in the '90ies and today it represents 40% of the total meat consumption. Further increase in consumption can be expected with the growing incomes.

From the aspect of competitiveness however the situation of the Hungarian broiler sector is not easy. Poultry is purchased at a relatively high price from the breeders and the cost advantage further decreases in the processing industry. The internal consumer price is low compared to the EU countries. This is positive from the aspect of maintaining the demand but it is rather negative as concerns the development sources, generation of innovation funds especially when the world broiler market is characterised by quick development and globalisation. The financial situation of the sector is weak, the buildings and machines are obsolete, the processing capacity is unutilised, the funds necessary to development are not available or are scarce.

MATERIALS AND METHODS

In this study we try to give a picture of the negative characteristics of the broiler sector using the KSH (Central Statistical Institute) and AKII data furthermore with the help of the representatives of the Broiler Product Council and of the experts working in the sector.

RESULTS AND DISCUSSION

The *broiler sector* made up *13.6 per cent* of the gross production value of agriculture in 1997 with products of market price of *HUF 142 billion*. In 1995 and in 1996 the sector had a similar weight.

554 tons of *meat poultry* were produced in Hungary in 1998 (KSH preliminary data), approximately 100-120 tons of which were produced for own consumption thus did not make part of the circulation of commodities. According to the data of the Broiler Product Council the volume of poultry purchases amounted to 424 thousand tons in 1998 that is 77 per cent of the total production. The remaining 50-60 thousand tons for sale were distributed in 50-50 per cent between the small local manufacturers and the black slaughter houses evading taxation.

The broiler sector generated an *annual export income of US $420-440 million* between 1995 and 1998. Though the value of the export slightly - by 3% - decreased in 1998 this sector was the only one among the other meat exporting sectors (pork, beef, lamb, rabbit) which managed to maintain the level of export. Foreign markets represent 36-37 per cent of the total broiler sales meaning that the majority of the products is sold in Hungary.

Following the peak in 1988 (almost 400 thousand tons) broiler production reached the lowest point in 1993 (188 thousand tons). In 1998 the industry purchases amounted to 424 thousand tons on the basis of the data of the factories operating under the product councils. This is 15.6% higher than the meat poultry production in the previous year. The factories operating under the product councils sold 142 thousand tons of poultry at the domestic markets (that is 21 thousand tons more than in 1997). This is partly due to the fact that domestic poultry consumption grows and partly to the fact that because of the export market delivery problems the importance of the domestic market increased. By 1999, 35 thousand meat and processed poultry remained, a huge quantity compared to former years. (*Magyar Baromfi, April* 1999).

Trends of and issues regarding poultry consumption

Forecasts from benchmark sources say that the demand for poultry products will continue to grow all over the world in the 21st century as well. This can basically be explained by nutrition biology reasons as consumption is shifting in the direction of healthier, lean meats. Poultry is not a festive meal any more, it has become an indispensable product for the citizens of many developing and developed countries. Poultry consumption is an important element of the life style aiming at improving the quality of life at an affordable price (*Horn,* 2000). To what extend the sector is able to meet the consumers' requirements has an important role in the further growth of consumption.

Development - for the time being - seems to be smooth because the world poultry consumption amounted to approximately 72 million tons in 2000. This means a growth of 6% between 1990 and 2000. The distribution of growth by continents is however uneven. Asia shows the most dynamic growth of production (8%) while it is smaller, about 2.5% in Europe and Africa (*FAOSTAT,* 1999). The prognosis forecasts further growth to this however it is necessary to meet the market demands to the maximum extent.

Situation of the broiler industry in hungary

The prognoses forecast further growth and this is feasible as the Hungarian broiler industry offers many advantages: the meat is tasty, the animal health situation is well organised and sound, there is expertise and world quality biological basis. All these advantages can be utilised only in case the basis necessary to production is also of high quality. Here we mean the basis that constitutes the weak points of production in Hungary.

As regards the competitiveness of the Hungarian broiler industry, the technical condition of the buildings and machines of poultry breeding leaves much to be desired. The average age of the buildings is 25 years, the ones owned by economic organisations are usually older than that (26 years) compared to the buildings owned by private entrepreneurs (23 years). Three fourth of the buildings were built in the '80ies. Almost 2/3 of these buildings was renovated or reconstructed. This means that 1/3 of the pens are too old and in need of urgent renovation, repair or replacement.

Of the building technological equipment, *ventilation* seems to be in the worst condition. Except for the renovated horse stalls, ventilation is provided by 15-20 year old equipment which can function for several more years - with gradually increasing costs - if maintained carefully. The air inlet and outlet ducts and profiles are strongly corroded, technically obsolete and should be replaced by all means. The surveys say that the equipment should be urgently renovated and replaced in every fifth building.

The technical condition of *heating systems* is better, the equipment should be replaced only in every eighth building.

Feeding systems are considered to be satisfactory in case of half of the places and should be urgently renovated or replaced only in every sixth plant. The *drinking systems* are in a better shape, they should be replaced only at every seventh plant.

It is a critical environment protection related problem that the *handling of manure* is considered to be inadequate in 68 per cent of the buildings.

The technological projects concerning these buildings would require several million forints. The average one time investment cost of the technological equipment for a broiler hen-house for about 20 thousand broilers (about 1200 m^2) is approximately HUF 8.5 million provided the buildings are at disposal.

There are small, medium and big companies in the Hungarian broiler sector but there is no international size giant company. The problem is that the concentration processes the leading broiler producing countries went through have not taken place in Hungary as yet though the most important issue from the aspect of competitiveness is to create units of optimal size and operating at full capacity. The majority of the companies being present at foreign markets manufacture their products using state-of-art technology and size economic abattoir lines- This can't be said about small enterprises. The total slaughtering capacity of the sector is more than what the solvent market demand.

The fact that the proportion of poultry taken away from the hatcheries and slaughtered black is large and part of this poultry - through black channels - goes to the market. A consumption of 15 kg/person/year can be calculated on the basis of the production of plants being members of the product councils. Though the members of the Broiler Product Council give 95% of the legal domestic production capacity, the statistics calculates with 25 kg consumption per person.

Profit generating capacity of the sector

There is a substantial difference in the profitability of production by years and farms. There differences in natural efficiency between the individual producers are huge and this greatly affects the profitability of production. At the same time, lots of local factors can change profitability (e.g. the prime cost of fodder depending on the local conditions, yields sometimes showing very exorbitant values, etc.). As regards the costs, it can be underlined that the specific fodder consumption is very high. In 1998, fodder consumption was 0.2 kg higher and the breeding period was 3 days longer while the slaughtering weight was 120 grams less and mortality 15-30 per cent higher than in the EU countries or in the USA.

The loss of income in the livestock breeding sectors in 1999 can be traced back to the decreasing selling prices - as a result of the oversupply due to loss of markets - and to the more expensive inputs. The growing fodder prices "swallowed" a part of the income generated at low prices or resulted in losses. The efficiency reserve is not enough to reverse this process, the "prodigal" fodder consumption could nevertheless be reduced if the appropriate interestedness was created. In order to reduce the fodder consumption the quality thereof should by all means be improved. On the basis of the laboratory tests the fodder often lacks nourishing substance and the (microbiological) conditions thereof is not appropriate.

The proportion of alien funds (bank loans) plays a more important role than desirable in financing the agricultural production. The relatively high interest rates consume a disproportionately large part of the profit - sometimes all of it. To make the situation worse, the consideration for the goods is often paid with - 60-90 days - delay to the producers which means that the producer not only has to finance processing but often the current asset requirement of commerce, too.

Shortage of funds affects adversely the competitiveness of this slice of agriculture and puts raw material production in especially unfavourable situation and consequently preserves the weak technical condition thereof. The integration and globalisation which has taken place in the leading poultry producing countries could be a good solution for these negative impacts as well. If these fusions and mergers fail to take place the situation of the sector may further deteriorate.

The role of state subsidies

The disadvantage of state subsidies is that they usually are announced late and it hampers the necessary foresight and preliminary calculations. Another disadvantage of subsidies is that they do not take into consideration the cyclic character of poultry production (the different cost requirement in the different phases) either. The unforeseeable state interventions often disturb the market and have adverse influence on the sector.

Vision

The international poultry industry is forced to intensify efficiency. In addition to improve the parameters, it is unavoidable to increase utilisation and decrease the input costs. Concentration is a method to achieve this, consequently fusions of companies can be expected. The former revaluation of areas of favourable characteristics and producing at low prime cost is expected. In these areas the quantity of the poultry meat production will significantly increase. Cheap and safe fodder and labour is mandatory for the broiler industry. Only biological limits and deliver costs can set limits to this.

Integrations dominating countries and regions focus their forces on further processing, commerce and marketing after the realisation of the integration of production and processing. Direct presence at the market makes possible to control profits, to reach and maintain the economic size and optimise capital investments. The development of logistics made possible the introduction of direct deliveries to consumers as a result of which only companies delivering fresh products can remain on the market.

Swot analysis of the broiler sector

Here follows the SWOT analysis of the Hungarian broiler sector on the basis of the above.

Strong points
- Increasing production and internal market,
- Tax free quota in the EU,
- Favourable market conditions for export after the various animal disease epidemics,
- Excellent genetic basis,
- No scandals, good reputation at export markets,
- Traditionally high grade of integration,
- Large number of universal processing lines,
- Relatively cheap labour,
- Developed technology, high technical level,
- High concentration,
- Well-organised representation of interests,

Weak points
- High fodder prices,
- Need for fodder import,
- Unstable fodder prices,
- Low efficiency in poultry production,
- High proportion of small-scale poultry production,
- Low profitability,
- Low level of capital supply,
- Presence of the "black economy",
- Unstable subsidy systems,
- Obsolete breeding technology,
- Unutilised capacities in the processing industry,

Possibilities
- Appearance of new, capital-strong owners,
- Entering new market segments in the EU,
- Growing world market,
- Growing proportion of processed goods in the export,
- Advantage because of the closeness of the western and eastern European markets,
- Favourable changes in the preferences of consumers,
- The room of "black economy" is decreasing,
- Growing consumption,
- Well-known western markets,
- Improving bargaining position due to the high concentration

Dangers
- Invasion of overseas poultry,
- Disappearing export subsidies,
- Lots of small and medium size processing companies,
- Lack of brand products,
- Tightening competition on the world market,
- Fluctuating and low profitability,
- Increasing import to the Hungarian market from western European countries,
- Efforts of the surrounding countries to protect their markets,
- Inappropriate international competitiveness,
- Extensive need for investments in the fodder production sector

CONCLUSIONS

The broiler sector has a long past in Hungary as well as in the European Union but its situation is not good. The sector is fighting several serious problems the most important of which is capital shortage which has been affecting the industry for long years and forms at the same time the basis for the other problems as well. In addition to this the obsolete condition of buildings and machinery should be mentioned - which could be improved only by projects- as well as the prodigal use of the low quality fodder. In 1998, fodder consumption was 0.2 kg higher and the breeding period was 3 days longer while the slaughtering weight was 120 grams less and mortality 15-30 per cent higher than in the EU countries or in the USA.

It is absolutely necessary to solve these problems so that the Hungarian broiler sector could be well-prepared for the accession to the European Union and could successfully face the challenges.

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Corresponding author:

Andrea Keszi
University of Kaposvár, Faculty of Animal Science
H-7401 Kaposvár, P.O.Box 16., Hungary
Tel.: 36 82 314 155 Fax: 36 82 320 175
e-mail: kesziandi@freemail.hu

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

The organic food sector in the South Transdanubian region (Perspectives)

K. Tóth , A. Keszi , A. Csorbai , P. Jankovics , I. Marton
University of Kaposvar, Faculty of Animal Science, Institute of Economics and Management
Kaposvár, H-7400 Guba Sándor u. 40., Hungary

ABSTRACT

The organic food sector changes dinamicaly to the advantage of the organic foods all over the world. The organic food production needs more extensive technologies and the products have higher prices. The South-Transdanubian region has a good chance (good soil and climate, sufficient production factors) inthis field. In our paper we try to present how to organise the organic production in the region, what was the share of the different organic products in the past few years, what is the tendency, where and how many products will sell and on which market.
(Keywords: organic production, SWOT, Hungary, perspectives)

INTRODUCTION

Hungary is poor in industrial raw materials, but 60 percent of its land is usable for agricultural production. The agricultural products directly (crops, fruit and vegetable) or indirectly (animal feed) are the basis of the human food. It is getting more important for the consumers that the good quality of the food is guaranteed. One of the most important features of the organic food production is that the whole foodchain is monitored and the high quality is warranted. The demand for these warranted high quality products is increasing all over the world. In addition these products can be sold at a higher price.

We considered the following questions: Out of the Hungarian regions, is the South Transdanubian region suitable for organic animal and human food production in ecological and economic point of view?

MATERIALS AND METHODS

The frame of our study was based on a work conducted by GATE-KTI and MTA-TAKI, whom the Agricultural Ministry comissioned to elaborate the agricultural land zone system. Also agricultural statistics, periodicals and papers and the rules of subsidies were used as references.

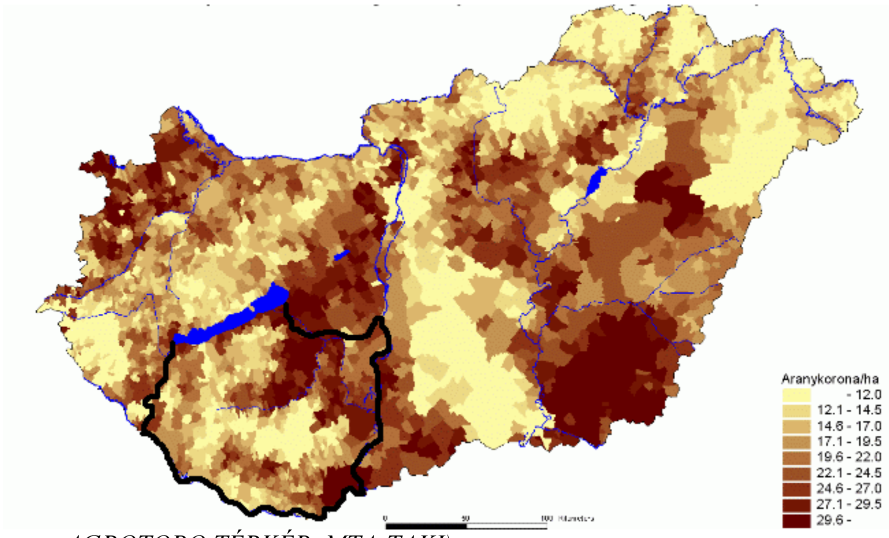
The authors consulted with experts in organic production, and made the SWOT analysis of the region.

RESULTS

Figure 1 shows the map of different productivity of land in Hungary. The South Transdanubian region represent the mid level of the country with small differences between the eastern and western parts.

Figure 1

Average productivity of the land in different regions

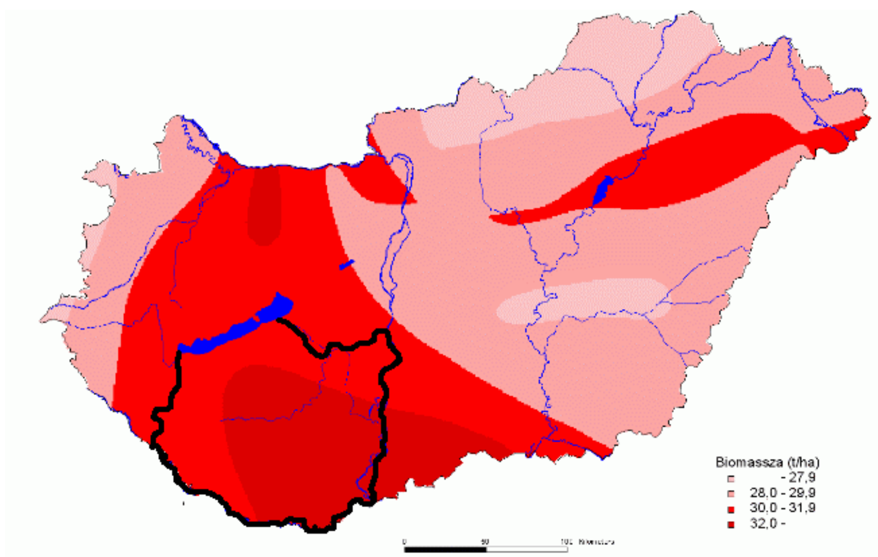


(Source: AGROTOPO TÉRKÉP, MTA-TAKI)

The favourable climate conditions in the South Trandanubian region enable the best usage of the land conditions, thus rich combination and great amount of plant production.

Figure 2

Climatic agricultural potential

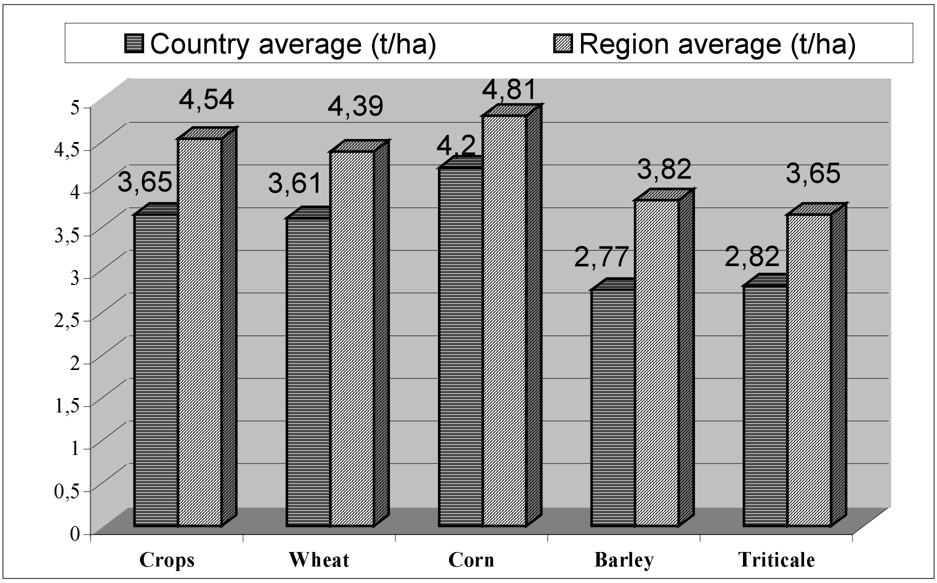


(Source: AGROTOPO TÉRKÉP, MTA-TAKI)

In analysing the ecological potention of the region, the average crop yields show that the productivity in the region is higher than the average of the country. (Source: KSH, 2000). *Figure 3* shows the average crop yields in Hungary and in the South Transdanubian region.

Figure 3

Average crop yields in Hungary and in the South Transdanubian region



The crop production is directly related to the size of animal herds in the region. The statitics show that cattle and fowl are kept in a smaller number per hectare than the country average, but in the case of swine the density is somewhat higher than the country average. According to these data, the organic crop production has a scope in the region, providing the basis for the organic animal production that can satisfy the existing demand for organic food.

Table 1

Number of animals per hectare

	Cattle	Swine	Fowl
Hungary	18.3	108.4	911.7
South Transdanubian region	15.9	117.3	774.3

The intensive agricultural production causes several problems in the quality of the soil, natural waters and life places, in general, it decreases the biodiversity. In Hungary, these problems are smaller than in industrial or other countries with industrialised agriculture. Therefore, Hungary has a very good basis for organic production.

Taking our environmental and natural conditions into consideration, development of three types of land usage is suitable:

- land usage in protective way (quality of water and soil, enviroment protection),
- extensive land usage (in regions with unfavourable conditions) and
- intensive production (taking the good ecological potential and environment protection into account).

Organic production is an extensive way of farming that is suitable for the subsidies of EU and WTO; therefore it can play a significant role in protecting the nature, biodiversity and transforming the technologies (Source: www.ktg.gau.hu).

The main problem is the lack of organising, control and monitoring along the foodchain, giving no warrantee for the quality of the products. It causes problems in the competitiveness and the market situations of the products.

It is favourable that the organic production and other controlled ways of production are spreading gradually. These considerably take the environmental, the animal and human health and hygienic requirements into account.

Figure 4

Total size of lands with organic production (ha)

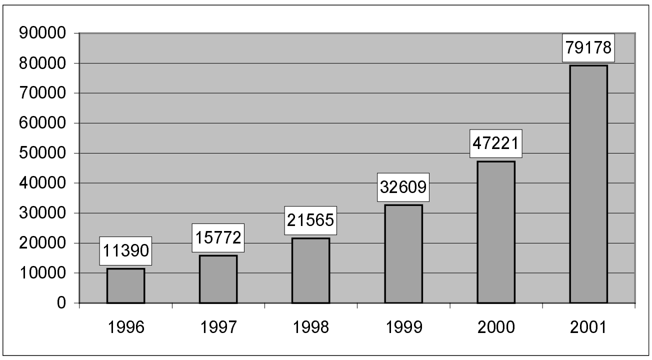


Figure 5

Number of organics farms

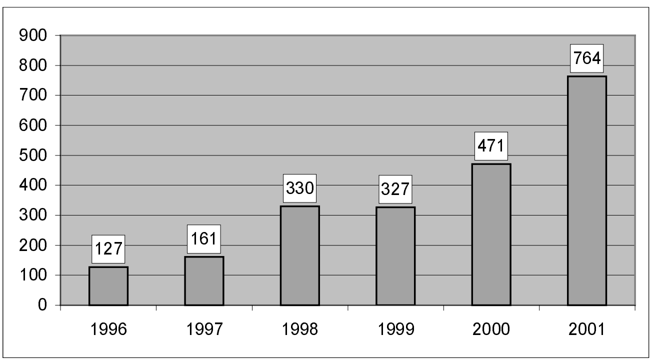
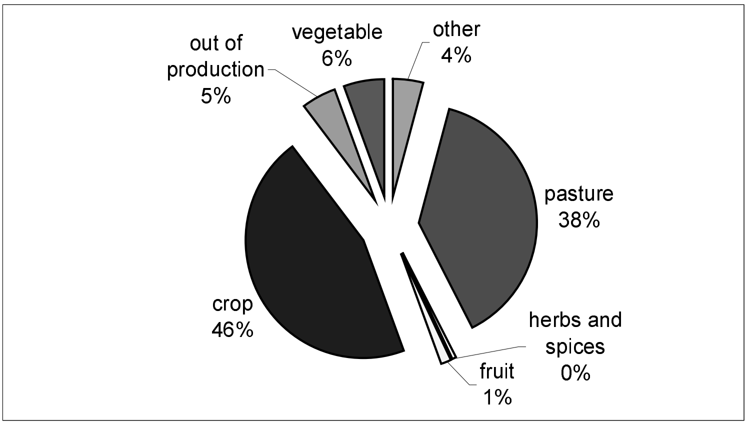


Figure 6

Types of organic production on monitored farms in 2001



According to the data of 2001, the total organic land (both transforming and producing farms) is 79,178 hectare. The production is monitored and the products are qualified by Biokontroll Hungária Kht. However, there is not exact information what extent the South Transdanubian region has share in the total organic land.

Having seen the importance and perspectives of the organic production in Hungary and in the EU, the Agricultural Ministry is supporting the Hungarian organic production. The declaration on the agricultural subsidies (102/2001. XII. 16.) deals with the direct payments for the protection of the environnment. Farms over the transformation period are supported from that year.

Table 2

SWOT analysis of the organic production in the South Transdanubian region

Strenghts	Weeknesses
☺ lot of good quality land (high yields)	☹ Information
☺ low rental fees	☹ Lack of integrity
☺ low price of labour	☹ Varying yields
☺ good natural endowments	☹ Infrastructure (roads)
	☹ Relatively low number of animals
	☹ Low level of processing of the products
Opportunities	**Treaths**
☺ Export	
☺ Improving domestic market	☹ Changes in the consumers' views
☺ State subsidies	☹ Higher production cost
☺ Better profitability	☹ Lower yields
☺ Modifying the view of consumers	☹ More strickt regulation

CONCLUSIONS

- Summarising, we can say that the South Transdanubian region's potential is suitable for the extention of the organic production.
- Outstanding attention should be drawn to the organic feed production providing the basis for the organic animal production. The higher added value realised in higher achieveable price gives the reason to increae the production.
- It would be necessary to establish processing capacity for this greater amount of organic product in the region. Thus the demand of the region could be satisfied, and other rmarkets could be targeted from here.
- In the organic production, the yields are lower, but higher specific returns could be achived. This type of production is only reasonable if the loss due to the lower yields in the income can be compensated by the added (and stable!) price.
- Both transforming and producing farms are supported by the subsidy policy improving their profitability. This tendency is favourable, though it would be necessary to make the subsidies reachable for more farmers and to increase the amount of the direct payments.
- Establishing and widening the information system is important in order to monitor and control the entire foodchain.
- It would be important to mark these product with standard trade marks, even with regional trade marks in order to enforce the advantages of the organic products and make the consumers trust.

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Corresponding author:

Katalin Tóth
University of Kaposvár, Faculty of Animal Science
H-7401 Kaposvár, P.O.Box 16., Hungary
Tel.: 36 82 314 155, Fax: 36 82 320 175
e-mail: toka022@mail.atk.u-kaposvar.hu

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Some characteristics of egg production on small farms in Somogy county

A. Csorbai, P. [1]Jankovics, G. Cservári, I. Marton
University of Kaposvár, Faculty of Animal Science, Institute of Economics and Organaization
Kaposvár, H-7400 Guba Sándor u. 40., Hungary
[1]Egg-Ker Ltd. Ócsa-Felsőbabád, Hungary

ABSTRACT

In the small farm animal production is so caracteristic in Hungary. One of them the egg production, wherein is nearly the falf of the all yearly production. There is a lot of question, how the small farms manage. In our examination we try to find some answer.On our result the small farms have positove and negative side also, and have chance to survive the joining of the EU.
(Keywords: egg production, small farm)

INTRODUCTION

Nowadays it is more and more obvious that the developed industrialised countries of the integrating Europe head for a direction that would cease the laying battery system through limiting this technological solution. In the background it is the strengthening of green movements and the pressure of animal welfare groups who fight for “animal welfare.”

The more and more stringent animal protection laws of the EU will induce severe changes in laying hen management (*Botos*, 1999; *Szekeres*, 1999).

Out of the animal management tightenings we should highlight the increase of floor space per laying hen, the tightening of mechanical feeder and drinker system and other animal management conditions. Besides these things the product marketing conditions will also change (*Latouche*, 1999; *Sandoe*, 1999). Since the current Hungarian requirements are much more permissive than in the EU when we become member of the Union the sector should make very heavy investments to implement intensive production. It should be mentioned that the requirements are not valid for laying hen stocks below 300 heads that would be of paramount importance for small farms.

The preparing Hungary has several features, characteristics. Out of these perhaps the most important is that a serious proportion of egg production volume (about 50%) is produced by individual farmers by extensive and semi-intensive, periodical production. According to the statistical office and the product council the role of small farms seem to decrease, a marketing problem still exists in the domestic market. It is caused by the periodical production since the production of the very high proportion of stocks around the house is concentrated to the long-day period (from spring to autumn). One of its consequences is the serious fluctuation of the egg price in the different periods of the year that has influence on the profitability of the intensive farms.

The aim of the experiment was to examine whether the small farms playing significant role in the production volume comply with the animal protection requirements in egg production of the EU and what kind of possibilities and reserves they have. We examined the profitability issues of the production, too.

MATERIALS AND METHODS

We chose the following methods for the issues determined in the aims.
The survey of the basic parameters of egg production on small farm:
- We performed 200 questionnaire surveys at county level (Somogy County).
- The survey was representative on the basis of the county settlement structure and population distribution.
- Contingency is provided by the "random walk" process.
- The experiment was performed in 1999-2000.

The examined parameters

The survey of egg production on small farms:
The examined parameters in egg production on small farms were grouped into four sections, the questionnaire aimed at the following issues.
- Basic data: hen stock at farmer, production capacities, survey of stocks according to type of use, produced eggs, stock purchase.
- Animal nutrition: daily quantity of used feed, the content of daily used feed, annual quantity of feed per laying hen, annual cost of feed per laying hen.
- Other factors of production: produced quantity for own consumption, for sales, working hours of production, original cost of animals, direct costs per laying hen.
- Calculated values: cost price of produced eggs, proportions of costs per laying hen, specific profit in the case of sales.

Processing of experiment data

In the case of surveying the basic parameters of egg production on small farms
- Data input into computer (Microsoft Excel)
- Ranging of data lines
- Calculation of basic statistics (mainly mean value, class frequency)
- Comparison of results from the point of view of animal welfare (mainly on the basis of number of laying hens per m^2)
- Evaluation of the received economic and breeding indicators.

At the end of the Material and methodology Chapter we should mention that this survey on egg production on small farms is beyond example so we did not have the possibility to compare the data. We also had troubles with elaborating the methodology of the experiment.

RESULTS AND DISCUSSION

The number of hens was 22 on the average at the farms. In the survey we paid special attention to the m^2 per laying hen that is one of the most important factors in animal welfare. On the basis of it we grouped the farmers: those who are able to comply with the „free range" (organic) way of production – at least as regards the m^2 per laying hen. The base of comparison is provided by the current requirements: minimum 2.5 m^2 run per laying hen is necessary. For this we examined and measured the size of the area for hen management then we divided it by the stock sizes. On the basis of the received values we can say that 75% of the stock produces under such "happy" conditions. We placed the use classification of animal livestocks to the farmers. According to their answers out of the hens in the examined farms 57% was laying hen, 37% dual-use and about 6% hobby poultry.

We found large differences in the annual egg production per laying hen (minimum 110 pieces/year, maximum 230 pieces/year). The indicator was 163 pieces per laying hen on the average, the farmers determined the average production intensity as 53.3% while the peak intensity indicator as 87%.

Feeding

A significant proportion of egg production is feed cost. We calculated the feed quantity per laying hen as 201.5 g/laying hen/day; it was much higher than in the case of livestocks kept intensively in batteries: 120-130 g/laying hen/day. The reason is, on the one hand that all the examined stocks were kept in free run; on the other hand the heterogeneous genotypes and age of the stocks.

Economic parameters (calculated values)

We converted the annual feed consumption per laying hen into costs. In the first case we calculated with the purchasing costs of feed (provided by the farmers) and in the second case we used the cost prices of cultivation. We performed both calculations and found that the purchase prices by the farmers were much less than the cultivation cost prices given by the AKII (5.6). The reason for it that in 1998 the selling price of the cereals did not cover the costs of production. So the calculated average annual feed cost per laying hen was HUF 1.097 in the case of purchase and it was HUF 1.353 in the case "burdened" by the cost price.

42% of the interviewed farmers sold the proportion above the own consumption. It is interesting that the above-mentioned farmers possessed 54% of the stock, it means that they had stock size above the average. As regards capacity, the same farmers would like to enlarge their stocks.

The daily working time per laying hen was 3.13 minutes. If we tried to convert these figures into costs and we used HUF 200/hour hourly wages as the cost of the work of the farmers then we would reach a cost that is much higher than the feed cost is.

In terms of costs we were not able to calculate with the amortization costs of buildings since the average age of the buildings in the examined small farms were above 20 years. Similarly, we were not able to calculate with the amortization costs of the machinery, too.

At the costs we took into account feed costs, purchase costs of animals, costs of renovation and disinfection of buildings, electricity costs (lighting, grinder). We calculated the proportions of annual costs per laying hen on the basis of these direct costs and the different feed costs. The direct cost is HUF 1.724 in the case of own-produced feed while HUF 1.468 in the case of purchased feed (laying hen/year).

As knowing the average egg production/hen we calculated the cost price per egg. Besides the differences in feed purchase we also took into account that in many cases the examined small farms used the culled hens so we calculated the direct costs decreased by the hen cost, too. *Figure 1* shows that feed cost has the largest influence on the cost price per egg, nevertheless the use of culled hens increases the profit.

We compared the cost price figures with the average market prices in 1999 (Source: Statistical Office, Somogy County: Monthly consumer prices at the markets in Kaposvár) so we received the specific profitability indicators (*Figure 2*).

Figure 1

Average cost price per egg of the examined small farms

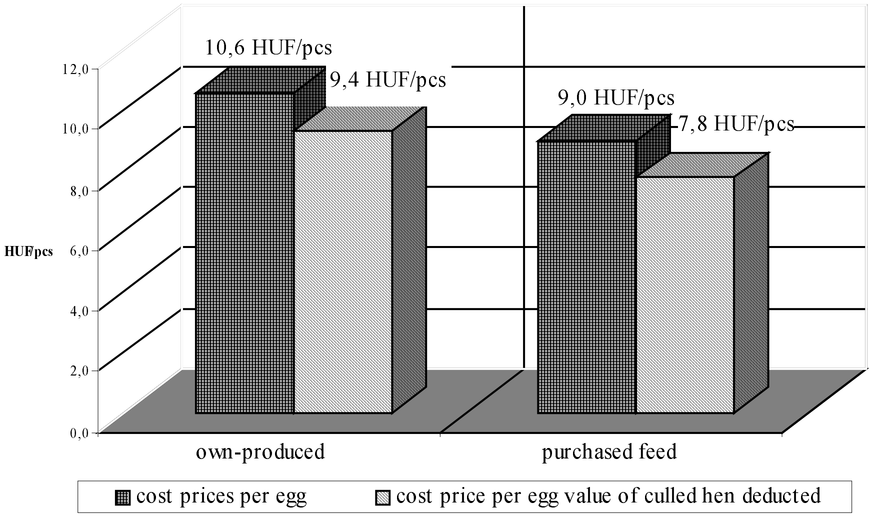
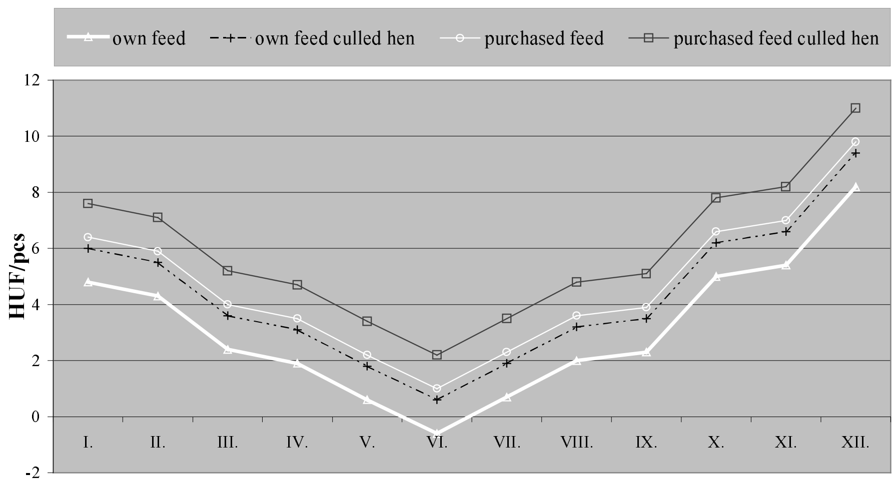


Figure 2

The development of specific profit at the examined farmers with different cost price calculations



months (1999)

Source of market prices: Statistical Office, Somogy County monthly consumer prices at the market in Kaposvár, 1999

The results showed that specific profits were very high. Farmers realised average HUF 3.08/pieces in the least favourable case, and HUF 5.9/pieces in the most favourable case. At the same time one should know that cyclical effects significantly bias these relatively good average figures.

CONCLUSIONS

Besides its negative features (cyclical effects and their consequences), egg production on small farms has many advantages compared to factory farms. We should mention the quick reaction to market conditions and the fact that it is able to produce special products due to the extensive management.

In spite of the low production indicators the farmer (if he sells the product himself) could gain significant (gross) income. It would be the most successful to reduce seasonality to a minimal extent (e.g. use of lighting). Due to the small stock, however, it would be, anyway, the rational increase of livestock; in this case not only the specific profits would be higher but also the bulk of profit.

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Corresponding author:

Attila Csorbai
University of Kaposvár, Faculty of Animal Science
Institute of Economics and Organaization
H-7401 Kaposvár, P.O.Box 16., Hungary
Tel.: 36 82 314 155, Fax.: 36 82 316 705
e-mail: csorbaia@mail.atk.u-kaposvar.hu

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Customizing possibilities of Croatian apiaries for organic production of honey regarding of the type of beehive

Z. Puškadija, I. Štefanić, D. [1]Bubalo, N. [1]Kezić, Maja [2]Dražić
University of J.J. Strossmayer, Faculty of Agriculture, Osijek, HR-31000 Trg Svetog Trojstva 3., Croatia
[1]University of Zagreb, Faculty of Agriculture, Zagreb, HR-10000 Svetošimunska cesta 25., Croatia
[2]Croatian Cattle Breading Centre, Zagreb, HR-10000 Kačićeva 9/III., Croatia

ABSTRACT

The EU Regulation (2092/91) concerning the organic-biological agricultural production gives also a standards for the organic-biological production of honey. This Regulation sets a highest requests to the beekeepers regarding the type and construction of beehive, and for the ecological approach in the curation of bees using natural substances and biotechnological methods. The large variety in types of beehives is an obstacle towards to cheaper and efficient constructive adaptability of beehives for the organic-biological production. Although there are many different types of hives at Croatian apiaries, with large differences in parameters, the Albert-Žnidaršić (AŽ) with 49%, and Langstroth (LR) hives, with 45% prevails. Among these hive types there is a significant portion of hives characterised by no-standard parameters. More than hundred different parameters for the beehives are known in the EU countries, so, Apimondia recommends promotion of LR and Dadant parameters as a standard. It is obvious that by an effective constructive adaptability the organic-biological honey production is possible only on 40% of beehives in Croatia.
(Keywords: beehives, beekeeping, organic production)

INTRODUCTION

Chance for complete success of Croatian agriculture lays in development of the ecological production of various agricultural products. Great areas without heavy industries, less use of protection resources in agriculture and large wastelands are good prerequisite for development of ecological agriculture and eco-tourism. Apiculture as a specific agricultural cattle raising production could adapt to the standards of organic-biological production faster then other cattle raising productions. To stimulate apiculture to that direction, first of all it is necessary to educate interested bee-keepers and adjust beehives to the standards of ecological production. Certification and assured sale of such honey product like this is unavoidable upgrade of every production and of apiculture and organic-biological production too.

MATERIALS AND METHODS

The base of work is information's gathered through surveying of bee-keepers. This survey was done in Slavonija and Baranja region in co-work with apiculture associations. That research enfolded all apiculture associations in sub regions and bee-keepers are selected by the cluster sample (*Czaja* and *Blair* 1995).

Size of the sample

According to the informations from Croatian Apiculture Alliance in Slavonija and Baranja region there are 1642 bee-keepers. A sample from 157 bee-keepers represents 9, 56% of a total number of bee-keepers from this two sub regions who makes a 24, and 4% of national apiculture.

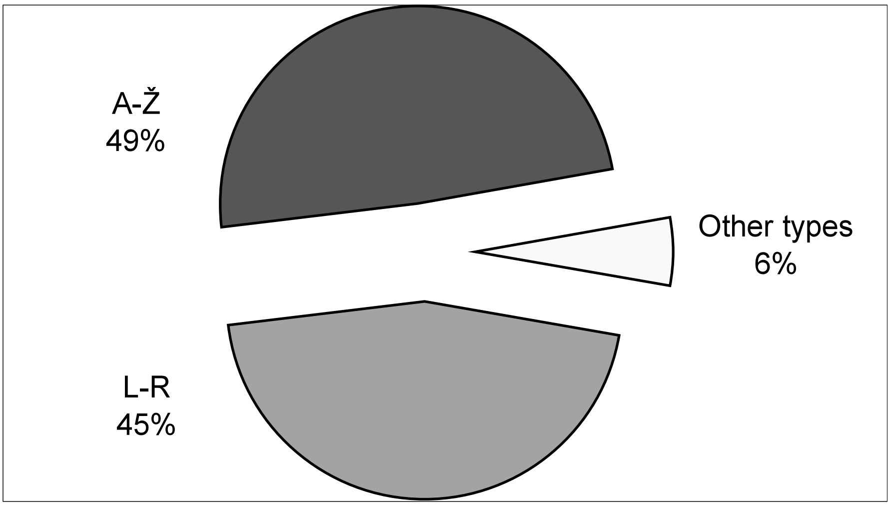
RESULTS AND DISCUSSION

Types of beehives in use

In Croatian apiaries we merely are finding two types of beehives: AŽ and LR beehives. Other types like: Farrar's, Dadant-Blat's, prickled beehives and some other are less in use. Their number is 6% (*Figure 1*).

Figure 1

Beehive types in surveyed regions



Resource: Survey list

AŽ beehives are found at 56.7% bee-keepers. There are 31.8% AŽ apiaries from total sample. Average number of AŽ beehives on Croatian apiaries is 49. A mixed apiaries with dominant AŽ and smaller number of LR beehives is 15 or 9.5% of the total sample. 5.8% of the total of AŽ beehives is non standard dimensions and the number of this beehives moves from 4-78 unites per apiary which we find in 9 beehives or 5.7% beehives in sample.

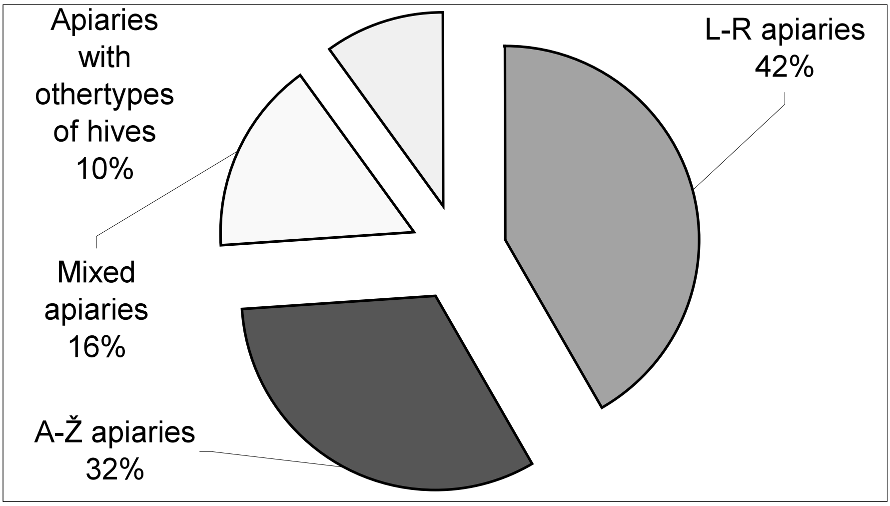
LR beehives are present among 65.6% bee-keepers. Total of LR apiaries samples is 41%. Average number of L-R beehives is 38. A mixed apiaries with dominant LR and smaller number of AŽ beehives is 10 or 6.4%. Total number of LR beehives is 8.5% with non standard dimensions and their number is 15-80 per apiary, 7% beehives in sample.

Equal number of AŽ and LR apiaries makes 3.8% of the total sample.

Other beehive types: Farr's, Dadant-Blat's, prickled and others beehives are in possession of 10% of bee-keepers of the total sample. These types of beehives are placed by the other beehives and they are dominating 4.5% in number. Their number is between 10-116 units for one apiary. Various types of beehives are placed on apiaries in Slavonia and Baranja. AŽ types or LR types cover only 74% of the sample. Area that counts 15.9% of LR and AŽ types counts large number of non-standard beehives. Maximum number of other types of beehives makes 116 units per apiary which shows that they are there for economical reasons and not for emotional (*Figure 2*).

Figure 2

Types of apiaries regarding of the hive type in researched regions



The source: Survey

The condition of hives in researched regions was good according to 77.2% bee-keepers. In 11% cases, they said it was bad. Most common cause of bad condition bee-keepers claimed its age and not keeping. 8.9% of them claimed theirs hives were in excellent condition. Only 2.9% bee-keepers rated theirs hives are in very bad condtion.

Stationary and moveable aparies

Stationary bee-keepers in surveyed regions move their hives up to 5 times a year. Most of bee-keepers (61.5%) move their hives twice a year. 18.5% of them moves their hives once a year, 4.4% doing so four times a year and only 1.3% moves three times a year. Percentage of bee-keepers who moves 5 times a year is 14% of the total number of moveable apiculture.

Regardless of the relatively big number of pasture in surveyed regions we can say that stationary apiculture prevails, because only 45.23% hives are actively moved in moveable apiculture. The structure of the hives in moveable apiculture non-directly, but clearly shows both, level of mechanization and technological level of moveable apiculture in surveyed regions. In this kind of apiculture dominates AŽ hives: 64.6%. So, for moving apiculture, bee-keepers using pavilion beehives, trailers, buses, containers, trucks and similar (*Table1*).

Table 1

Moving references, hive type and number of pastures on which they move to

Number of pastures in one year	Type of hive			Total		
	L-R	A-Ž	Other	Total	% of moveable hives	% of the total number of hives
1	861	1025	85	1971	49.5	22.4
2	-	125	15	140	3.5	1.6
3	40	50	-	90	2.3	1.0
4	-	406	-	406	10.2	4.6
5	318	966	90	1374	34.5	15.6
Total	1219	2572	190	3981	100.0	45.2
%	30.6	64.6	4.7	100	Total of hives: 8 800	

The source: Survey

CONCLUSIONS

In Croatian apiaries dominates AŽ and LR beehives, and a quarter of them is mixed regarding the type of hive. Some of them are non-standard size, which makes significant barrier in adjustment this beehive on organic-biological production.

AŽ hives dominates in moveable apiculture. Most number of hives moves at least ones a year and number of moving rise up to 5 times a year. As AŽ hives moves mostly by pavilions, we can say that there is low use of mechanization during moving hives.

Only 40% of total beehives are standard size LR hives. Since Apimondie recommended promotion of Dadant and LR sizes, we also suggest adjustments of Croatian beehives for organic-biological production.

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Corresponding author:

Zlatko Puškadija
University of J.J. Strossmayer, Faculty of Agriculture
HR-31000 Osijek, Trg Svetog Trojstva 3., Croatia
Tel.: 385 31 224 275, Fax: 385 31 207 017
e-mail: pzlatko@suncokret.pfos.hr

POSTER SECTION

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

The effect of multienzyme preparation on the growth performance of broilers

G. Kralik, I. [1]Bogut, Z. Škrtić, G. Kušec

Josip Juraj Strossmayer University of Osijek, Faculty of Agriculture, Osijek, HR-31000. Trg Sv. Trojstva 3., Croatia
[1]University of Mostar, Faculty of Agronomy, Mostar, BiH-81000 Trg Hrvatskih Velikana 1., Bosnia-Herzegovina

ABSTRACT

The multienzyme preparation, as a stabilised mixture of enzymes: β-glucanase, xylanase, α-amylase, protease, β-glucosidase, cellulase and chemicellulase, and its effect on fattening characteristics of broilers were investigated in this study. The research has been carried out on male Avian 34 broilers. Broilers in control group were fed with preparations containing 21.25% crude proteins and 13.3 MJ/kg ME, i.e. 19.45% crude proteins and 13.53 MJ/kg ME. The polienzyme preparation in the amount of 0.05% was added to the diets for broilers in experimental group. After 6 weeks of fattening, the average live weight of broilers in experimental group was 2088±69.89g, while the average live weight of broilers in control group was 1962±65.70g ($P<0.01$). Supplementation of multienzyme preparation influenced the achievement of higher live weights of the broilers from the experimental group for 6.42%, compared to the control and enhanced feed conversion for 5.52%. Evaluation of the inflection point (T_I) proved that the supplementation of multienzyme preparation into the broiler diets improves progressive growth stage of broilers.
(Keywords: broiler, enzyme, body weight, feed conversion)

INTRODUCTION

As energetic forage, maize, barley, triticale, rye and oats are used in the feeding of poultry. These cereals contain in the cell membranes non-starch polysaccharides such as cellulose, xylanase and beta-glucanase. Because of the presence of non-starch polysaccharides, the approach to amylolytical enzymes for starch decomposition and proteolytic enzymes for decomposition of proteins in aleuronic layer of the grain is made more difficult. For that reason, one part of nutritive substances does not dissolve in small intestine but in large intestine, what results in decrease of digestion efficiency. By adding enzymes into the broilers' food, digestibility and energetic value of forage is increased. Suggestions for adding the enzymes in the preparations (mixtures), which besides maize, contain also barley, are based on studies of *Rotter et al.* (1989), *Jeroch et al.* (1993) and *Salobir et al.* (1995). These results are related to the improved digestibility, higher energetic value of feedstuffs, increased feed consumption, increased daily live weight gain, propitious conversion and decreased frequency of sticky excrements. Enzymes can be added to diets separately or in the form of enzyme preparations, which has proved more effective because of its synergetic function (*Graham* and *Pettersson*, 1992). By using mixtures which contained polienzyme preparations, *Jeroch et* al. (1991) and *Richter et al.* (1991) have proved the improvement of broilers live weight for 5.6% and 2.5% respectively in relation to the control group.

Rajmane (1992) and *Brenes et al.* (1993) claim that, besides increased live weight for 5.7–9.7%, better food conversion of 8-16% is also achieved. By supplementation of polienzym preparation, which has also been used in our research, *Vranešić et al.* (1994, 1999) achieved better growth rate for 3.4-5.4% and better conversion for 1.92-8.34%. By using preparations with different enzyme mixture, *Kralik et al.* (1993, 1994, 1995) also achieved better growth of broilers for 8.2–12%, as well as better feed conversion into the live weight gain for 8-11%.

The aim of our research was to found out whether a multienzyme preparation "Pliva" containing beta-glucanase, xylanase, alpha-amylase, protease, beta-glucosidase, cellulase and chemicellulase, can improve utilization of the diets based on maize and barley (32.20% and 24.63%, and 40.90% and 22.20% respectively) and enhance the growth of broilers.

MATERIALS AND METHODS

The study of the multienzyme preparation effect on product results has been carried out on 140 Avian 34 male broilers. By a random choice they were divided in two groups (70 broilers in control and 70 broilers in experimental group) and kept in two separate boxes within the same object. The fattening period lasted 6 weeks. Starter and finisher diets were prepared of the same components so that they had the same chemical composition. The broilers were fed with starter diet from the 1^{st} until 21^{st} day and with finisher diet from 22^{nd} until 42^{nd} day of life. Enzyme preparation was supplemented into diets for experimental group in amounts of 0.05% or 0.5 g/kg diet (*Table 1*).

The amount of water in the diets was determined by drying the sample at 105°C up to constant mass. The protein content was established by Kjel-Foss type of nitrogen analyser (protein content=N%x6.25). Crude fibres of the diet mixture were determined by *Hennberg-Stockman* method. The content of amino acids was established by automatic analyser (LKB 4101) using Merck standards (Merck, Germany).The inflection point and individual stages of growth were established by asymmetric S-function (*Kralik* and *Scitovski*, 1993):

$$f(t) = \frac{A}{(1+be^{-c\gamma t})^{1/\gamma}} \quad A, \gamma > 0$$

$$t_B = \frac{1}{c\gamma}\ln\frac{2b}{\gamma(\gamma+3)+\gamma\sqrt{(\gamma+1)(\gamma+5)}}$$

$$t_C = \frac{1}{c\gamma}\ln\frac{2b}{\gamma(\gamma+3)-\gamma\sqrt{(\gamma+1)(\gamma+5)}}$$

Asymmetric S-function with one inflection point is continuously increasing in the whole area, in which it has been defined. The parameters of the function, b and c, are determined on the basis of experimental data using the least square method, while biological maximum A and coefficients of asymmetry are given empirically. Herewith, the point t_B is the maximum in the region of intensive growth (convex region) and point t_C is minimum in the region of depressive growth (concave region). The interval $t \le t_B$ represents the stage of growth preparation, the interval $t_B \le t \le t_C$ the stage of intensive growth, and the interval $t \geq t_C$ is the stage of growth retardation (*Kralik* and *Scitovski*, 1993). The results of the investigations of particular traits were presented by arithmetic mean and standard deviation ($\overline{x}$ ±s) and differences between the groups of broilers were tested by t-test. Statistical data were processed on personal computer using Statistica v.5.0 for Windows software.

Table 1

Composition and nutritive value of the diet

Ingredient (%)	Starter		Finisher	
	Control	Experiment	Control	Experiment
Maize	32.20	32.20	40.90	40.90
Barley	24.63	24.63	22.20	22.20
Soybean meal (42% c. protein)	30.80	30.80	25.90	25.90
Fish meal (65% c. protein)	4.50	4.50	3.50	3.50
Animal fat	4.10	4.10	3.50	3.50
Lysine	0.10	0.10	0.10	0.10
Methionine	0.22	0.22	0.20	0.20
Salt	0.25	0.25	0.20	0.20
Limestone	1.20	1.15	1.50	1.45
Monocalcium phosphate	1.50	1.50	1.50	1.50
Premix	0.50	0.50	0.50	0.50
Enzyme polizyme	-	0.05	-	0.05
Total	100.00	100.00	100.00	100.00
Calculated values (%):				
Crude protein	21.25	21.25	19.45	19.45
Crude fat	6.35	6.35	5.70	5.70
Crude fiber	3.68	3.68	3.49	3.49
Lysine	1.10	1.10	0.96	0.96
Methionine	0.56	0.56	0.48	0.48
Threonine	0.74	0.74	0.65	0.65
Triptophane	0.25	0.25	0.20	0.20
Leucine	1.36	1.36	1.30	1.30
Cystine	0.31	0.31	0.25	0.25
ME (MJ/kg)	13.33	13.33	13.53	13.53

RESULTS AND DISCUSSION

The effect of multienzyme preparation supplementation was monitored on the basis of live weights of the broilers and conversion of feed into live weight gain. At the beginning of the fattening period, the average live weight of broilers was the same in control and experimental group. At the end of the study period of 42 days, average live weight of the broilers in control and experimental group was 1962±65.70 g and 2088±69.89 g, respectively. The live weight of the broilers from experimental group was 126 g (6.42%) higher than in control group. Statistically significant differences in live weights between experimental and control group were established after the first week ($P<0.01$) and they remained constant until the end of the fattening period (*Table 2*).

Significantly higher daily weight gains throughout the fattening period were found in the experimental group and were higher for 6.25% in the 1st week and 15.8% in the 6th week than in control group.

Table 2

Average live weight of chickens in fattening

Age of chickens	Number of chickens		Average live weight (g)		Significance of differences
	C	E	C	E	
1 day	70	70	41 ± 1.06	41 ± 0.90	
1	69	70	148 ± 4.60	151 ± 6.07	**
2	67	68	393 ± 16.91	415 ± 13.74	**
3	66	68	701 ± 22.97	724 ± 17.14	**
4	66	68	1081 ± 41.41	1147 ± 70.60	**
5	66	68	1626 ± 46.54	1688 ± 35.99	**
6	66	68	1962 ± 65.70	2088 ± 69.89	**

*C=control group; E=experimental group; ** P<0.01*

Comparing the results of feed conversion rate between control and experimental group of broilers, it is evident that broilers from the experimental group had 5.52% better feed conversion ratio at the end of the fattening period (*Table 3*). From these data it is evident that, during the 42 days of fattening period, the broilers in experimental group consumed negligible quantity of feed than the broilers in control group, but the food conversion into the live weight gain was better in experimental than in control group. The utilization of food (FU), presented as a relation 1 kg live weight and feed consumption in particular period of time, showed that polienzyme preparation enabled better digestion of nutritive substances, which affected digestion efficiency, as well as better feed conversion in experimental group of broilers in comparison to the control group of broilers (50.25% and 53.19%, respectively).

Table 3

Cumulative review of consumption, conversion and utilization of feed

Week	Consumption (kg)		Conversion (kg)		Feed utilization (%)	
	C	E	C	E	C	E
1	0.19	0.19	1.77	1.73	56.50	57.80
2	0.63	0.65	1.80	1.74	55.55	57.47
3	1.21	1.20	1.83	1.76	54.64	56.82
4	1.95	1.98	1.87	1.79	53.47	55.86
5	3.10	3.03	1.95	1.84	51.28	54.35
6	3.83	3.85	1.99	1.88	50.25	53.19

C=control group; E=experimental group

The parameters of asymmetric S-function used in modelling of the live weight growth of broilers from both groups are presented in *Table 4*. The parameters show different position of the inflection point (T_I: control group 33.75 days and 1478.84 g; experimental group 32.52 days and 1479.08 g). According to this, the supplement of polienzyme preparation stimulated the progressive growth, so that the inflection point (T_I) occurred 1.23 day earlier in the experimental group than in the control group. Analysis of evaluated parameters shows that broilers in experimental group would reach the same weight (2736 g) in 53.38 days, whereas broilers in control group would reach the same weight in 55.74 days.

Table 4

Parameters of the function – growth model

Parameter	**Chicken groups**	
	Control	Experiment
b	0.044105	0.045141
c	4.396885	4.635193
γ	0.01	0.01
T_I	33.7507; 1478.8448	32.5167; 1479.0776
t_B	11.7605; 298.3351	11.6571; 298.4667
t_C	55.7409; 2736.6406	53.3763; 2736.8734

Curves and growth characteristics are described by asymmetric S-function and presented on *Figures 1* and *2*.

Control group $$y = \frac{4000}{(1 + 0.0441047 \cdot e^{-4.3968845 \cdot 0.01t})^{1/0.01}}$$

Experimental group $$y = \frac{4000}{(1 + 0.0451412 \cdot e^{-4.635193 \cdot 0.01t})^{1/0.01}}$$

Figure 1

Growth curve of the control group of broilers

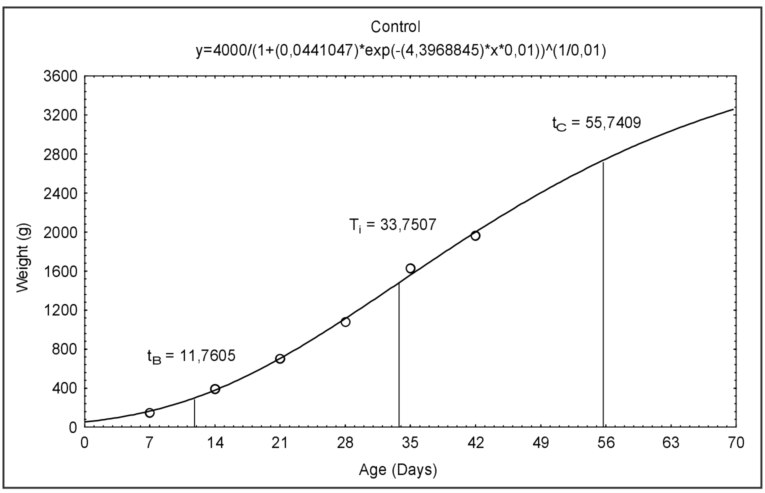
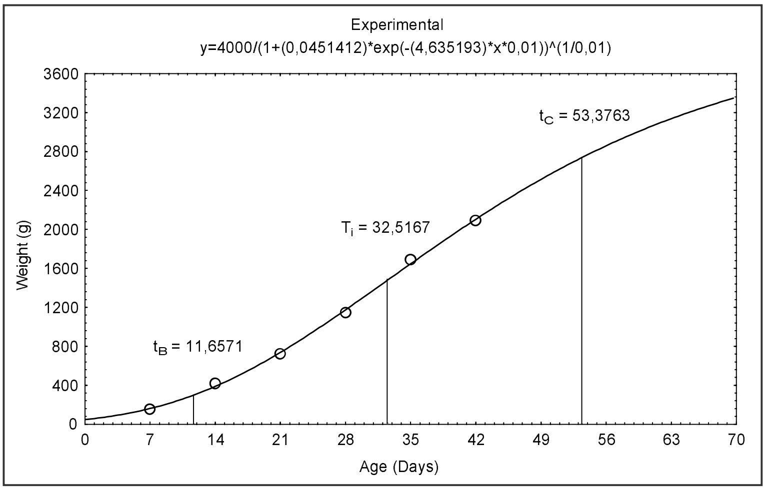


Figure 2

Growth curve of the experimental group of broilers



The analysis of fattening traits of broilers (*Tables 2* and *3*) shows positive effect of multienzyme preparation, which, as a stabilized mixture of enzymes: beta-glucanase, xylanase, alpha-amylase, protease, beta-glucosidase, cellulase and chemicellulase, resulted in better digestibility of nutrients and increased the energetic value of feed. Therefore, better feed utilization of 53.19% in comparison to 50.22% resulted in better weight gain of broilers in experimental group. These results are in accordance with results of *Rotter et al.* (1989), *Richter et al.* (1991), *Graham* and *Pettersson* (1992), *Jeroch et al*. (1993), as well as of *Salobir et al.* (1995). At the end of the fattening period, the increase of broilers live weight is approximately the same as the results of the quoted authors are. However, it should be emphasized that the efficiency of the enzyme depends on the feedstuffs and on the concentration of enzyme supplement of the diet. The results of our research concerning the feed conversion in the live weight gain are approximately the same as the results of *Rajmane* (1992) and *Šerman et al.* (1997), but they are considerably below those of *Brenes et al.* (1993). By adding polienzyme preparation into the diet, *Vranešić et al.* (1994) achieved approximately the same effect of the fattening traits of broilers as we did. Research results of adding multienzyme preparation in amount 0.05% to the broiler diet (21.25%/19.45% crude proteins and 13.3 MJ/13.53 MJ ME/kg) showed positive effects on the fattening traits of broilers. After 42 days of fattening the broilers live weight was increased for 6.42%. The feed conversion into the live weight gain was also increased for 5.52%. The mortality of the broilers was lower in experimental than in control group (2.86% and 5.71%, respectively). Supplementation of multienzyme preparation in the diet enhanced intensive stage of growth (group E 11.66-53.38 days, group C 11.76-55.74 days). The period of intensive growth in experimental group of broilers lasted shorter than in control group, which was proved by the different positions of inflection points (T_I=32.5167 for experimental group and T_I=33.7507 for control group). This research confirms positive effect of supplemented polienzyme preparation on the fattening characteristics of broilers what is in accordance with earlier studies (*Kralik et al*., 1993, 1994 and 1995).

CONCLUSIONS

On the basis of results of the study on effect of multienzyme preparation, supplemented to the diet in amount of 0.05%, on productive traits of the broilers, following conclusions can be defined: The average live weights of the broilers fed diets with multienzyme preparation were for 126 g or 6.42% higher ($P<0.01$) compared to the control group fed by the same diet without multienzyme preparation. Supplemented multienzyme preparation had positive effect on feed conversion ratio which was better for 5.52% in the experimental group, compared to the control group. It was found that supplementation of multienzyme preparation in the diet enhance intensive stage of live weight growth of broilers (group E 11.66-53.38 days, group C 11.76-55.74 days).

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Corresponding author:

Gordana Kralik
J.J. Strossmayer University of Osijek, Faculty of Agriculture
HR-31000 Osijek, Trg Sv.Trojstva 3., Croatia
Tel.: 385 31 224 241, Fax: 385 31 207 017
e-mail: gkralik@pfos.hr

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University of Kaposvár, Faculty of Animal Science, Kaposvár

Correlation between meat color and some indicators of carcass and meat quality of pigs

G. Kralik, G. Kušec, H. [1]Gutzmirtl, A. Petričević, D. [1]Grgurić

Josip Juraj Strossmayer University of Osijek, Faculty of Agriculture, Osijek, HR-31000 Trg Sv. Trojstva 3., Croatia
[1]Center of Livestock Production Improvement, Osijek, HR-31000 Vinkovačka 63., Croatia

ABSTRACT

In this study, carcasses of 68 pigs from one test station in eastern Croatia were used. At the weight of approximately 100 kg pigs were slaughtered and measurements on the hot carcass were collected: hot carcass weight, carcass length (a and b), meat percentage (TP), and pH_{45}. After 24 hours of cooling other quality indicators were measured: pH_{24}, w.h.c., backfat and loin muscle areas. Pig carcasses weighted 78.79 kg (hot) and after 24 hours of cooling 77.32 kg. Mean values of the carcass length were 89.43 and 104.41 cm ("a" and "b", respectively). The estimated mean leanness of pig carcasses was 54.28%, with backfat thickness of 17.25 mm and loin muscle depth 67.28. Areas of fat and loin muscle were 17.39 and 40.25 mm^2, resp., while fat/meat ratio 0.44. Meat quality indicators showed good quality of the meat in average (pH_{45} was 6.19, pH_{24} 5.71, w.h.c. 9.97, Minolta L 53.04, a* 6.89 and b* 6.24. Medium strong, negative correlation was found between Minolta L* values and carcass length (-0.41 and -0.45, "a" and "b", resp.), and backfat thickness TP (-0.34). Fat/meat surface ratio was negatively weak correlated with L* value (-0.29), while weak positive but significant r value was calculated between L* and MLD surface (0.28). The significant, weak and negative correlation was found between a* value and length "b" (-0.27). Correlations between Minolta values (L* and b*) and meat quality traits were also calculated. Strong, negative correlation was found between L* and pH_{24} values (-0.54). Between Minolta L* and pH_{45} values, the correlation was significant, medium strong and negative (-0.34). Medium strong and positive correlation was found for w.h.c. (0.44). Minolta a* value was negatively correlated with pH_{24} (-0.46) and pH_{45} (-0.33).*

(Keywords: pig, carcass traits, meat quality, color)

INTRODUCTION

The competitiveness of pork industry depends in great deal on the production of lean pigs characterized by high quality of meat. The quality of pork is described in different manners by different participants in production chain, but the most important goal to all of them is to keep the customers satisfied. One of the most important meat quality trait is color, because it is the first to be observed by the consumer. The ideal color of fresh pork is reddish pink. However, under genetic and/or environmental influences, it can turn out to be too pale or too dark. These undesirable conditions are known as PSE (pale, soft, exudative) and DFD (dark, firm, dry) meat. The incidence of poor quality pork can be reduced on the basis of the knowledge about quality traits, their relations and actions needed in order to improve them.

It is well known that the rate and extent of post mortem pH decline are the main determinants of pork quality. On the other hand, color alone does not fully describe the overall quality of meat. Measuring the color is effective only after the carcasses had enough time to cool and develop their final color. Good overview of various measures of pork quality, including color, and interactions between them is given by *Forrest* (2000). *Eikelenboom et al*. (1995) studied the significance of pH_{24} for pork quality (Minolta L* values, drip loss, water uptake, shear force etc.). He found that ultimate pH was the most predictive determinant of pork quality. The same conclusion was given by *Petersen et al*. (1996) who found no correlation between pH_{45} and Minolta L* values. On the other hand, correlation between pH_{24} and L* was significant. *Huff-Lonergan et al.* (2002) found significant correlation between color (Hunter L* values) and drip loss. Different authors found similar relations in other species. *Wulf* and *Wise* (1999), *Page et al.* (2001) in beef, *Owens et al.* (2000) in turkey meat, *Barbut* (1997) and *Fletcher* (1999) in the breast meat of broilers. The objective of this paper is to give an overview of the main carcass and meat quality traits of pigs slaughtered in slaughter houses in east Croatia. Special emphasis is given on the meat color and its correlation with other carcass and meat quality characteristics.

MATERIALS AND METHODS

This study was performed on 68 carcasses of pigs from one test station in eastern Croatia. The pigs were slaughtered at approximately 100 kg live weight in "Sotin" slaughter plant VUPIK, Vukovar. At the slaughter line, the measurements of warm carcass weight, carcass length, fat thickness and muscle depth, muscle and fat surfaces of *m. longissimus dorsi* between 13^{th} and 14^{th} rib and pH_1 values were taken on primarily processed swine carcasses. The length of the carcass was measured from *os pubis* to the 1^{st} rib (a) and from *os pubis* to *atlas* (b). The lean percentage (TP) was calculated on the basis of backfat thickness (mm) measured caudally on the place where *m. gluteus medius* gets the deepest in the subcutaneous fat, and muscle depth (mm) measured as the shortest distance between the cranial end of *m. gluteus medius* and dorsal spinal edge. After 24 hours of cooling, backfat and muscle area (cm^2), pH_2 values, water holding capacity (w.h.c.) and color of *m. longissimus dorsi* were taken. Backfat and muscle areas were measured by geometric procedure (*Comberg,* 1978) using digital planimeter "HAFF 350 E" and expressed as the fat/muscle area ratio; water holding capacity (w.h.c.) was determined using compression method by *Grau and Hamm* (1952); the color of the meat was measured by "Minolta CR-300" device at *m. longissimus dorsi* cut. The measurements of pH_{45} and pH_{24} were carried out by digital pH-meter "Mettler MP 120-B". Statistical analysis was performed using STATISTICA (5.0) for Windows program.

RESULTS AND DISCUSSION

The carcass traits of investigated pigs are presented on *Table 1*. Warm pig carcasses weighted 78.79±5.94 kg; after 24 hours of cooling their weight was 77.32±5.96 kg indicating drip loss of 1.87%. The carcass length was measured in two manners: length "a" was 89.43±2.89 and length "b" was 104.41±3.68 cm. The leanness of pig carcasses was estimated by TP method at the slaughter line and average value was 54.28±4.91%, with backfat thickness of 17.25±5.88 mm and loin muscle depth 67.28±6.58 mm.

Backfat and muscle area were 17.39±4.55 and 40.25±6.92 mm^2; fat/muscle ratio was 0.44.

Table 1

Carcass traits of investigated pigs

Trait	Mean	Min.	Max.	Standard deviation
Warm carcass weight, kg	78.79	66.00	101.50	5.94
Cold carcass weight, kg	77.32	64.00	99.00	5.96
Carcass length "a", cm	89.43	83.00	98.00	2.89
Carcass length "b", cm	104.41	97.00	115.00	3.68
Lean percentage (TP)	54.28	44.38	67.76	4.91
Backfat thickness, mm	17.25	5.00	35.00	5.88
Muscle depth, mm	67.28	55.00	85.00	6.58
Backfat area, cm^2	17.39	7.60	33.60	4.55
Loin muscle area, cm^2	40.25	27.20	63.50	6.92
Fat/muscle ratio	0.44	0.18	0.78	0.13

From the data presented in the *Table 2* it can be seen that meat quality traits of the investigated pigs had in average favorable values. The mean value of pH_{45} which indicate the velocity of postmortal glycolysis was 6.19±0.32, while those of pH_{24} 5.71±0.22. These values were, according to *Hoffman* (1994), within the boundaries of "normal" meat. The rapid fall of pH value 45 minutes post mortem is usually used as the main indicator of PSE meat. Values of pH_{45} higher than 6 are considered to be "normal"; between 5.8 and 6 are said to be suspicious to PSE; and below 5.8 are clearly PSE meat. Ultimate pH value measured after the meat rested 24 hours in cooler can also be used as a predictor of PSE meat. *Forrest* (1998) stated that when pH_{24} is 5.5 or lower, nearly 99%of the pork is PSE, and when this value is above 5.65 there will be almost no PSE meat, although the level of drip loss may be variable; van *Laack* (2000) reported pH_{24} less than 5.7 as the indicator of PSE meat. Also, the ultimate pH value higher than 6.2 is a sign of dark, firm and dries (DFD) meat (*Hoffman,* 1994). Water holding capacity of the investigated pigs was to some extent higher than expected regarding the pH values which were quite satisfactory. Other authors reported similar values of w.h.c. in the meat of pigs with noticeably lower pH_{45} (*Kralik et al*., 1996; *Petričević et al.,* 2000). Mean Minolta L* value indicating the lightness of the meat was 53.04, which suggests a normal color, having in mind that Minolta L* values above 58 are usually considered as PSE (*van Laack*, 2000). *Pettersen et al.* (1996) reported similar L* values (pH values were similar as in present study too) measured in Danish Landrace pigs *anno* 1995. Danish Landrace pigs from the year 1995 had significantly paler color than those from 1975, although the differences between pH values were insignificant. Minolta L*, a* and b* values presented here were similar to those reported by *Oksbjerg et al.* (2001). To some extent lower L* and higher a* values with similar values of b* and pH_{24} reported *Leach et al.* (1996).

Table 2

Meat quality traits of investigated pigs

Trait	Mean	Min.	Max.	Standard deviation
pH_{45}	6.19	5.44	6.97	0.32
pH_{24}	5.71	5.35	6.43	0.23
Water holding capacity	9.97	6.50	12.70	1.36
Minolta L*	53.04	43.98	61.10	3.66
Minolta a*	6.89	1.65	11.83	1.88
Minolta b*	6.24	2.19	10.02	1.70

Medium strong, negative correlation was found between Minolta L* values and carcass length (-0.41 and -0.45, "a" and "b", resp.), and backfat thickness TP (-0.34). The correlation between Minolta L* value and lean percentage was significant, very weak and positive (r=0.29). Minolta a* value, indicating the redness of the meat was negatively correlated to carcass length "b"; the correlation was very weak but significant (r=-0.17). Carcass length "a" and "b" were also correlated with Minolta b* value (r=-0.29 and r=-0.35, respectively). Weak, significant correlation was found between loin muscle area and Minolta L* and b* value (r=0.28 and r=0.29, resp.), while correlation of the same strength, only negative was determined between L* value and fat/muscle ratio (r=0.28). *Petersen et al.* (1996) reported very weak and insignificant correlations between Minolta values and carcass lean, although the correlation of Minolta L* and b* values and lean percentage in loin and ham were significant (between 0.23 and 0.28). All measured meat quality traits were found to be significantly correlated with Minolta L* values (*Table 3*). Medium strong, negative correlation was found between pH_{45} and Minolta L* value (r=-0.34); correlation of the same strength but positive was determined between water holding capacity and L* value (0.44). Correlation between pH_{24} and L* value was strong, negative (r=-0.53) which makes ultimate pH value the best predictor of muscle lightness. *Eikkelenboom et al.* (1995) reported to some extent higher correlation than in current study between pH_{24} and Minolta L*(r=-0.61) and water holding capacity (0.56). They concluded that pH_{24} was better predictor of color, w.h.c. and water uptake than pH_{45}. This was also found for some other species such as *Fletcher* (1999) for broilers breast muscle and *Page et al.* (2001) for beef. *Owens et al.* (2000) reported that L* value and pH were correlated with w.h.c. in turkey meat, but that L* had more predictive value. Minolta a* values which measure the redness of meat were correlated with both pH values; correlation coefficients were medium strong and negative. Meat yellowness expressed by Minolta b* value was significantly correlated with all measured meat quality traits. The highest correlation coefficient between b* value and meat quality traits was found for pH_{24} value; it was strong and negative (r=0.61); medium strong, negative for pH_{45}, and medium strong, positive for water holding capacity (r=-0.37 and r=0.40, resp.). *Wulf* and *Wise* (1999) found higher correlations between Minolta L*, a* and b* values and muscle pH of beef.

Table 3

Correlation coefficients between carcass and meat quality traits and Minolta L*, a* and b* values

Trait	L*	A*	B*
Warm carcass weight, kg	-0.12	0.14	0.09
Cold carcass weight, kg	-0.16	0.09	0.03
Carcass length “a”, cm	**-0.41**	-0.21	**-0,29**
Carcass length “b“, cm	**-0.45**	**-0.27**	**-0.35**
Lean percentage (TP)	**0.29**	-0.11	0.01
Backfat thickness (TP), mm	**-0.34**	0.12	-0.01
Muscle depth (TP), mm	0.19	0.04	0.11
Backfat area, cm^2	-0.12	0.05	0.01
Loin muscle area, cm^2	**0.28**	0.22	**0,29**
Fat/muscle ratio	**-0.29**	-0.08	-0.17
pH_{45}	**-0.34**	**-0.33**	**-0.37**
pH_{24}	**-0.53**	**-0.46**	**-0.61**
w.h.c. (cm^2)	**0.44**	0.23	**0.40**

CONCLUSIONS

From the present study, following conclusions can be drawn:

- Minolta L* value was significantly correlated with carcass length “a” and “b”. Correlation was medium strong and negative (r=-0.41 and -0.45, resp.). Significant, weak and negative correlation was found between L* value and backfat thickness (r=-0.34). Very weak, but significant positive correlation was determined between L* value and lean percentage as well as loin muscle area (r=0.29 and 0.28, resp.). The correlation of the same strength but negative was found for fat/muscle ratio (r=-0.29). Carcass weights (warm and cold), muscle depth and backfat area determined by planimetry were not correlated with Minolta L* value.
- All measured meat quality traits were significantly correlated with Minolta L* value. Strong, negative correlation was found for pH_{24} value (r=-0.53). Water holding capacity and pH_{45} value were correlated with L* value by medium strong negative correlation (r=-0.44 and -0.34, resp.).
- Redness of the meat indicated by Minolta a* value was significantly correlated with carcass length “b”, pH_{45} and pH_{24}. All correlation coefficients were negative. Correlations with pH_{24} and pH_{45} were medium strong (r=-0.46 and 0.33, resp.), while with carcass length “b” was weak (-0.27).
- Minolta b* value which measures yellowness of the meat was significantly correlated with carcass length “a” and “b”. Both correlation coefficients were negative. Coefficient r was medium strong in case of “b” length and weak for “a” (r=-0.35 and 0.29, resp.). Loin muscle area was significantly correlated with b* value, coefficient r was positive weak (r=0.29). Positive, medium strong correlation was found between b* value and w.h.c. (r=0.40). Correlations between pH values and b* value were both significant and negative; coefficient r found for pH_{24} was strong, while that of pH_{45} medium strong (r=-0.61 and -0.37, resp.).

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Corresponding author:

Gordana Kralik
J.J. Strossmayer University of Osijek, Faculty of Agriculture
HR-31000 Osijek, Trg Sv.Trojstva 3., Croatia
Tel.: 385 31 224 102, Fax: 385 31 207 015
e-mail: gkralik@suncokret.pfos.hr

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Influence of terminal sire breed on carcass and meat quality traits of pigs

G. Kušec, G. Kralik, H. [1]Gutzmirtl, A. Petričević, D. [1]Grgurić
Josip Juraj Strossmayer University of Osijek, Faculty of Agriculture, Osijek, HR-31000 Trg Sv. Trojstva 3., Croatia
[1]Center of Livestock Production Improvement, Osijek, HR-31000 Vinkovačka 63., Croatia

ABSTRACT

The carcasses of 53 pigs were included in this study. They were divided in two groups according to the breed of the terminal sire as follows: 28 progenies of Large White and 25 progenies of Pietrain sire. Dams were all Large White×Swedish Landrace crossbreeds. Sire line had no influence on cold carcass weight, length and fat thickness measured as in "two points" (TP) method of lean percentage estimation, as well as on ham length and ham index (P>0.05). On the other hand, carcasses of the pigs originated from Pietrain sires had significantly higher thickness of MLD measured as in both TP and instrumental (FOM) method of lean percentage estimation, while fat thickness measured at the place of FOM method was significantly lower (P<0.01). These carcasses had also higher estimated lean percentage, ham circumference and ham weight (P<0.01). Although progeny of Pietrain sires performed better regarding the carcass traits, their meat quality was inferior compared with the meat of the pigs originated from Large White sires. The value of pH_{45} of the pigs originated from Pietrain sires was significantly lower, at the border of PSE meat, and Minolta L values indicated significantly paler color than in the case of Large White crosses. Crosses with Pietrain had, however, higher MLD surface and fat/muscle ratio (P<0.01) than Large White crosses. Other meat quality traits, such as pH_{24}, water holding capacity, consistency and fat surface, were unaffected by the breed of terminal sire.*
(Keywords: pig, breed, carcass, meat quality)

INTRODUCTION

The choice of sire is important decision in every breeding program because it determines main performances of fatteners in production of pork such as growth, carcass and meat quality. These traits are also of great economic importance, but still seldom recorded in routine selection programs in Croatia. This results in the constant lack of information for the choice of optimum breeds of sires to be used in Croatian pig production. Some of these information can be found in scientific literature, some from the experience of pig breeders from other countries, but it is important to know that breed effects are not fixed. They can differ from region to region and even among different producers within the same local area. These differences result from various attempts of pig breeders to achieve various selection goals with also various success. Therefore, it is very important to have an overview of the available information on the breeds of potential sires and their influence on production traits of their progeny, i.e. crossbred slaughter pigs in the local production environment. For this purpose, sires used in production of pork should be tested on main carcass and meat quality characteristics, and the results of these tests should be known to the producers of fattening pigs.

The objective of this article is to investigate the influence of terminal sire breed on carcass and meat quality traits of slaughter pigs produced in east Croatia.

MATERIALS AND METHODS

This study was performed on 53 carcasses of three way crossed castrated pigs divided into two groups regarding the breed of the terminal sire. The dams were all double crossbred: Swedish Landrace×Large White, while Pietrain and Large White boars were used as terminal sire. Pietrain group had 25 and Large White group included 28 pigs. The pigs were slaughtered at approximately 100 kg live weight in "Sotin" slaughter plant VUPIK, Vukovar. At the slaughter line, the measurements of carcass length, fat thickness and muscle depth, muscle and fat surfaces of *m. longissimus dorsi* between 13^{th} and 14^{th} rib and pH_1 values were taken on primarily processed swine carcasses. Backfat thickness - TP (mm) was measured caudally at the place where *m. gluteus medius* gets the deepest in the subcutaneous fat, and muscle depth (mm) measured as the shortest distance between the cranial end of *m. gluteus medius* and dorsal spinal edge. Backfat thickness and muscle depth – ins (mm) were obtained from the instrumental method of lean percentage estimation by Fat-o-Meter (FOM). The length of the carcass was measured from *os pubis* to the 1^{st} rib (a) and from *os pubis* to *atlas* (b). The lean percentage was calculated on the basis of "two points" and instrumental method of estimation. After 24 hours of cooling, cold carcass weight, backfat and muscle area (cm^2), pH_{24} values, water holding capacity (w.h.c.), consistency and color of *m. longissimus dorsi* were taken. Backfat and muscle areas were measured by geometric procedure (*Comberg*, 1978) using digital planimeter "HAFF 350 E" and expressed as the fat/muscle area ratio; water holding capacity (w.h.c.) was determined using compression method by *Grau and Hamm* (1952). The consistency was expressed here as the area of the compressed muscle tissue (cm^2) obtained in the procedure of taking wh.c. measurement. This is a modified method and it is used only to compare the samples taken from different populations. The color of the meat was measured by "Minolta CR-300" device at *m. longissimus dorsi* cut. The measurements of pH_{45} and pH_{24} were carried out by digital pH-meter "Mettler MP 120-B". Statistical analysis was performed using STATISTICA (5.0) for Windows program.

RESULTS AND DISCUSSION

It is obvious from *Table 1* that sire line had no influence on cold carcass weight, length and fat thickness measured as in "two points" (TP) method of lean percentage estimation, as well as on ham length and index ($P>0.05$). On the other hand, carcasses of the pigs from Pietrain group had significantly higher thickness of *m. longissimus dorsi* measured as in "two points" and instrumental (FOM) method of lean percentage estimation, while fat thickness, measured at the place of instrumental method was significantly lower ($P<0.01$) than in the carcasses from Large White group of pigs. These carcasses had also higher lean percentage estimated by both "two points" and instrumental method ($P<0.05$ and $P<0.01$, respectively). Although the ham length of both groups of pigs were approximately the same, Pietrain sire progeny had significantly higher ham circumference and ham weight ($P<0.01$) suggesting more intensive development of hams of the pigs from this group. In general, linear carcass measurements indicate better carcass characteristics of the pigs with Pietrain as terminal sire breed. Contrary to present study, *Hamilton et al.* (2001) found significant effect of sire line on hot carcass weight, but no influence on carcass length which is in agreement to the results presented here. Sire line had significant effect on both hot and cold carcass weight, while no influence on carcass length, fat measurements and lean percentage was found by *Miller et al.* (2000). Similar results reported *Leach et al.* (1996) who found significant differences between the two sire lines in cold carcass weight and no differences in lean meat percentage, carcass length and fat measurements. However, these differences were influenced by different MHS-genotype of the sire.

Table 1

Differences in carcass traits between crossbred pigs with different terminal sire

Carcass trait	Pietrain	Large White	Level of significance
Cold carcass weight, kg	78.56	75.75	n.s.
Carcass length “a”	88.68	88.86	n.s.
Carcass length “b”	103.16	103.68	n.s.
Fat thickness (TP), mm	16.60	19.57	n.s.
MLD thickness, (TP), mm	70.48	63.71	P<0.01
Lean percentage (TP), %	55.21	52.06	P<0.05
Fat thickness (ins.), mm	13.20	16.32	P<0.01
MLD thickness, (ins.), mm	61.60	53.79	P<0.01
Lean percentage (ins.), %	57.60	53.60	P<0.01
Ham length, cm	31.68	31.25	n.s.
Ham circumference, cm	71.06	68.52	P<0.01
Ham weight, kg	11.32	10.49	P<0.01
Ham index	44.65	45.66	n. s

n.s.: not significant (P>0.05)

Although progeny of Pietrain sires performed better regarding the carcass traits, their meat quality was inferior compared with the meat of the pigs originated from Large White sires. Meat quality traits are presented on *Table 2*.

Table 2

Differences in meat quality traits between crossbred pigs with different terminal sire

Trait	Pietrain	Large White	Level of significance
pH_{45}	6.04	6.28	P<0.01
pH_{24}	5.66	5.73	n.s.
w.h.c.	10.23	9.87	n.s.
Consistency	3.25	3.23	n.s.
Minolta L*	54.58	51.99	P<0.01
Minolta a*	7.70	6.56	P<0.05
Minolta b*	7.25	5.67	P<0.01

n.s.: not significant (P>0.05)

From the data presented it is obvious that pH_{45} values measured in the loin muscle of pigs from Pietrain group were significantly lower, at the border of PSE meat indicating faster glycolysis flow in the muscles of these pigs compared to the pigs from Large White group. Ultimate pH values of the pork from Pietrain group were also lower but this difference was not significant ($p>0.05$). However, it should be stated that the mean pH_{24} value measured in the meat of pigs from Pietrain group was below the border value for PSE meat (5.7) suggested by *van Laack* (2000). Nevertheless, *Forrest* (1998) reported that pH_{24} of 5.5 or lower would result in 99% of PSE pork, but when this values is above 5.65 there will be almost no PSE, although drip loss may be variable. By this criterion mean ultimate pH measured in the meat of pigs from Pietrain group would be almost at the border of PSE condition. Minolta L* values indicated significantly paler color of the meat of pigs from Pietrain than in Large White group. According to *van Laack* (2000), PSE meat is characterized by L* values above 58 which means that both groups of pigs from current study had normal meat brightness. Although PSE condition of pork is often induced by MHS gene, number of authors reported lowered meat quality of pork in Pietrain based crossbreeds, independently of MHS gene status (*Howard* and *Smith*, 1977; *Oliver et al.* 1993; *Hamilton et al.* 2001). Since MHS gene status of Pietrain sires used in this study was not determined, it is not known whether the reduced meat quality resulted from the effect of MHS gene. This demonstrates that MHS genotype of the boars used as sires in commercial crossings must be known which is not always the case in east Croatia. Statistically significant differences between two groups with different sire lines were also found for Minolta a* and b* values ($P<0.05$ and $P<0.01$, respectively). Water holding capacity and consistency were unaffected by the breed of terminal sire.

CONCLUSIONS

From the present study on influence of terminal sire breed on the carcass traits and meat quality of fattening pigs, following conclusions can be drawn:

- The breed of terminal sire significantly influenced some carcass traits. Pigs originated from Pietrain sire had significantly higher MLD thickness measured as for TP and instrumental method of lean percentage estimation ($P<0.01$); lower fat thickness measured as for FOM method ($P<0.01$); higher lean percentage estimated by TP and instrumental method ($P<0.05$ and $P<0.01$, resp.); higher ham circumference and weight ($P<0.01$) than the progeny of Large White terminal sires.
- Meat quality traits of the pigs originated from Petrain sires had less favourable values compared to progeny of Large White terminal sire. Their pH_{45} was significantly lower ($P<0.01$), while Minolta L* values indicated significantly paler meat color ($P<0.01$) than in the muscles of pigs from Large White group.
- The inclusion of Pietrain boars as terminal sires can improve the muscularity of fattening pigs but they can also reduce the quality of meat.

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Corresponding author:

Goran Kušec
J.J. Strossmayer University of Osijek, Faculty of Agriculture
HR-31000 Osijek, Trg Sv.Trojstva 3., Croatia
Tel.: 385 31 224 1233, Fax: 385 31 207 015
e-mail: gkusec@pfos.hr

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Correlation between carcass sides meatness and ultrasound measures on live pigs

Đ. Senčić, T. Šperanda, M. Šperanda, Z. Antunović
Department of Animal Science, Faculty of Agriculture in Osijek, Osijek, HR-31000 Trg Sv. Trojstva 3., Croatia

ABSTRACT

Correlation (r) between carcass sides meatness, determined by the Regulations («two points« method) and by dissection, and bacon thickness and musculus longissimus dorsi (MLD) measured at various places (between 10^{th} and 11^{th} rib, behind the last rib, in the middle of the loins and at the sacrum) by an ultrasound device on live pigs (n=60) at their body weight of approximately 100 kg was investigated. Bacon thickness on the small of the back (r=-0.85 and r=-0.75) was determined to be the best indicator the sides meatness and potential selection criteria.
(Keywords: carcass sides, ultrasound measures, meatness, correlation)

INTRODUCTION

Pigs of high meatness are required by developed world markets. Meatness of the pigs in the Republic of Croatia, especially on family farms, is low and coupled with higher food consumption for the gain unit of their body weight. Due to higher fattening costs and lower slaughter quality, low meatness pigs are not market competitive, whereas pig production is not profitable. The carcass sides meatness can be faster improved by selection since it is characterized by high heritage compared to fattening and reproductive pig traits. While selecting pigs for higher meatness, optimal meatness indicators (selection criteria) significantly related to it, should be chosen. This paper aims to determine optimum selection criteria in pig meatness improvement by means of ultrasound measurings on live pigs.

MATERIALS AND METHODS

The investigation was conducted with 60 Swedish Landrace pigs weighed 98.17±5.66 kg. Sex ratio was equal. The pigs were kept in the same conditions at optimal air temperature and moisture. They were fed with a mixture including 16.14% crude protein and 12.5 MJ metabolic energy/kg ad libitum from 30 to 100 kg of body weight.

Bacon and MLD thickness was measured on live pigs weighed about 100 kg on the places as follows: between 10^{th} and 11^{th} rib, behind the last rib in the middle of the loins and in the sacrum. The measuring was conducted 6 cm from medial line by means of ultrasound device Shimatzu (Tokio, Japan) prior to slaughtering.

The carcass sides meatness was determined in the slaughter house by using the Regulations (N.N. No. 119, 1999) and by dissection after *Weniger et al.* (1963).

Arithmetic means ($\bar{x}$) and variability measures (s and v) of the investigated pig meatness indicators as well as their mutual relation (r) were computed by using statistical program *Stat Soft, Inc.* (2001). The correlation intensity (r) between meatness indicators was evaluated by Roemer-Orphal scale.

RESULTS AND DISCUSSION

Indicators of slaughter quality in Swedish Landrace pigs can be seen in *Table 1*.

Table 1

Indicators of slaughter quality in Swedish Landrace pigs

Indicators	$\bar{x}$	s	v
Final body weight, kg	98.17	5.66	5.77
Bacon thickness, mm:			
- between 10^{th} and 11^{th} rib (1)	7.39	2.23	30.18
- behind the last rib (2)	6.26	2.12	33.79
- in the middle of the loins (3)	8.17	2.79	34.14
- sacrum (4)	8.57	2.48	28.99
MLD thickness, cm:			
- between 10^{th} and 11^{th} rib (5)	50.13	3.98	7.94
- behind the last rib (6)	49.74	3.73	7.50
- in the middle of the loins (7)	54.22	4.32	7.96
- at the beginning of the sacrum (8)	58.91	4.61	7.83
Carcass sides meatness, %:			
- by the Regulations (9)	53.47	3.24	6.06
- by dissection (10)	54.85	3.15	5.74

The thickest bacon of the live pigs weighed about 98 kg was in the middle of the sacrum, whereas thinnest one behind the last rib. Musculus longissimus dorsi (MLD) was the thickest in the beginning of the sacrum and the thinnest behind the last rib. Meatness of the carcass sides, determined by the Regulations (53.47%) and by dissection (54.85%) was approximate to the meatness determined earlier by *Senčić et al.* (1999) for young boars (56.92%) and gilds (54.53%) of Swedish Landrace. However, this meatness was lower compared to the meatness (61.20% and 58.30%) determined by *Stern et al.* (1990). On the other hand, the meatness differences were not conditioned only by a genotype but differences in fattening conditions.

Correlation between some ultrasound measures i.e. slaughter quality indicators on live pigs and carcass sides determined by the Regulations on the slaughter lines and by dissection can be seen in *Table 2*.

The bacon thicknesses on some places in live pigs were mutually in slight to strong positive correlation. Correlations between bacon and musculus longissimus dorsi (MLD) thickness varied depending on measuring places. Bacon thickness between 10^{th} and 11^{th} rib was in slight and positive correlation with MLD thickness on the same place; in medium and positive correlation with MLD thickness behind the last rib and in slight or medium and negative correlation with MLD thickness in the middle of loins and at the beginning of the sacrum. Correlation between bacon and MLD thickness was mostly slight and positive.

The pig sides meatness, determined by the Regulations and dissection, decreased on that places where bacon thickness increased. Bacon thickness in the middle of the sacrum (r=-0.85 and r=-0.75) was in the strongest correlation with the carcass sides meatness. Thus, it is the best indicator of the carcass sides meatness.

Table 2

Correlation among indicators of slaughter quality in Swedish Landrace pigs

Indicators[1]	2	3	4	5	6	7	8	9	10
Bacon thickness (1)	0.27*	0.26	0.71**	0.20	0.53**	-0.38**	-0.53**	-0.51**	-0.48**
Bacon thickness (2)	-	0.50**	0.52**	0.10	0.38**	0.22	0.17	-0.56**	-0.50**
Bacon thickness (3)	-	-	0.58**	0.08	0.14	0.21	0.17	-0.59**	-0.52**
Bacon thickness (4)	-	-	-	0.06	0.29*	0.04	0.09	-0.85**	-0.75**
MLD thickness (5)	-	-	-	-	0.49**	0.05	-0.24	0.18	0.10
MLD thickness (6)	-	-	-	-	-	-0.22	0.05	0.10	0.07
MLD thickness (7)	-	-	-	-	-	-	0.49**	0.02	0.05
MLD thickness (8)	-	-	-	-	-	-	-	0.05	0.02
Carcass sides meatness (9)	-	-	-	-	-	-	-	-	0.86**
Carcass sides meatness (10)	-	-	-	-	-	-	-	-	-

*[1]Measure places: 1 and 5 – between 10th and 11th rib, 2 and 6 – behind the last rib, 3 and 7 – in the middle of the loins, 4 and 8 – at the sacrum, 9 - carcass sides meatness determined by the Regulations, 10 – carcass sides meatness by dissection; * $P<0.05$, ** $P<0.01$*

Hulsegge and *Sterenburg* (1992) determined that the best anticipation of the sides meatness was provided by bacon thickness measuring between 3rd and 4th rib from behind and 60 mm from the medial line (point HGP). This measuring point was also used by other authors (*Mc Laren et al.,* 1989; *Orcutt et al.,* 1990; *Zhang et al.,* 1993; *Uremović et al.,* 1995; *Senčić et al.,* 1999). *Evans* and *Kempster* (1979) determined that bacon thickness on the last rib and 65 mm from dorsal line (P2) enabled anticipation of meatness percent in the carcass sides. *Uremović et al*. (1995) studied correlation between ultrasound measurings on live Swedish Landrace pigs weighed 30 to 100 kg and sides meatness. They determined that correlation between back bacon thickness in HGP point ranged from –0.42 to –0.79, whereas on P2 point from –0.27 to –0.63 in both sexes.

Thickness of the musculus longissimus dorsi (MLD) on some measuring places were in a very slight and insignificant correlation with the carcass sides meatness.

CONCLUSIONS

Based on the correlation investigation between back bacon and musculus longissimus dorsi (MLD) thickness on various places (between 10th and 11th rib, behind the last rib, in the middle of the loins and at the sacrum) in live pigs and their sides meatness according to the Regulations on the slaughter line and by dissection, it was determined that bacon thickness on the sacrum (r=-0.85 and r=-0.75) is the best indicator of the carcass sides meatness as well as a potential selection criteria .

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Corresponding author:

Đuro Senčić
Faculty of Agriculture in Osijek
HR-31000 Osijek, Trg Sv. Trojstva 3., Croatia
Tel.: 385 32 224 223; Fax: 385 31 207 017
e-mail: dsencic@suncokret.pfos.hr

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Effect of selection on the body fat content of rabbits by means of the TOBEC method on the body composition and slaughter traits of their offspring

G. Milisits, A. Lévai
University of Kaposvár, Faculty of Animal Science, Kaposvár, H-7400 Guba Sándor u. 40., Hungary

ABSTRACT

The aim of this study was to clarify the usefulness of TOBEC method in the selection of body fat content of the rabbits. For this purpose rabbits of average ±1 S.D. live weight at 10 weeks and of average ±1 S.D. daily weight gain between 6 and 10 weeks of age were chosen from the experimental stock of the university, and their fat content was determined with an EM-SCAN SA-3152 type small animal body composition analyser (by means of TOBEC method). Based on the fat content determined, the best and worst 16% of the does and the best and worst 8% of the bucks were chosen and mated with each other (fatty doe with fatty buck and lean doe with lean buck). In the body fat content of the offspring significant differences were observed at 10 weeks of age (9.7 in the fatty and 7.1 in the non-fatty rabbits). Next to the fat content also the liver (3.0 and 2.1%) and other edible organs (2.3 and 1.8%) showed higher values in the offspring of fatty rabbits. In spite of these a higher ratio of the carcass was observed in the non-fatty animals (49.8 and 52.3%, respectively). Due to the higher ratio of the carcass, the protein content of the body was also higher in these rabbits (18.7 and 19.3%). Based on the results, the TOBEC method for the selection of rabbits based on their body fat content seems to be useful.
(Keywords: rabbit, fat, TOBEC, selection, body composition)

INTRODUCTION

The slaughter value and body composition of rabbits could be determined by different methods in practice (*Fekete*, 1992). In the case of growing rabbits, experimental slaughter and chemical analysis are most frequently used. These techniques are very reliable and accurate, but because of the slaughter of the animals they have become an obstacle to the genetic progress. Therefore the development of the non-invasive methods was required to estimate the body composition of the animals alive.

The high technology of the non-invasive methods is represented by computer tomography (CT) and magnetic resonance tomography (MR) nowadays. Both methods were effectively used by the researchers of our faculty to determine the slaughter value (*Szendrő et al.*, 1992, 1994), the body composition (*Romvári*, 1996; *Kövér et al.*, 1998; *Milisits*, 1998) and also the changes in the body composition of rabbits (*Romvári et al.*, 1994; *Milisits*, 1998; *Milisits et al.*, 1999b). These methods are also very reliable and accurate, but because of their high investment and action costs they are not widely prevalent.

The EM-SCAN small animal body composition analyzer (based on the TOBEC method) is much cheeper than the CT or the MR and also its action costs are more favourable. Above all it is a mobile machine, so measures can be taken at the place of the animals without any transferring, which is a possible stress factor of the animals.

The TOBEC (Total Body Electrical Conductivity) method (*Van Loan* and *Mayclin*, 1987), which was developed principally for pediatric research, can be used for the determination of fat-free mass of the body. Based on the former results it seems, that this technique is very accurate (r=0.88-0.99) in determining fat-free mass in living animals (*Cunningham et al*., 1986; *Fiorotto et al*., 1987; *Fekete* and *Brown*, 1993; *Staudinger et al*., 1995), but it can be used only with medium accuracy (r=0.59) to predict the ratio of fat in the body (*Fekete et al*., 1995).

Because this latter is more informative for the practice, several projects have been focused on this topic recently. But the results showed that the fat content of the whole body can be predict only with medium accuracy in the case of newborn (*Milisits et al*., 1999a) and growing rabbits (*Milisits et al*., 2000) and also in the case of rabbit does (*Szendrő et al.*, 1998).

In our experiment we wanted to try if a TOBEC method – in a range of medium accuracy – can be used in a selection program based on the fat content of rabbits or not. The aims of our study were as follows:

- Determination of the body fat content in 10 week old growing rabbits by TOBEC using a formerly developed prediction equation (*Milisits et al*., 2000).
- Execution of a two-way selection based on the estimated fat content.
- Comparison of the slaughter value and body composition of 10 week old rabbits in the next generation.

MATERIALS AND METHODS

The experiment was carried out with Pannon White rabbits, weaned at the age of 6 weeks and housed in a closed building, in groups of 5 or 6 per cage (800x500mm). The animals were kept under artificial lighting conditions (16 hours per day) and at a room temperature of 15-20°C prior to the TOBEC measurement. For the *ad libitum* feeding of the rabbits a commercial pelleted diet (DE 10.30 MJ/kg, crude protein 17.5%, crude fat 3.6%, crude fibre 12.4%) was used. Drinking water was available continuously from self-drinkers.

At 10 weeks of age the animals were weighed and those that represented the average (average±standard deviation) in the live weight and in the daily weight gain between 6 and 10 weeks of age were chosen for the experiment (n=915). Their fat content was determined by an EM-SCAN SA-3152 type small animal body composition analyzer, by the so-called TOBEC method. All of the animals were measured three times and the average of these measures was used for further calculations. The coefficient of variation was under 2% in every case. The fat content of the rabbits was calculated from the values measured using a prediction equation developed formerly (*Milisits et al*., 2000).

Based on the predicted fat contents the extreme 16-16% from the does and the extreme 8-8% from the bucks were chosen for the experiment. Fatty does were inseminated with sperm of fatty bucks and lean does with sperm of lean bucks. For every insemination fresh, attenuated sperm was used.

The fat content of the offspring was measured by TOBEC at birth and at 10 weeks of age. In both group rabbits with an average fat content predicted (average±standard deviation) at 10 weeks of age were slaughtered immediately after the TOBEC measurements (n=17 and n=10, respectively). During the slaughter procedure rabbits were dissected according to *Blasco et al.* (1993). For the chemical analysis of the body composition the whole bodies were cut into pieces and homogenized by grinding them twice. A 100g sample was taken from each of the homogenates and stored at -20°C until use. The dry matter, crude fat, crude protein and crude ash content of the samples was measured according to the Hungarian Standards.

Data were evaluated by one-way ANOVA (LSD test) and discriminant analysis using the SPSS statistical software package (*SPSS for Windows*, 1999).

RESULTS

The basic data of the rabbits chosen for the experiment can be seen in *Table 1*.

Table 1

Basic data of the rabbits chosen for the experiment

Traits	Does				Bucks			
	Fatty (n=63)		Non-fatty (n=57)		Fatty (n=33)		Non fatty (n=36)	
	Average	S. D.	Average	S. D.	Average	S. D.	Average	S. D.
Weight at 10 weeks of age	2280	140	2305	174	2346	191	2277	166
Fat (%)	7.5	1.4	4.2	1.4	8.4	1.3	3.6	1.4

It is well visible that the predicted fat content of the rabbits clearly differs from each other between the two experimental groups. The differences observed between the fatty and non-fatty does and between the fatty and non-fatty bucks are also statistically proved ($P<0.05$).

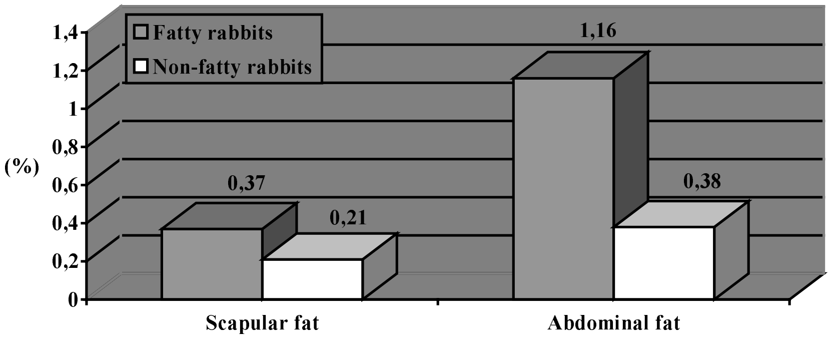
The offspring of the fatty and non-fatty parents showed the same fat content at 1 day of age. The average fat content in both group was 4.1% at that time. Based on this result it seems that the body fat content of the parents do not have a significant effect on the body fat content of the newborn rabbits.

The fat content values, predicted at 10 weeks of age, showed a higher body fat content in the fatty rabbits than in the non-fatty ones. The average predicted fat content was 6.5% in the fatty and 5.3% in the non-fatty rabbits. The difference observed between the groups was also statistically proved ($P<0.001$). The fat content of the fatty rabbits was 22.6% higher than the fat content of the non-fatty rabbits. According to the fat content at 1 day of age fatty rabbits showed 1.6 times, non-fatty rabbits 1.3 times higher fat content at 10 weeks of age.

The scapular and abdominal fat content at slaughter also showed a significant ($P<0.001$) difference between the two experimental groups (*Figure 1*).

Figure 1

Ratio of the scapular and abdominal fat to the liveweight in the offspring of fatty and non-fatty rabbits



The ratio of scapular fat to the live weight was 1.8 times, the ratio of abdominal fat to the live weight 3.1 times higher in the fatty than in the non-fatty rabbits.

The chemical analysis of the whole bodies also showed a higher fat content in the fatty rabbits (9.7±1.9 in the fatty and 7.1±1.6 in the non-fatty rabbits). The difference between the two groups was statistically significant at the level of $P<0.05$.

The success of the selection can also be proved by the result of the discriminant analysis. Based on the chemically analyzed fat content the offspring of the fatty and non-fatty rabbits can be correctly identified by 82% (*Table 2*).

Table 2

Result of the discriminant analysis based on the chemically analyzed fat content

Real groups	**Estimated groups**	
	Fatty rabbits	**Non-fatty rabbits**
Fatty rabbits (n=17)	**76.5%** (13)	23.5% (4)
Non-fatty rabbits (n=10)	10% (1)	**90%** (9)

The identification based on the estimated fat content was also successful, but the accuracy of this grouping was a little bit lower (*Table 3*).

Table 3

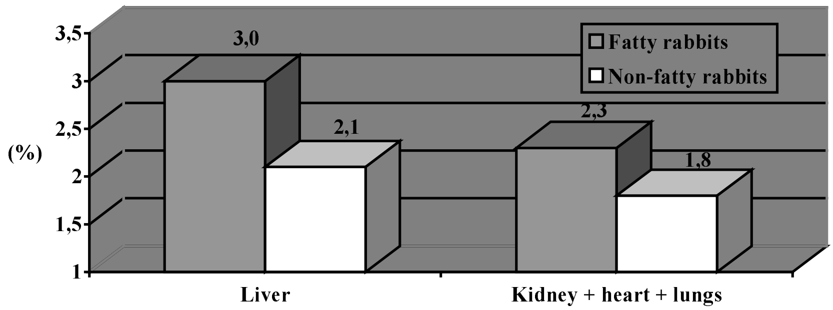
Result of the discriminant analysis based on the estimated fat content

Real groups	**Estimated groups**	
	Fatty rabbits	**Non-fatty rabbits**
Fatty rabbits (n=17)	**70.6%** (12)	29.4% (5)
Non-fatty rabbits (n=10)	20% (2)	**80%** (8)

It was interesting to see that the ratio of the liver to the liveweight also showed a significantly higher value in the offspring of fatty rabbits. Its ratio was about 1.5 times higher in the fatty than in the non-fatty rabbits (*Figure 2*).

Figure 2

Ratio of the liver and other edible organs to the liveweight in the offspring of fatty and non-fatty rabbits at 10 weeks of age



Other edible organs also showed a higher ratio in the fatty rabbits, but the difference between the groups was not statistically significant in this case.

In contrast to the ratio of fat and edible organs the ratio of the carcass to the liveweight was lower in the offspring of fatty rabbits (49.8 and 52.3%, respectively). The difference between the groups was significant at $P<0.05$ level.

Due to the higher ratio of the carcass in the non-fatty rabbits the crude protein content of these animals also showed a higher value (18.7±0.4 in the fatty and 19.3±0.9 in the non-fatty animals). This difference could be proved statistically at $P<0.1$ level.

CONCLUSIONS

Based on these results it seems that the EM-SCAN machine (TOBEC method) is a useful device in the selection of rabbits based on their body fat content. However, it is necessary to mention that these results have been originated from an early stage of a long experiment, so for proving the usefulness of this method and clarifying the correlation between fat content and reproductive traits the continuation of the experiment is necessary.

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Corresponding author:

Gábor Milisits
University of Kaposvár, Faculty of Animal Science
H-7401 Kaposvár, P.O. Box 16., Hungary
Tel.: 36 82 412 091, Fax: 36 82 412 091
e-mail: milisits@mail.atk.u-kaposvar.hu

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Studies on the effect of nitrate selective resin on the water quality and growth rate of common carp (*Cyprinus carpio* L.) reared in recirculating system

T. Koltai, Cs. Hancz, I. Magyary, P. Horn
University of Kaposvár, Faculty of Animal Science, Kaposvár, H-7400 Guba Sándor u. 40., Hungary

ABSTRACT

Intensive rearing of cultured fish species in recirculating systems is growing worldwide due to the limited capacity of outdoor rearing ponds whereas the regulations of environmental protection can be secured. The accumulation of nitrate which is a metabolic product derived from ammonia is one of the most serious problems in closed rearing systems having harmful effects on the growth rate and fecundity of fish. The nitrate level can be decreased traditionally with water exchange or filtering plants. Recently the application of nitrate selective ion exchange resin is spreading as a new technique. The main aim of our experiment was to study the efficiency of this new technique on the growth rate of common carp reared in an experimental recirculating system.
(Keywords: nitrate selective resin, water quality, *Cyprinus carpio*)

INTRODUCTION

Aquaculture is one of the most dynamically growing sectors producing high quality animal protein. While extensive fish-breeding is performed in ponds, the intensive production is done whether in closed recirculating or flow-through systems. In lack of water recirculating systems are becoming more and more widespread as they can be settled anywhere.

Ammonia is one of the most significant metabolic product of fish. It is transformed into nitrite by *Nitrosomonas* bacteria that can be found on the biological filtering surface of recirculating systems, then *Nitrobacters* transform it into nitrate that accumulates in the system because of oxidative conditions (*Van Rijn* and *Rivera*, 1990). As the final product of the oxidisation of ammonia, nitrate can reach outstanding concentrations in nitrifying recirculating systems (*Van Rijn*, 1996). The highest concentrations measured exceeded 400-500 mg/l NO_3-N (*Otte* and *Rosenthal*, 1979; *Honda et al.*, 1993). The measured maximum values vary by system and indicate the necessity of water exchange and denitrifying activity. The process of denitrification is fulfilled by facultative anaerobe bacteria, which in lack of oxygen and in the presence of organic matters, as final electron acceptors, are able to utilise nitrate, nitrite, dinitrogen oxide and nitrogen monoxide and transform them into a final product, N_2 (*Payne*, 1973). Although most recirculating systems are aerobe, these organisms usually develop in the zone of organic sediment. It is the same in the filter of all nitrifying systems (*Dalsgaard* and *Revsbech*, 1992; *Watanabe et al.*, 1992), and also in other aquaculture facilities (*Kawai et al.*, 1964; *Hirayama*, 1974; *Bullock et al.*, 1994).

The undesirable ammonia, nitrite and nitrate, in a small amount are not toxic to aquatic organisms. However their high concentration with low buffer capacity and low pH is toxic in aquatic cultures. For instance, it is dangerous to the respiration of octopuses (*Hirayama*, 1966) and in fresh water to some species of ornamental fish (*Yirshkovich*, 1994 cit. *Van Rijn*, 1996) where it hinders the development of eggs. The nitrate content should always be controlled because of its toxic effect. After getting into the body of fish, nitrate leads to the formation of the so-called "methaemoglobinemia" as a result of the interactions with haemoglobin. This may end in death by suffocation in case of high concentration (*Helder* and *Vries*, 1983; *Alleman*, 1985).

According to our current knowledge, the removal of nitrate from closed fish breeding facilities could be accomplished either by partial water exchange or by plants if not an anaerobe denitrifying unit is installed. The local removal of nitrate would be a great possibility for reducing high nitrate content. In connection with this, the effectiveness of micro-organisms that reduce nitrite and nitrate - including denitrifiers- has been examined recently (*Betlach* and *Tiedje*, 1981; *Wilderer et al.,* 1987). There is a high nitrite content in intensive fish breeding systems because of the low oxygen content of water. As a consequence, nitrification is unfinished, what is more, denitrification and the transformation of organic matters are also hindered (*Van Rijn* and *Rivera*, 1990; *Van Rijn* and *Sich*, 1992).

Due to considerations on environmental and sanitary matters, the ministries of the environment have made strict rules in most countries for the permissible nitrate content of effluent water, which can not be over 11.6 mg/l according to the EU standard. As we are informed nobody has tried to remove nitrate from fish breeding systems by using nitrate selective ion exchange resin until now, however this method could easily become the most profitable and modern one despite the higher initial investment.

The aim of our experiment was to study the efficiency of this new technique on the growth rate of common carp reared in an experimental recirculating system.

MATERIALS AND METHODS

The experiment was carried out in the Fish Laboratory of the Faculty of Animal Science of the Kaposvár University between January 8 and March 19 in 2001. The experimental stock was one-year-old mirror carp. The experiment lasted for 10 weeks preceded by a conditioning period of 11 days. (The conditioning could be so short because the fish were reared in the laboratory from the autumn harvest and were already adapted to the artificial keeping conditions.)

Fish were stocked in four 150 l plastic troughs, 20 individuals in each. Total initial fish biomass/trough varied between 2.26 and 2.42 kg, consequently the stocking density was 15.71±0.44 g/l at the beginning of the experiment. Fish were weighed individually in the beginning and at the end of the experiment. Fish keeping troughs worked in a recirculating system where water was supplied from a tank by gravity and the effluent water of troughs was pumped back to the tank of supply after flowing through biofiltering unit. The total volume of the system was 850 l. The average water flow was measured as 1.5 l/minute that corresponds to a change of 14.4 times/day in the troughs.

In the first 42 days period of the experiment 2 kg nitrate selective resin was placed in the tank of water supply. This type of resin is generally used for nitrate removal from drinking water. The resin was packed in a textile bag that was fixed under the water inlet. At the beginning of the second period, that was considered as control, the resin was removed from the system and the total water volume was changed to tap water. This period lasted only for 14 days and was terminated because of the drastic deterioration of the water quality. (In terms of fish biomass the final weight of the first period is the beginning weight of the second one.)

Main nitrogen forms (ammonium, nitrate and nitrite) were determined by photometer (Viscolor PF-10), pH was measured by HANNA Watercheck and dissolved oxygen by spectrophotometer (HI-93732N) from samples taken weekly from every trough. Water temperature changed between 19.5 and 21.0°C during the experiment.

Fish were fed ad libitum by floating carp feed fabricated by the Feed-Full Co., Hernád, Hungary. Nutrient content of the feed is given in *Table 1.*

Table 1

Chemical composition of the feed used in the experiment (%)

Dry matter	Raw protein	Raw fat	Raw fibre	Raw ash	N-free extract*
86.5	30.1	5.2	1.6	5,6	44.0

**Calculated value*

Statistical data analyses were carried out by SPSS for Windows 7.5 (1996). Means of the nitrate and oxygen level at the 7^{th} and 14^{th} day of resin treated and control period were compared by Student's t-test. The same means within periods were compared by the Student-Newman-Keuls test in one-way ANOVA.

RESULTS AND DISCUSSION

Stocking density has increased from the initial 15.71±0.44 to 20.82±0.93 g/l for the 42^{nd} day of the experiment and this value changed for 21.79±1.13 g/l at the end of the second period. The specific growth rate of fish (S.G.R.) showed an average of 0.67±0.007%/day in the first period when nitrate removal by resin was applied. This value decreased to 0.32±0.263%/day in the final 14 days when the system worked without nitrate removal. The increased standard deviation clearly indicates deteriorating keeping conditions.

Feed conversion showed the excellent 1.32±0.17 value in the first period while this trait could not be evaluated for the second period because of the extremely high values observed in two troughs due to the near zero growth.

Changes in the nitrate level during the first and second period can be followed in *Figure 1* and *2*. There is a significant growth of nitrate in the first three weeks in the resin treatment period but even the highest concentration measured (132.5 mg/l) is much less than values reported by *Otte* and *Rosenthal*, 1979 and *Honda et al.*, 1993 for similar recirculating systems. It is remarkable that nitrate remained in the same range in the second half of the first period while nitrite and ammonium were below the level of measurability. Nitrate concentration has reached to 135 mg/l at the end of the second (control) period while parallel to it nitrite was 0.43 mg/l and ammonia 0.1 mg/l. These metabolite levels proved to be intolerable for common carp causing mortality and therefore the experiment was terminated. Evidently nitrate changing capacity of the resin came to its end for this time at the given proportions (2 kg:850 l:12.5 kg of resin:water:fish biomass).

The first rearing period had to be terminated because of the drastic fall of dissolved oxygen occurring at the end of the period. Oxygen showed quite elevated levels until that time as it can be seen in *Figure 3* and *4.* Dissolved oxygen content dropped to 1.45 mg/l for the end of the second, "without resin" control period that also has contributed to the final deterioration of the rearing conditions.

Figure 1

Change of nitrate concentration during the resin treated period (means with standard deviations)

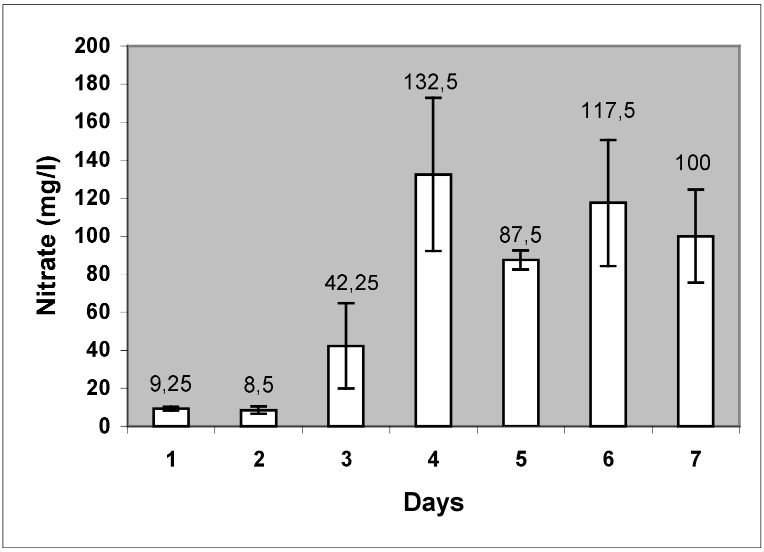


Figure 2

Change of nitrate concentration during the control period (means with standard deviations)

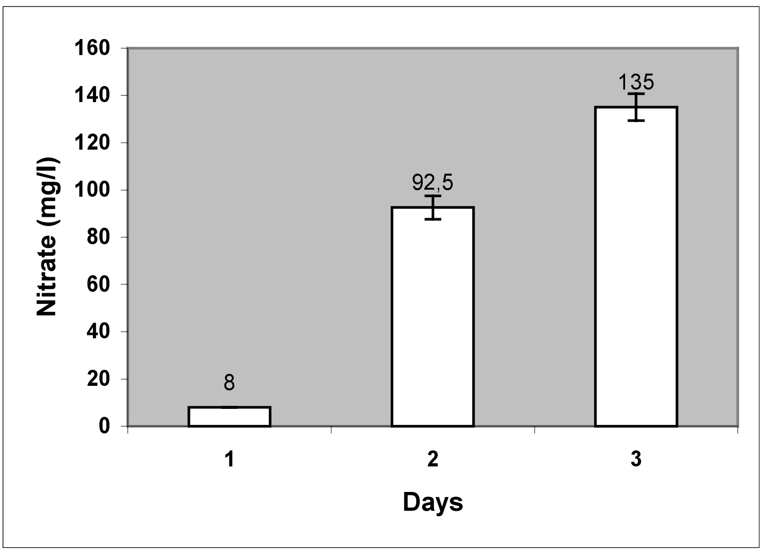


Figure 3

Change of dissolved oxygen during the resin treated period (means with standard deviations)

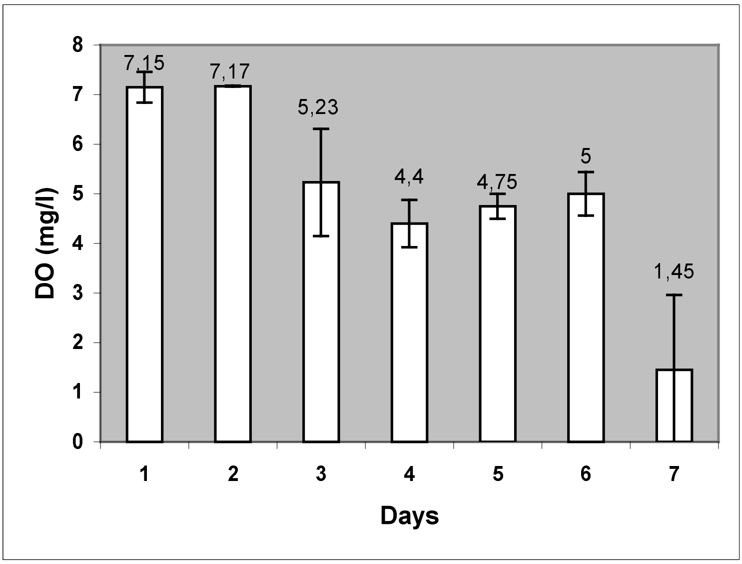
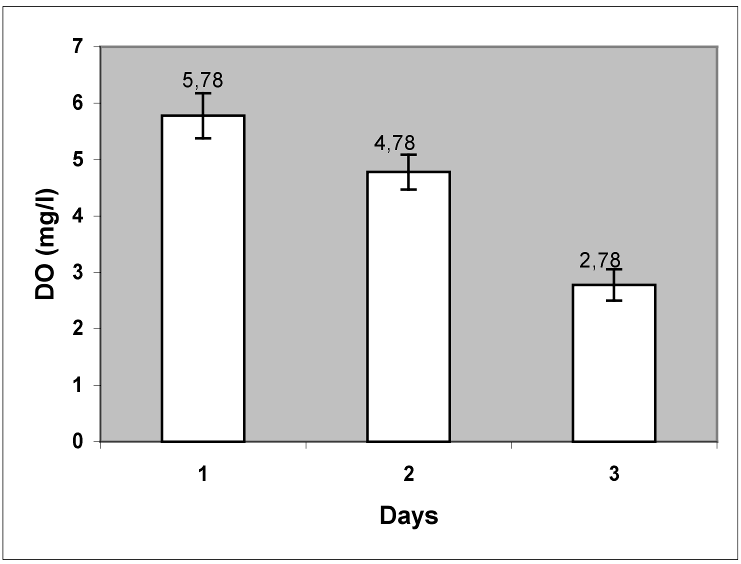


Figure 4

Change of dissolved oxygen during the control period (means with standard deviations)



CONCLUSIONS

It was proved that nitrate changing resin, normally used for drinking water treatment, can be utilised in closed recirculating fish rearing systems. 3.1 kg total gain of common carp was achieved in an 850 l rearing facility with 2 kg of resin applied in 6 weeks of rearing. However the initial investment of this method is relatively high it can be profitable especially considering the fact that this resin is easily renewable with common salt solution and can be used in several successive periods.

Further investigations are needed to determine the necessary rearing parameters for other, more sensitive fish species, but the use of nitrate selective resin seems to be promising especially in experimental recirculation systems for fish rearing, hatcheries or ornamental fish production.

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Corresponding author:

Csaba Hancz
University of Kaposvár, Faculty of Animal Science
H-7401 Kaposvár, P.O.Box 16., Hungary
Tel.: 36 82 314 155, Fax: 36 82 320 175
e-mail: hancz@mail.atk.u-kaposvar.hu

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Observations on the behaviour of pond pre-reared pike-perch under intensive rearing conditions

T. Molnár, Cs. Hancz, M. Molnár
University of Kaposvár, Faculty of Animal Science, Kaposvár, H-7400 Guba Sándor u. 40., Hungary

ABSTRACT

Authors summarized the results of the ethological observations carried out on pike-perch fingerlings between 1999 and 2001. Some elements of intensive rearing techniques developed in catfish and trout culture can be applied for pike-perch with good efficiency, however important differences should be considered. The aim of our investigations was to determine the feeding habit of pike-perch fingerlings in the period of transition from zooplankton to lifeless feed, because this knowledge is essential for the elaboration of the intensive technique. It can be concluded that two rearing parameters (stocking density and different feed) have significant influence on the feeding behaviour that, on the other hand, is an important factor in survival rate and occurrence of cannibalism.
(Keywords: pike-perch, behaviour, intensive rearing, stocking density)

Corresponding author:

Tamás Molnár
University of Kaposvár, Faculty of Animal Science
Department of Fish and Pet Animal Breeding
H-7401 Kaposvár, P.O.Box 16., Hungary
Tel.: 36 82 314 155, Fax: 36 82 320 175
e-mail: molnart@mail.atk.u-kaposvar. hu

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

The effects of the domestication on the behaviour of goose under intensive conditions

M. Molnár, F. Bogenfürst, T. Molnár, A. Almási
University of Kaposvár, Faculty of Animal Science, Department of Poultry Production
Kaposvár, H-7400 Guba Sándor u. 40., Hungary

ABSTRACT

In the intensive rearing techniques of goose the adequate keeping conditions needed for continuous production are provided independently of seasons. It is a totally new technology about which very small amount of information has been collected till now. The needs of geese under intensive conditions are almost unknown, so it is important to examine their behavior in the offered circumstances. Based on the these results factors of the rearing technology can be elaborated according to the characteristics of the species and the production, parallel to the well-being of the animals can be improved. Nowadays, when the rules of animal welfare tend to become more and more strict, importance of studies like this is evident.In our study the behavior of 8 Szentes Big White and 8 wild geese were compared to examine the effect of domestication. Based on our results it can be declared that the wild goose is more active in the rearing period than the domesticated form. It manifests in a higher ratio of the preening and playing, but the frequency of the feeding and drinking was also higher. The explanation of this phenomenon in case of feeding can be the stronger need for search of food, while the differences in the preening can be rooted in the inability of flying of the domesticated form. The social behaviour had a lower level by the domesticated goose because the domestication has a reducing effect on the aggression.
(Keywords: domestication, goose, intensive conditions)

Corresponding author:

Marcell Molnár
University of Kaposvár, Faculty of Animal Science
Department of Poultry Production
H-7401 Kaposvár, P.O.Box 16., Hungary
Tel.: 36 82 314 155, Fax: 36 82 320 175
e-mail: molnarm@mail.atk.u-kaposvar.hu

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Preliminary study on spermatological characteristics of frizzled Hungarian ganders

A. Almási, Á. [1]Varga, J. [1]Barna, F. Bogenfürst, M. Molnár
University of Kaposvár, Faculty of Animal Science, Kaposvár, H-7400 Guba Sándor u. 40., Hungary
[1]Institute for Small Animal Research, Gödöllő, H-2103 P.O.Box 417., Hungary

ABSTRACT

One of the most significant results in the poultry breeding researches of the 20th century was the elaboration of the technique of artificial insemination. By its help higher fertility rate and reduced reproduction problems can be reached in the different poultry species.Although, the low fecundity rate (62-63%), the susceptibility to monogamy, asynchronism of the sexual activity in the two sexes, the hygienic problems (phallus-disease, infection during mating) and the seasonality indicate the need of the routinely application of the artificial insemination in the goose breeding, in the practice it is achieved only ad hoc.Contrary to the generally used farm types with the frizzled goose there were no examinations focused on the parameters of male reproduction. The aim of our investigations was to determine the quantitative and qualitative parameters of frizzled gander semen (average volume, concentration, motility, morphology, frequency of abnormalities, viable: dead cell ratio) ensuring a basis for the long and short term storage of gander semen and the ex situ gene conservation.
(Keywords: spermatological characteristics, frizzled Hungarian ganders)

INTRODUCTION

The origin of the Hungarian goose is dated back to the Roman era, when domestication of the greylag goose (*Anser anser*) took place in the Carpathian basin. During the centuries the breed became well adapted to the special conditions and farming systems of the country. Its feather colours vary from white to greyish or spotted, and it is characterized by good fatty liver, meat and feather quality. Frizzled Hungarian goose is a unique variety of old Hungarian goose, which is considered now as a typical poultry breed for Hungary.

A new gene conservation programme of this breed has been started recently by the Institute for Small Animal Research (ISR, Gödöllő), where a growing population of white, greyish and spotted individuals – collected from Transylvanian villages – are maintained *(Szalay*, 2002*).*

In behaviour, production and reproduction parameters this hardy, resistant breed is genetically close to its ancient form (low egg production, strong seasonality, short reproductive cycle, poor sexual dimorphism). As a part of *ex situ* gene conservation programme the need of sperm cryoconservation of this breed has raised. As a first step the monitoring of suitability for artificial sperm collection, of the characteristic signs of the phallus and of the sperm parameters was carried out in Gödöllő, in the spring sexual cycle of this year.

MATERIALS AND METHODS

Birds and husbandry

14 two-year-old frizzled Hungarian ganders selected from 52 free ranged individuals from the poultry gene bank stock of ISR were used for the investigations. The birds involved in the study were housed individually in 2 m^2 individual cages under an artificial lighting programme of 10L/14D at the beginning of March, which was increased to 12L/12D to the end of the month. They were fed *ad libitum* by a commercial food for breeding geese (17% crude protein, 12 MJ/kg metabolisable energy). The selection and training were carried out from the middle of February to the beginning of March according to the following points of view: good health, steady temper, appropriate size of phallus (at least 50-55 mm), good and quick (10-15 sec) reaction ability for massage technique. During the experimental period the caged males had visual and sound contact with females.

Semen preparation and evaluation

Samples of semen were collected once a week by dorsal-abdominal massage by the same two persons into a single layer glass artificial vagina. In order to get clean ejaculates food was removed from the cages one day before sperm collection. Evaluation of samples was done at room temperature in the laboratory of ISR. The qualification of the semen was carried out macroscopically (volume, colour, consistency, uric, faecal or blood contamination) and microscopically (motility, concentration, morphology of spermatozoa, ratio of live/dead sperm).

The motility of spermatozoa was scored subjectively by the same operator under x 250 magnification from 0 to 3, where 0=immotile spermatozoa; 1=5-30%; 2=35-70%; 3>75% motile spermatozoa. From time to time the motility was checked objectively by a version of computer aided sperm analyser (CASPAR, Picktron Ltd. Hungary) as well. The evaluation of concentration was carried out by the use of a special chamber developed for sperm counting (Makler counting chamber, Sefi-Medical Instruments, Israel). For determine the morphological abnormalities and the ratios of live/ dead spermatozoa smears were stained by anilin-eosine and examined under oil immersion objective (×1250 magnification). The proportions of abnormal spermatozoa were assessed subjectively out of at least 200 cells.

RESULTS AND DISCUSSION

According to *Kisné* and *Hargitai* (1995) usually 50-60% of Hungarian ganders are suitable for semen collection, however, in this case only 30% of frizzled Hungarian males gave good response to massage. The handling of the ganders was not easy due to their wilder temper.

The lengths of the phalluses are 40-50 mm during the reproductive cycle and 25-35 mm out of this period, which is shorter by 1-2 cm than that of the meat type breeds *(Csuka* and *Ledec,* 1984*)*.

During the mentioned two months altogether 40 semen samples were collected, from which 28 ejaculates were appreciable for assessment. Some samples were contaminated by faces and/or urates; the volumes of others were too small for the assessment. Two ganders did not produce any sperm during the cycle. The various sperm parameters can be seen in *Table 1* and *2*.

Table 1

Mean values of semen of frizzled Hungarian ganders

Ganders	Volume (µl)	Motility (scores 0-3)	Concentration (10^6sp/ µl)	Ratio of live/dead sp (%)
1	130	3, 3	1.665	84/16
2	344	3, 2, 1	0.996	89/11
3	412	2	1.14	93/7
4	125	2	0.98	-
5	-	1	-	-
6	300	3, 3, 3	0.565	76/24
7	250	3, 3, 3	1.05	93/7
8	210	3, 3, 1, 1	1.375	84/16
9	133	1, 0	0.26	-
10	300	3, 1	-	-
11	-	-	-	-
12	293	2, 2, 2	0.811	86/14
13	261	2, 1	0.425	75/25
14	120	1	0.7	-
Mean value	***258***	***2.071***	***0.900***	***84/16***
Extreme values	80-700	0 - 3	0.26 – 2.25	93/7 % – 70/30

Table 2

Ratios of the various morphological abnormalities in the frizzled Hungarian gander semen (%)

Gander	Micro-head	Big nuclei	Bulb head	Broken head	Other head anomaly	Acrosome anomaly	Swollen mid-piece	Crooked neck	Double tail	Broken tail	Bended tail
1	0.5	11	15	4	2	8.5	1	7.5	0	1	0
2	0	9.3	5.5	3.3	2.5	11.3	1.2	5	0	1.7	1.5
3	0	8	7.5	3	4	13.5	2.5	9	0	1.5	2
6	0	7	3.5	3.2	4	10.7	0.2	5.4	0	2	1
7	0	11	3	1	0	15	0	1	Non examined		
8	0	5	6	4	4	4.7	0.7	8.5	0	1.2	2
12	0.5	3.2	1.5	2.25	1.2	19.7	0.2	0.7	0	0.7	0.7
13	1	2.5	5.5	1	1	6.5	2.5	3	0	0.5	1.5
Mean value	***0.2***	***7***	***5.3***	***3***	***2.5***	***11.4***	***0.9***	***5***	***0***	***1.3***	***1.3***

The main value of semen volume of frizzled Hungarian ganders was at the lowest level of the average range compared to the different breeds**:** White Italian: 160-230 µl (*Lukaszewicz*, 2001), Kubanskaya: 400-1300 µl (*Kurbatov*, 1976), Landes: 300 µl (*Sellier et al.*, 1995) and 720 µl (*Nickolova* and *Guerzilov*, 2000), Benkowsky White: 660 µl (*Nickolova* and *Guerzilov*, 2000).

There are not many data about gander sperm motility but the spermatozoa of frizzled ganders showed poorer motility than that of White Italian ganders, which produced 60-70% positive movement (*Lukaszewicz*, 2001).

Regarding to the concentration there were extreme deviations among the values (0.26-2.25x10^6/µl) however the mean value was similar to be find in others breeds:

White Italian: 0.320-0.980x10^6/µl (*Lukaszewicz*, 2001), Landes: 0.500x10^6/µl (*Sellier et al.*, 1995) and 0.268x10^6/µl (*Nickolova* and *Guerzilov*, 2000), Benkowsky White: 0.300x10^6/µl (*Nickolova* and *Guerzilov*, 2000).

The ratio of live/dead spermatozoa shows an acceptable value with 84% live cells though *Lukaszewicz* (2001) found better ratio in White Italian gander semen: 93/7.

The ratio of morphologically abnormal spermatozoa was around 37%, which is lower than that of White Italian semen with around 50% *(Lukaszewicz,* 2001*)*. The most frequent anomalies are the different types of acrosome aberrations (11.4%) and – interestingly – the big nuclei spermatozoa (2.5-11%). This anomaly was shown to be frequent (10-40%) in Houbara bustard semen *(Lindsay et al.,* 1999*)* and in guinea fowl semen (*Barna,* personal communication) and these spermatozoa are presumed as diploid cells.

The ratio of bulb heads - as immature forms - is high as well despite that the sperm collections were not too frequent (once a week).

As a conclusion, artificial sperm collection is difficult from this breed, the reproductive season is too short to get many semen samples and the sperm quality is a bit poorer than the average of commercial breeds. In spite of these difficulties the need of sperm freezing of this species justifies the resumption of such investigations.

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Corresponding author:

Anita Almási
University of Kaposvár, Faculty of Animal Science
H-7401 Kaposvár P.O.Box 16., Hungary
Tel.: 36 82 314 155, Fax: 36 82 320 175
e-mail: alan0906@hallgato.atk.u-kaposvar.hu

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Effect of dietary fumonisin B_1 on certain immune parameters of weaned pigs

G. Tornyos, M. Kovács, M. [1]Rusvai, P. Horn, F. Kovács
University of Kaposvár, Faculty of Animal Science, Kaposvár, H-7400 Guba Sándor u. 40., Hungary
[1]Szent István University, Faculty of Veterinary Science, Budapest, H-1078 István u. 2., Hungary

ABSTRACT

There are only a few data available on the effect of fumonisins on immune response. The aim of the present study was to examine whether dietary fumonisin B_1 (FB_1) has any effect on the humoral and cellular immune response in weaned pigs, depending on dose and time of toxin exposure. Twenty weaned pigs of approximately 12-14 kg body weight were used. In the 1st experiment the piglets were divided into four groups (n=5). In the 2nd experiment two groups (experimental group, n=14 and controls, n=6) were formed. Fusarium moniliforme fungal culture containing a known amount of FB_1 was added to the experimental animals' diet to ensure FB_1 intake of 1, 5 and 10 ppm (1st exp.), or 100 mg per animal per day (2nd exp.) In order to determeine immune response animals were vaccinated against Aujeszky disease with inactivated vaccine (Aujespig K). Specific and non specific in vitro cellular immune response was measured by the lymphocyte stimulation test (LST). In order to investigate non specific cellular immune responsiveness, blastogenic transformation of lymphocytes was induced by PHA-P, ConA and LPS. Specific cellular immune response was induced by the inactivated suspension of the Aujeszky virus. Humoral imune reponse, e.g. specific antibody titre was measured by virus neutralisation test. None of the immunological parameters examined showed significant differences between groups. It could be concluded, that fumonisin B_1 had no significant effect on the humoral and cellular specific and non specific immune response when fed in high dose (100 mg/animal/day for 8 days), or in low concentration even for a longer period (1, 5 and 10 ppm for 3-4 months).
(Keywords: fumonisin B_1, immune response, lymphocyte stimulation test, pig)

Corresponding author:

Gábor Tornyos
University of Kaposvár, Faculty of Animal Science
H-7401 Kaposvár, P.O.Box 16., Hungary
Tel.: 36 82 314 155, Fax: 36 82 320 175
e-mail: tornyos@mail.atk.u-kaposvar.hu

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Objects as habitats of various pathogens in the hunting-ground

Z. Tucak, M. [1]Periškić, M. [1]Krznarić, T. Florijančić, M. [2]Grubešić, I. Bošković

University of Josip Juraj Strossmayer in Osijek, Faculty of Agriculture in Osijek, Osijek HR-31000 Trg Svetog Trojstva 3., Croatia
[1]Croatian Veterinary Institute, Veterinary Department in Vinkovci, Vinkovci HR-32000 J. Kozarca 24., Croatia
[2]University of Zagreb, Faculty of Forestry, Department of Hunting and Forest Protection, Zagreb HR-10000 Svetošimunska 25., Croatia

ABSTRACT

Continuous monitoring in 2001 and 2002, of the microflora abundance at several objects, vehicles, trees and water bodies in the hunting-ground Mačkovac, indicated the presence of several micro-organisms during the whole time period. Thus the infections in wild-game populations is made possible by this pathogens. Disinfecting measures concerning the exclusion of the infection are required in the maintenance of the zoohygienic conditions in the hunting-ground.
(Keywords: hunting-ground, micro-organism, animal hygiene)

INTRODUCTION

For a long period of time a large interest is assigned into maintenance of the zoohygienic conditions in the hunting-grounds, with primary purpose disposing the carcasses and decreasing the spreading of the various disease vectors (*Brudnjak*, 1989a; *Cvetnić*, 2002; *Kalenić*, 1995; *Tucak at al.*, 1989; 2000). The aim of this work was to determine which objects, vehicles and things, present and utilised in the habitat of the hunting-ground, hosts micro-organisms that possess pathogenic characteristics, and to compare seasonal variation in their distribution in the course of the year.

MATERIALS AND METHODS

Study area was the hunting-ground Mačkovac (Djakovo, Croatia). Standardised sampling methods by swab-stick from various objects, things, tractor wheels and surface of the water bodies, and culturing the micro-organisms at agar plates have been used (*Brudnjak*, 1989b; *Kalenić* and *Mlinarić-Galinović*, 1997). Analyses were carried out at the Veterinary Institute in Vinkovci. The following micro-organisms have been studied: *Bacillus sp, Streptococcus sp., Coliformic bacteria, Escherichia colli, Proteus sp., Yeasts and Molds,* in all four seasons.

Swab samples was collected from the following objects in the hunting-ground:

- pine tree (*Pinus sylvestris*), serving as animal scratching point
- beech tree (*Fagus sylvatica*), serving as animal scratching point
- tractor wheels
- mud-pool 1, situated within the forest
- feeding place for piglets
- mud-pool 2, situated near the food warehouse

RESULTS AND DISCUSSION

The bacteriological and mycological investigations from the numerous sampled swabs resulted in the isolation and determination of the micro-flora composition (*Table 1*).

Table 1

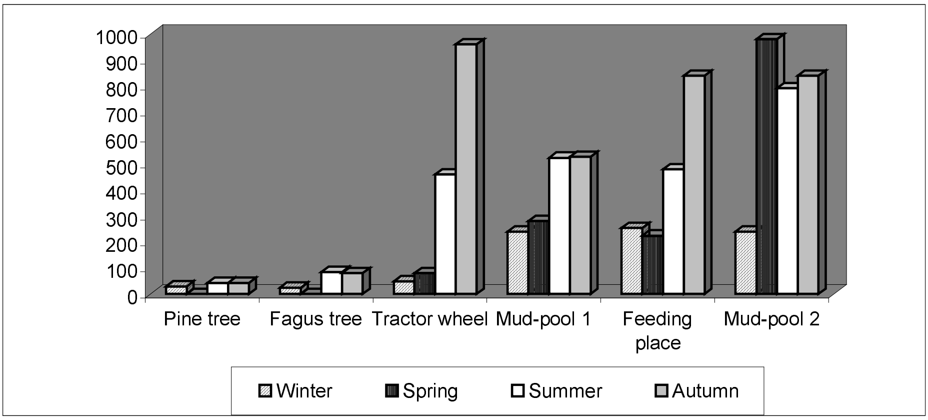
Composition and seasonal distribution of the micro-organisms in the hunting-ground

Swab sample		Pine tree	Fagus tree	Tractor wheel	Mud-pool 1	Feeding place	Mud-pool 2
Number of bacteria in sample	W	28	24	48	240	254	240
	SP	0	0	80	280	224	98
	S	42	84	460	524	480	792
	A	42	80	960	528	840	840
Bacillus sp.	W	+	+	+	+	+	+
	SP	-	-	-	+	-	+
	S	+	+	+	+	-	+
	A	+	+	+	+	+	+
Streptococcus sp.	W	+	-	-	+	-	+
	SP	-	-	-	-	-	+
	S	+	-	-	-	+	+
	A	-	-	-	-	+	-
Coliformic bacteria	W	-	-	-	+	+	+
	SP	-	-	+	+	+	+
	S	+	+	+	+	+	+
	A	+	+	-	+	+	+
E. colli	W	-	-	-	-	-	-
	SP	-	-	+	-	-	+
	S	-	+	-	-	-	+
	A	-	-	-	-	-	-
Proteus sp.	W	-	-	-	-	-	-
	SP	-	-	+	+	+	-
	S	0	+	+	+	+	+
	A	-	-	+	+	+	-
Yeasts	W	-	-	-	+	-	+
	SP	-	-	-	+	+	-
	S	+	+	+	+	+	+
	A	+	-	+	+	+	-
Molds	W	+	+	+	+	+	+
	SP	-	-	+	-	+	+
	S	+	+	+	+	+	+
	A	+	+	+	+	+	+

Seasonal dynamics of total number of bacteria is shown in *Figure 1*.

Figure 1

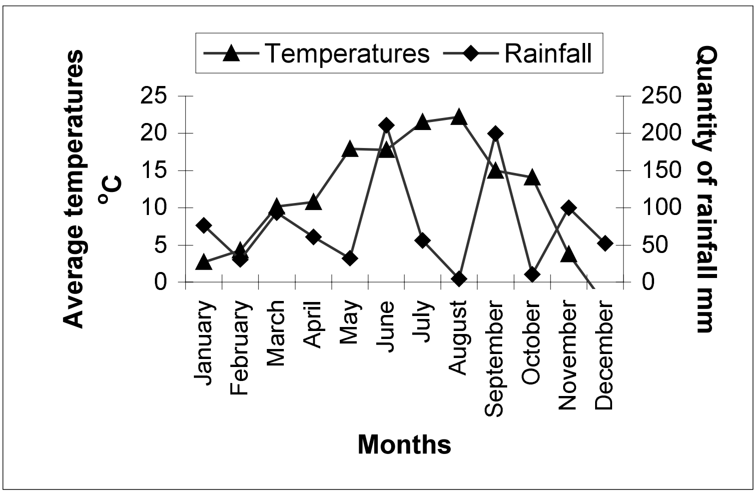
Seasonal dynamics of total number of bacteria



Seasonal dynamics of average monthly temperatures and precipitation in hunting-ground Mačkovac, during the study period, is shown in *Figure 2*.

Figure 2

Seasonal dynamics of average temperatures and rainfalls



In the winter period the presence of micro-organisms is low at all habitats, which is explained by unfavourable living conditions (low monthly temperatures and cold).

In the spring, after the snow-melting and with rising of temperature the activity of micro-organisms is high at mud-pools, where the wild-game is gathering for the feeding.

The period with maximum monthly rainfalls in early summer and start of autumn, coincidence to the highest total number of micro-organisms. This is also a period of full grown plant cover and enlarging of the animal populations (*Tucak at al.*, 2001).

High summer temperatures strongly increase reproduction of micro-organisms at all habitats

The results indicates that previously neglected objects and things (tractor wheels, trees with tracks of animal scratching), have a significant role in the assessment of the epyzootiological situation in the hunting-ground (*Cvetnić*, 1997; *Davis* and *Anderson*, 1971; *Kostović-Knežević*, 1996). The most important factor disturbing the animal hygienic conditions is illness of wild-game which constituted a large input of pathogenic micro-organisms through the excretion (*Kotrla*, 1984; *Tucak* and *Bukvić*, 1980; *Tucak at al.*, 2000). Many artificial objects serving as feeding places and warehouses are built in the hunting-ground. It is known that surface of this objects accommodates numerous micro-organisms, many of them are pathogenic and harmful for the wild-game. So it can be said for the wheels of tractor and restricted shallow mud-pools. Various animal species living in the ecosystems of the hunting-ground eliminates parasites and other micro-organisms from their bodies by scratching on the tree trunks. The result is accumulation of the large quantity of different pathogens into crevices or scratching tracks created on the tree trunks.

CONCLUSIONS

During the 2001 and 2002, a seasonal distribution of micro-flora in summer, autumn, winter and spring has been monitoring. The presence of various micro-organisms at objects, things and water-bodies in the habitats of the hunting-ground is recorded. Total number of micro-organisms was under the parameters defining infectious dosages, so zoohygienic condition in the hunting-ground was undisturbed and spreading of disease was not possible. It is obvious that seasonal dynamics influence on the composition and quantity of the microbial populations.

The results of our study recommends disinfecting procedure at the micro-organisms habitats for the purpose of the animal hygienic improvement in the hunting-ground.

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Corresponding author:

Zvonimir Tucak
University of Josip Juraj Strossmayer in Osijek, Faculty of Agriculture
HR-31000 Osijek, Trg Svetog Trojstva 3., Croatia
Tel.: 385 31 224 200, Fax: 385 31 207 017

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Trichinellosis as an ecological problem in the Republic of Croatia

T. Florijančić, D. Rimac, B. Antunović
University of J.J. Strossmayer, Faculty of Agriculture, Osijek, HR-31000 Trg Svetog Trojstva 3., Croatia

ABSTRACT

Trichinellosis is considered to be a dangerous invasive zoonosis that has become the most serious public health threatening problem within invasive diseases in the last decade. The most frequent source of invasion for people is consuming of insufficiently boiled or baked and non-properly dried pork containing Trichinella spp. Monitoring of epidemiological and epizootiological situation in Croatia has shown the biggest prevalence of the disease in the areas of east Slavonija, which are marked as endemic regions. East Slavonija is well known for its traditional way of breeding and slaughtering swine, as well as for its specific processing of meet products. This way of keeping swine enables contacts with silvatic reservoirs of trichinellosis and, on the other side, gives possibility of invading wild animals by eating carrions from trichinellotic domestic swine. Rats and other sinantropic rodents, as well as non-caring out the systematic deratisation and inappropriate removing of pork with Trichinella spp. are of big importance in spreading and conveying this disease. Our primary aim in this paper was to point out the problems concerning this disease from ecological view, especially in cases when the regulations about its eradication have been carried out, as well as to provide statistical analysis of its prevalence in the endemic areas of east Slavonija.
(Keywords: trichinelosis, swine, game, zoonosis, ecology)

INTRODUCTION

According to *Pozio* (1995), *Murrell* and *Pozio* (2000), the prevalence of people fallen ill from trichinellosis in the World has significantly increased in the last ten years. The authors find the reasons for this trend in human manipulations with eco-system, wars, political problems of developing countries and rapid changes in food distribution and market system.

In the Republic of Croatia, number of sick people increased during the Homeland War (1991-1995), and even more in the years of reintegration of territorial entirety (1996-1999) (*Gašpar* and *Marinculić,* 2000; *Rimac et al*., 2001a). The greatest number of people were infected by consuming trichinellotic pork from domestic boar, while lower number were infected by consuming insufficiently termicaly processed meat from shoot wild swine, badger or bear (*Beus,* 1999). Due of the highest prevalence of people fallen ill in east Slavonija, especially in Vukovarsko-srijemska county, this area was marked as endemic region for trichinellosis in Croatia. Game was found to play significant role in epizootiology of this disease because of the parasites' constant presence within them (*Tucak et al*., 2000; *Kovač et al*., 2001; *Vučemilo et al*., 2001). This situation has resulted with issuing sub-legislative regulations, which determine particular measures for eradication and prophylaxis of the disease. Primary, this refers to obligatory trichinelloscopic inspection of meat originated from slaughtering for household purposes. In the cases of positive findings, all the swine from infected yard were compulsory slaughtered and their carrions were removed in a proper way. Due to the fact rodents, and especially rats, are found to be the most important reservoirs and vectors in conveying this disease, providing of systematic deratisation in endemic region is obligatory. Inadequate veterinary-sanitary supervision, non-existing of systematic deratisation, sanitary disorder, unsolved question of trash deposits and removing of carrions, confiscates and waste animal matter for sure have participated in spreading of the disease, as well as presented serious ecological problem in the war and post-war periods. It was postulated that these problems gradually have to be solved.

In the aim to check the efficiency of mentioned measures for eradication and prophylaxis of the disease, we have analyzed frequency of positive findings from inspected samples of meat brought for examination to the veterinarian surgeries in Vukovarsko-srijemska county in the last three years (1999-2001).

MATERIALS AND METHODS

Examinations were carried out by the classic method of trichinelloscopy with registering the number of positive samples for the parasites from genus *Trichinella* in the total number of examined samples of meat. The places of examinations were the veterinary organizations in the area of Vukovarsko-srijemska county during 1999, 2000 and 2001. According to the aims of the investigation, all the pork samples were separated in few statistical groups. The yearly data were separated by months and 11 surgeries.

General descriptive statistical methods were used for the data analysis, while ANOVA was used for determining statistically significant differences in relative number of positive pork samples by months and years.

Data were analyzed by the meanings of statistical computer program SPSS 10.0.

RESULTS AND DISCUSSION

In three mentioned years, the total number of 543.911 pork samples were inspected, from which 4.831 were found to be positive (0.89%), which is presented in *Table 1*. It is obvious from *Figure 1* that number of inspected and positive swine had decreasing trend during the examination period of three years.

Table 1

Number of inspected and positive swine and relative share of positive samples in examined population during the monitored period

Year	Examined	Positive	Relative share (%)
1999	184.097	2463	1,34
2000	180.232	1806	1,00
2001	179.582	562	0,31
Total:	**543.911**	**4831**	0,89

Figure 1

Total number of examined and positive swine during the three monitored years

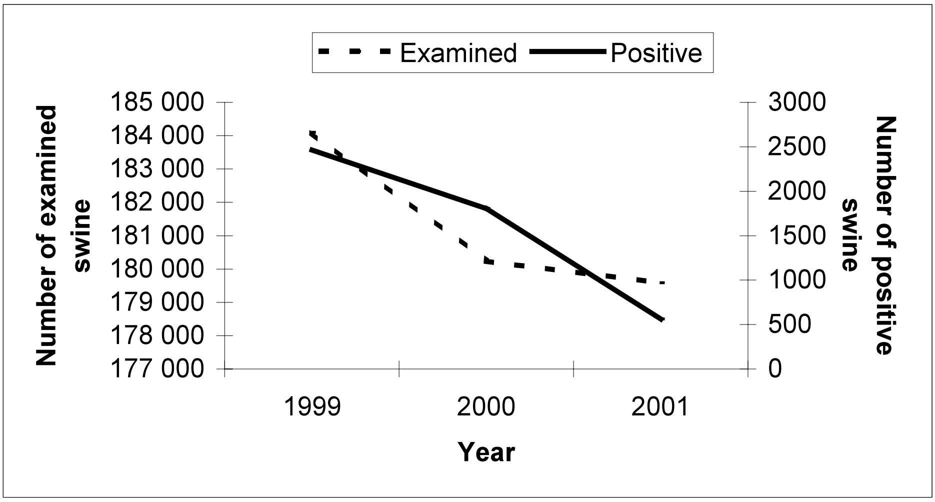

Figure 2

Percentage of positive swine in the total number of examined swine by years

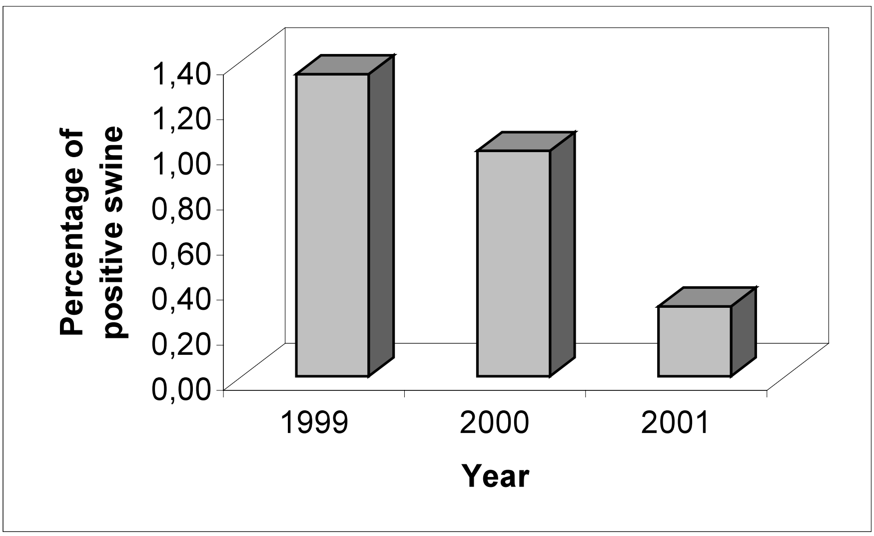

Figure 2 is presenting the percentage of infected swine in the total examined population separated for each year. The significant fall in the number of positive swine is especially seen in 2001 compared to 1999 (number decreased for 432.26%, respectively).

Table 2

F-values from ANOVA for influence of month and veterinary organization on occurring of positive results for each year separately

Year	F - values	
	Influence of month	**Influence of veterinary organization**
1999	0,847$^{n.s.}$	11,561**
2000	1,469$^{n.s}$	8,958**
2001	2,080*	2,489**

** P<0,05; ** P<0,01;* $^{n.s}$*=non significance*

ANOVA for the influence of veterinary organization on occurring of trichinellosis has shown highly significant differences for every monitored year separately (P<0.01), which is presented in *Table 2*. Influence of each month in a year on positive results in 1999 and 2000 was insignificant, while in 2001 it was found to be significant (P<0.05). ANOVA for influence of year on positive results in Vukovarsko-srijemska county has shown justifiable differences in middle relative values (F=21,252**). However, F-test has not given the answer if the difference was justifiable between the averages of all the groups or only few of them. Testing of justify of differences between averages from various groups was carried out by the meanings of the method from J.S. Tukey, modificated by Snedecor (*Snedecor* and *Cochran*, 1967). Mentioned method has shown that only one out of the three differences was higher than calculated value D (D=1.242). This refers to the difference between the years 1999 and 2001, while between 1999 and 2000, as well as between 2000 and 2001, the difference was not justifiable. Therefore, there is justifiable difference between mentioned group with the significance of 5% (P<0.05), which means that the number of positive swine has significantly decreased in 2001 compared to 1999 in Vukovarsko-srijemska county, and this is in accordance with the investigations carried out by *Rimac et al*. (2001b).

CONCLUSIONS

Systematic carrying out of measures for preventing spreading and eradication of trichinellosis in the Republic of Croatia, especially in the endemic region of east Slavonija, was sufficient for decreasing number of swine infected with the parasite from genus *Trichinella*, which significantly reduced danger for people' infection.

ANOVA for influence of veterinary organization has shown the spots in the endemic region of Vukovarsko-srijemska county that present the biggest centers of trichinellosis in Croatia.

Total eradication in endemic regions will hardly be carried out due to the fact the parasite is present in the population of wild animals, which presents significant epizootiological, but also ecological problem.

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Corresponding author:

Tihomir Florijančić
University of J.J. Strossmayer, Faculty of Agriculture in Osijek
HR-31000 Osijek, Trg Svetog Trojstva 3., Croatia
Tel.: 385 31 224 275; Fax: 385 31 207 017
e-mail: flory@suncokret.pfos.hr

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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

The effect of crude fiber on pregnant sows' and their piglets' performance

P. Papócsi, J. Gundel, A. Hermán
Research Institute for Animal Breeding and Nutrition, Herceghalom, H-2053 Gesztenyés u.1. Hungary

ABSTRACT

The crude fiber content of the pregnant sows' diets can influence the performance, primarily the reproductive performance of the sow. Feeding the pregnant sows according to their nutritional requirements can increase the number of stillborn pigs and weaned pigs. Fibrous feed components decrease the digestibility and the absorption of the other nutrients. However, a given amount of crude fiber is required in the pregnant sows' diets because of their special physiological role. Three different feeds (control, basal diet plus fermentable corn silage and basal diet plus non-fermentable wheat straw) were fed with pregnant sows in two repetitions in order to determine the crude fiber requirement of the sows during this period. The number of stillborn and number of weaned piglets, as well as the feed-intake (including the energy and protein intake) during lactation increased in response to the fiber supplementation. These findings confirm the beneficial effects of crude fiber addition by supplementing the pregnant sows' ratios with corn silage or wheat straw.
(Keywords: sow, fiber, nutrition, reproduction)

INTRODUCTION

Several research data have demonstrated that the fiber supply of pregnant sows is important from many aspects. Insufficient fiber supply of sows during pregnancy can lead to constipation or MMA syndrome (*Fekete* and *Hullár*, 1996; *Fekete*, 1995). Fibrous feed components decrease the digestibility and the absorption of the other nutrients, thus the amount of crude fiber in the diet cannot exceed a certain level. However, a minimum amount of crude fiber is necessary in the pregnant sows' diets in order to prevent decreasing feed-intake during lactation, production of toxic gases or colonisation of bacteria in the intestine or oesophagalis stomach ulcer (*Fekete*, 1995). The fibrous, bulky diet decreases the density of the feed therefore this feed stays longer in the stomach, however it is moved along quickly by the intensive intestinal passage (*Schmidt*, 1995). Supplementation of pregnant sows' diets with a fiber source, especially with wheat straw has been proved to increase the reproductive performance of the sows (*Ewan et al*., 1996; *Reese*, 1997; *Mroz et al*., 1986; *Nelson et al*., 1992) or improve the feed-intake during lactation (*Farmer et al*., 1996).

Once the energy and protein demands of an animal are not met, its productive performance will decrease. For instance 22 g ileal digestible, equals to 26 g total lysine per kg is needed in the lactating sow's diet for maximizing the litter growth (*Pettigrew*, 2000). Increasing the dietary lysine level from 0.8 to 1.2% during lactation can increase litter weaning weight, litter weight gain and reduce weight loss in high producing sows (*Richert et al*., 1997).

The excessive energy intake and obesity can lead to hoof problems and to 'fat sow' syndrome (*Rozeboom*, 2000), to longer farrowing (*Bilkei*, 1990) as well as to decreased feed-intake and increased weight-loss during lactation, abnormal development of the mammary tissues and extra costs (*Goihl*, 1994; *Matte et al*., 1994; *Tokach et al*., 1999). After insemination, the flushing of the sows hast to be finished within 4 days, otherwise the mortality rate of the embryos will increase (*Fekete*, 1995; *Peet-Schwering* and *Hartog*, 1997; *Safranski*, 2000). However, fat supplementation during the last third period of pregnancy can increase the number of stillborn piglets and the performance of the lactating sow (*Halas* and *Babinszky*, 2000). *Tokach et al*. (1999) suggested that about 27.2 MJ ME/day and 1.95 kg feed should be given to a 200 kg sow, while the NRC (1998) advising 26 MJ/day and 250 g crude protein/day. The lactating sow requires 3.5-6.4 kg feed, and then 48-87 MJ and 31-58 g lysine per day (*NRC*, 1998).

The average crude fiber content of the pregnant sows' ratios is relatively low in the daily practice, causing serious losses in the reproduction and production cycle of the sow. The proper nutrient levels, including the adequate crude fiber levels should contribute to increase the number of piglets born alive and weaned and also to improve the feed-intake during lactation. The aim of our experiment was to compare the reproductive performance as well as the energy and the protein transformation of sows consuming a diet with low crude fiber content to those that were receiving wheat straw and corn silage supplementation as fiber sources.

MATERIALS AND METHODS

The trial was conducted at the model farm of the Research Institute for Animal Breeding and Nutrition in Herceghalom with 21 Large White sows after more than one parturition. *Table 1* and *Table 2* show the nutrient content of the daily ratios from day 2 up to 90 and then from 91 up to 113 of pregnancy, respectively.

Table 1

Nutrient content of the daily ratios (g) (between day 2 and 90 of pregnancy)

Treatment	Control	Trial treatments	
		Treatment 1	Treatment 2
	2.4 kg feed	1.4 kg feed + 2.5 kg corn silage	2.1 kg feed + 0.3 kg wheat straw
Dry matter	2112	2132	2109
Crude protein	275	225	250
Crude fiber	108	243	219
Crude fat	69.0	64.0	63.6
DEs, MJ/kg	30.6	27.4	27.6
Lysine	13.9	13.9	13.9
Ca	12.7	12.9	12.7
P	12.2	12.2	12.3

Three treatments were defined for the pregnancy period: the control diet with low crude fiber level, treatment 1 was equal to control (basal) diet but it was supplemented with a fermentable fiber source, corn silage (CS) and treatment 2 was equal to control diet but supplemented with a non-fermentable fiber source, wheat straw (WS). During pregnancy sows received a controlled amount of feed. The crude fiber content in the two phases of the pregnant diets were 4.5% (control), 6.2% and 5.5% (CS); 9.1% and 8.2% (WS), respectively. The feed-intake during two lactations was monitored and metabolisable energy (ME) as well as lysine (reflecting the crude protein) intake were calculated. The dry matter, Ca, P, lysine, vitamin and trace mineral contents were the same in each diet. After farrowing sows in each treatment received the same lactating diet, *ad libitum*. Two pregnancy and two lactation periods of the sows had been investigated in this experiment. The following parameters were collected during the trial: a.) live weight of the sows during pregnancy and lactation, b.) number of live born piglets, weight of the litter, c.) number of piglets weaned and weaning weights of the piglets and d.) intake during lactation and its transformable energy and lysine content.

Table 2

Nutrient content of the daily ratios (g) (between days 91 and 113 of pregnancy)

Treatment	**Control**	**Trial treatments**	
		Treatment 1	**Treatment 2**
	3.0 kg feed	2.4 kg feed + 1.4 kg corn silage	2.7 kg feed + 0.3 kg wheat straw
Dry matter	2640	2616	2637
Crude protein	344	311.3	319
Crude fiber	135	209	247
Crude fat	85.8	82.2	80.7
DEs, MJ/kg	38.3	35.8	35.2
Lysine	17.4	17.4	17.5
Ca	15.9	15.7	15.8
P	15.3	15.4	15.4

The statistical analyses on the variants have been prepared and the preliminary results confirm that the differences found between the experimental treatments are related to the individual treatments. Some trials are still in progress, thus further analyses have to be done.

RESULTS AND DISCUSSION

The major findings of the experiment are summarized in *Table 3* and *4*. *Table 3* shows the effect of different fiber supplementation during pregnancy on the sows' and piglets' performance in the first period (first pregnancy and first lactation) of the trial. In the first period the weight gain during pregnancy was the highest in the control group (41 kg) and lowest in the corn silage fed group (28 kg) but the lactational weight-loss was also the greatest in the latter (CS) group (17%). The number of stillborn and weaned piglets, as well as the average litter size were consequently higher in the experimental groups. *Tritton et al*., (1996) reported, that voluntary feed intake during lactation is unaffected by lysine or energy content of the diets, but the sow body-weight loss during lactation can decline with increasing ME content up to 13.25 MJ/kg in first litter sows. However, the increasing ME levels during lactation in the first period of the experiment was followed by increasing sow weight loss. The lowest feed and ME intake during lactation was observed in the control group. *Table 4* shows the effect of different fiber supplementation during pregnancy on the sows' and piglets' performance in the second period.

Table 3

The effect of different fiber supplementation during pregnancy on the sows' and their piglets' performance in the first period of the experiment

Treatments	Control		Treatment 1 corn silage		Treatment 2 wheat straw	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
Weights of sows, before insemination, kg	192	4.7	196	31.7	194	27.6
Weights of sows, on d. 108 of pregnancy, 1st period, kg	233	25.0	224	25.9	226	32.3
Weight gain during pregnancy, kg	41	29.2	28	12.4	32	10.9
Weight of sows, end of 1st lactation	204	10.7	186	26.8	192	35.7
Weight gain during lactation, kg	-29	20.4	-38	16.3	-34	29.6
Live born piglets per sow, n	8.6	1.3	9.7	2.5	9.9	2.0
Average litter size, kg	13.2	3.1	17.0	6.1	14.9	4.4
Weaning weights of piglets, kg	6.6	2.0	7.5	0.9	6.5	0.8
Number of piglets weaned, n	8.0	1.6	8.6	1.7	9.0	1.4
Number of days until weaning, d.	30	2.7	31	1.0	30	1.6
Interval between weaning and maiting, d.	4.6	0.8	4.1	0.6	5.2	0.8
Feed intake of the lactating sows, kg	4.4	0.3	5.2	0.4	4.9	0.6
ME intake of the lactating sow, MJ	53.2	3.9	63.1	4.8	60.3	7.1
Lysine intake of the lactating sow, g	41	3.1	48	3.5	46	5.2

Table 4

The effect of different fiber supplementation during pregnancy on the sows' and their piglets' performance in the second period of the experiment

Treatments	Control		Treatment 1 corn silage		Treatment 2 wheat straw	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
Weights of sows, end of 1st period, kg	196	30.0	181	24.0	176	13.1
Weights of sows, on d. 108 of pregnancy, 2nd period, kg	237	30.1	219	9.9	233	14.7
Weight gain during pregnancy, kg	41	18.8	38	19.6	57	9.4
Weight of sows, end of 2nd lactation	205	24.7	193	16.8	211	17.7
Weigh gain during lactation, kg	-32	9.2	-26	16.4	-22	8.9
Live born piglets per sow, n	8.0	2.3	8.6	3.1	8.6	3.2
Average litter size, kg	13.6	2.9	14.3	4.9	15.2	6.3
Weight of stillborn piglets, kg	1.7	0.2	1.7	0.1	1.7	0.2
Weaning weights of piglets, kg	8.1	1.1	7.8	1.3	7.7	0.9
Number of piglets weaned, n	8.0	2.3	8.0	2.8	8.4	3.5
Number of days until weaning, d.	33	4.8	33	2.6	31	6.3
Feed intake of the lactating sows, kg	4.6	0.3	4.9	0.4	4.8	0.4
ME intake of the lactating sow, MJ	56.4	4.5	60.0	5.0	58.5	4.8
Lysine intake of the lactating sow, g	43	3.5	45	3.6	44	3.5

The highest lactational weight-loss was seen in the control group during this period. Furthermore, the number of piglets born alive and the litter size were consequently higher in the experimental groups. Feed intake in the control group was slightly lower than in the two treatments.

In case of feeding a corn-soybean meal based diet, the dietary total lysine requirement is 52 g for lactating sows (*Pettigrow* and *Yang*, 1997), thus probably the lysine demand of the lactating sows in this trial was not fully met. However, the energy demand during pregnancy was satisfied as 29.5-37.8 MJ/day ME is recommended for fifth parity pregnant sow between 28th and 112th days of pregnancy (*Peet-Schwering* and *Hartog*, 1997). The mean interval between weaning and mating was longer for sows that had been restricted in their food intake during lactation (*Mullan* and *Williams*, 1989) and similarly in this experiment, the corn silage supplementation with the highest feed-intake was paired by shortest weaning to mating interval. *Matte et al*. (1994) found no correlation between the length of the interval and feeding the pregnant sow with a bulky diet, while *Farmer et al*. (1996) found positive response.

The positive response to the fibrous feed supplementation can be explained by bacterial digestion of the cellulose in the large intestine and the energy derived from that (*Schoknecht*, 1997; *Varel* and *Yen*, 1997; *Fernandez et al*., 1986; *Reese*, 1997). The weight loss of the sows during lactation was about of 10-16% that is considered as a normal rate (*Halas* and *Babinszky*, 2000).

CONCLUSIONS

Most of the investigated parameters, shown in *Table 3* and *4*, have demonstrated that the crude fiber supplementation of the pregnant sows' diets improved the reproductive performance of the sows and increased the feed-intake during lactation, including the energy and the protein intake. The weight-loss of the sows was by 18% (CS) and 31% (WS) less then in the control group in the second experimental period, however, just the opposite tendency was observed in the first period. Feed-intake during lactation was the lowest in the control group and the highest in the group fed with corn silage in both periods. The numbers of piglets born and weaned were significantly higher in the experimental groups, however the weaning weights of piglets were higher in the control group. For these beneficial reasons, the crude fiber content of sows' diets during pregnancy should be increased from the most common 3-5% up to 8-9% (*Fekete* and *Hullár,* 1996*).* Corn silage and wheat straw are recommended for pregnant sows as they have positive effects on sows' performance.

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Corresponding author:

Péter Papócsi
Research Institute for Animal Breeding and Nutrition
H-2053 Herceghalom, Gesztenyés u. 1. Hungary
Tel.: 36-23-319-133/225, Fax: 36-23-319-133/120
e-mail: peter.papocsi@nutreco.com

CONTRIBUTORS

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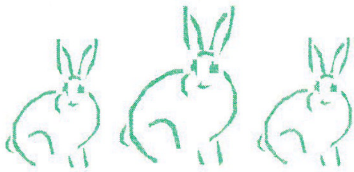

ISMERJE MEG ÉS PRÓBÁLJA KI NYÚLTAKARMÁNYAINKAT!

Beltartalom	Me.	Tenyésznyúl tak.kev. 151-100-00	Növendéknyúl tak.kev. 151-090-00	Hízónyúl tak.kev. 151-111-00
De. nyúl	MJ/kg	10,80	11,00	11,40
Nyersfehérje	%	16,30	15,70	15,00
Nyerszsír	%	2,90	2,90	3,00
Nyersrost	%	14,00	13,50	12,10
Lizin	%	0,79	0,77	0,59
Metionin	%	0,27	0,26	0,25
Met+cisztin	%	0,53	0,51	0,50
Kálcium	%	1,20	1,15	1,00
Foszfor	%	0,70	0,62	0,58
Nátrium	%	0,21	0,21	0,16
A-vitamin	NE/kg	12170,00	12170,00	6300,00
D_3 vitamin	NE/kg	2028,00	2028,00	1170,00
E vitamin	mg/kg	49,50	49,50	16,00
Kiszerelés: 40 kg/zsák				

Termékeinket a következő helyeken rendelheti meg:

Gamix Premixüzem Környe
2851 Környe, Tópart u. 5.
Telefon: 34/473-137
Telefax: 34/473-052
/premixek, ásványi kiegészítők, tejpótlók, tojásszínezők, koncentrátumok/

Tatai Keverőüzem
2890 Tata, Környei u. 20.
Telefon: 34/487-837
Telefax: 34/487-453
/késztápok, koncentrátumok, tápszerek, alapanyagok/

Nagyigmándi Keverőüzem
2942 Nagyigmánd, Bajcsy-Zs. u. 35.
Telefon: 34/356-558
Telefax: 34/356-689
/késztápok, koncentrátumok, alapanyagok/