Acta Agraria Kaposváriensis (2006) Vol 10 No 2, 63-69
Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Carcass and tissues composition at Turopolje Pig Breed – Autochthonous Croatian Breed

M. Đikić[1], K. Salajpal[1], D. Karolyi[1], V. Čubrić Čurik[1], D. Đikić[2], M. Mihelčić[1], V. Rupić[1], I. Jurić[1]

[1]Faculty of Agriculture University of Zagreb, Department of Animal Science, Svetošimunska c. 25, 10000 Zagreb, Croatia
[2]Faculty of Science University of Zagreb, Department of Animal Physiology, Roosweltov trg 6, 10000 Zagreb, Croatia

ABSTRACT

In Turopolje pig breed the carcass and tissues composition was established by analyzing the share of muscle (M), fat (F) and bone (B) tissues in the carcass and the chemical content (water, W, protein, P, lipid, L, ash, A) of the back fat and m. longissimus dorsi (MLD). Also, the some histochemical characteristics (diameter and proportion) of slow-twitch high-oxidative (SO), fast-twitch oxidative-glycolitic (FOG), and fast-twitch glycolitic (FG) fibre types of MLD were analyzed. Investigation was carried out on Turopolje breed pigs (n=10, age 679±20 days and 100.3 kg±4.9 kg). Pigs were fattened in the outdoor system of flood forests and marsh meadows biocenosis (Quercus robur and Deschampsietum caespitosae) according to traditional Croatian technology of low input feed (0.5 kg of corn seed/day/animal) in ecosystem. On the slaughter line the animals and carcasses were separately weighted and cut according to Weniger (1963) method and by total dissection. The samples of muscle and fat from the left side at the last rib level were taken after chilling 24 h at +4 °C and stored at -20 °C until chemical analysis. For histochemical analysis, sample from the same place and about 1 cm wide were taken 30 min after slaughter and frozen in liquid nitrogen until analysis. At Turopolje pig breed in the cold carcass (79.7 kg) were estimated the share of tissues respectively: M, 40.5%; F, 33.8%; B, 9.7% and share of the lard (4.0%) and double chain (3.2%). The chemical contents of MLD and back fat were respectively: W, 74.71% and 7.25; P 21.19% and 1.49; F, 1.46% and 91.76% and A, 1.06 and 0.06. The size and proportions of fibre types in MLD were respectively: SO, 38.9µm and 10.5%; FG, 57.7µm and 52.9%; FOG, 53.5µm and 36.7%.
(Keywords: Turopolje pig, carcass, tissue chemical content, fibre type)

INTRODUCTION

Turopolje pig breed is the autochthonous Croatian breed and one of older Europeans pigs and breeds (*Robić et al*., 1996). The numbers of scientific and expert papers were published about origin, historical and economic importance and factors which brought this breed into FAO list of endangered and disappearing breeds (*Loftus* and *Scherf*, 1993). This list was formed after signing the Convention on Biological Diversity (CBD) in Rio de Janeiro in June 1992. Republic of Croatia signed CBD (January 5, 1997) and in 1999. Croatia passes the strategy of biological diversity which includes Turopolje pig (*Radović*, 1999).

Table 1. gives the size of breeding population registered in herdbook of Turopolje pig breed in years 1996 (the start of programme of re-establishment and preservation) and in 2005 by annually reports of Croatian Livestock Center (*CLC*, 1997 and 2006).

Table 1

Breeding population of Turopolje pig breed in Croatia

Year	Sows	Boars	Gilt	Y.boar
1996	12	3	-	-
2005	129	14	107	-

Source: Annual report – pig breeding, CLC (1997, 2006).

Number of sows and boars (*Table 1*) besides the state subsidies, indicate the state of critical endangerment of this breed according to FAO standards (*Loftus* and *Scherf*, 1993), and during the last ten years the renewed is very slow, but number of gilts gives some the opportunity to change the present state. The breeding population is owned by family farms and by organization Universitas Communitas Nobilium Campi Turopolia (UCNCT, V. Gorica) which owns the majority of the population. It has to be said that UCNCT in 1996 started first with preservation by opening herdbook at CLC. This organization, a former land community (established in 13th century and legally suppressed in 1947, *Đikić et al*., 2002) renewed its activities and include them into the project of re-establishment and preservation of Turopolje pig as cultural and biological value as well as its natural habitat of origin and *in – situ* survival. It is important to emphasize that the traditional Croatian technology of low input pig production in the outdoor ecosystem of flood forests and marsh meadows, bound to Turopolje pig is a part of Croatian cultural heritage. Existing research results about characteristics of Turopolje pig mostly are published in monography "Turopolje pig – autochthonous Croatian breed – turopolka" (*Đikić et al.,* 2002).

However genetics conservation programs often focused only to maintain rare breeds, but many related questions need to be answered. Breeds are not genetically static. They are continuously developing and changing, and conservation policy must determine the historical point at which the true type existed. There are varieties and different types within a breed, which may have a risen as results of nature evolution or by introregression and the true type must be identified before conservation programs.
With this reason, the remainder of Turopolje pig population is under research of many biological traits, both on phenotypic and molecular level, and some of them are/were the problem at the first time (*Đikić et al*., 2002, 2006; *Harcet et al.*, 2006).

The objective of this study was to establish the carcass and tissues composition by analyzing the share of muscle, fat and bony tissues in the carcass, the chemical content of back fat and MLD as well as some characteristics of muscle fibre. Results of this research will be used as a base for defining the characteristics (standards) of today Turopolje pig breed, as well as a starting point for breeding and economical program of re-establishment, preservation and definition of production type of this breed.

MATERIALS AND METHODS

Animals and management

Investigation was carried out on Turopolje pigs (n=10). Pigs were fattened in the outdoor production system. The whole production cycle took place in the outdoor system of forest biocenosis (*Quercus robur, Fraxinus excelsior* and *Fagus sylvatica*) and marsh meadows (*Deschampsietum caespitosae*) in the Turopolje area (near to Zagreb). Traditional Croatian technology of low feed input (0.5 kg of corn seed/animal/day) in the ecosystem was implemented in the extensive management. Natural resources (acorn,

soil, pasture) were utilized, but having a mind the environmental balance as well. No industrial feed, vitamins or mineral were used nor in piglets rearing neither in fattening. The average age of fattened pigs was 679±20 days.

Carcass and tissues compositions

In the abattoir for each pig the live weights (average 100.3±4.9 kg) and warm carcass weights (average 80.1±4.6 kg) were measured. After chilling through 24 hours at +4 ^{o}C the weights of cold carcass and the single of halves (left) for the dissection were recorded. The dissection of halves were performed according to *Weniger et al*. (1963) with the aim to determine the quantity of muscle (M), fat (with skin, F) bone (B) tissues and less valuable parts (LVP: head, lower parts of legs tail, kidney), lard (L) and double chain (DC) which were weighted separately. On the basis of mass of each tissue and the weight of halves the percentage of tissues in the carcass were determined.

For the chemical analysis the samples of muscle and fat tissues were taken from the MLD and belonging back fat (between 13/14 ribs) after chilling (24 h at +4^{o}C). By chemical standard method in tissues were determined the percentage of water (W) protein (P) lipid (L) ash (A) and NET.

Muscle fibre characteristics were determined in the sample of the MLD and it was taken on dorsal side in the last rib level, 5 min after animal slaughtering and frozen in liquid nitrogen until analysis. By *Salomon* (1981) and *Pearse* (1972) methods, the histochemical differentiation of the three main fibre types, slow twitch oxidative, (SO) fast twitch glycolityc (FG) and fast twich oxidative-glycolytic (FOG) were obtained on the basis of the activity NADH, standard, alkaline and acid stabile adenosine tri-phosphatase (ATPase) and succinate dehydrogenase (SDH). The percentage of each fiber type was calculated from total number of fibres per cm^2 area. The fibre diameter was calculated from fibre cross section area assuming fibres were circular in shape.

The software package SAS (vs. 8, 1999) was used in data analyses. Experimental results were compared with literature (*Kralik* and *Petričević,* 2001; *Maltin et al.,* 1997 and others).

RESULTS AND DISSCUSION

Carcass composition

The results (*Table 2*) show cold carcass weights and composition of Turopolje pig breed and some production types (fatty type Mangalitsa and meat – fatty type Black Slavonian breeds and selected pigs) from literature (*Kralik* and *Petričević,* 2001; *Đikić* and *Jurić,* 2003).

According to the results (*Table 2*) of the Turopolje pig breed the established values of slaughtering and cold carcass weights in relation with age indicate very low daily gain at pigs produced in the outdoor system with technology of low feed input. Analysis of carcass composition (*Table 2*) in Turopolje breed showed that muscle: fat ratio in carcass without lard was in favor of muscle tissue. If both fat tissue and lard are included into the calculation then the ratio was 1.1:1. Regarding muscle: fat tissue relation in the carcass, according to other references (*Vukina*, 1961; *Belić et al.,* 1961) Turopolje pig is a late-mature fat production type of pig, together with Mangalitsa and Bagun. On the contrary, *Horvat* (1939) based on his own research conclude that fattened pigs with the average body weight of 101.7 kg and 81.6 kg of cold carcass weight were too fatty for fresh meat production and too little fatty for fat production (which was important at that time). Also the legs and shoulders conformations were very narrow and thin. The conclusions and results of Horvat induced us to investigate the tissue composition. However, if the established results (*Table 2*) for muscle:

fat tissue ratio were compared with recent data on breeds Mangalitsa and Black Slavonian (*Kralik* and *Petričević*, 2001) then the present population of Turopolje pig can be defined as a late mature combined meatiness – fatty type of pig for production in low feed input technology in the ecosystem of biocenosis of marsh meadows and flood forests. Besides, the obtained results (*Table 2*) indicate that Turopolje pig was not influenced by trends in pig selection directed by changes in demands for muscle and fat tissue on pig meat market which resulted in very high share of muscle tissue in carcass, (*Đikić* and *Jurić*, 2003). *Reeds et al.* (1993) reported that in the commercial fattened Landrace and Large White breeds at the age of 210 days and body weight of 90 kg, in the year 1940 muscle: fat tissue ratio was 0.87:1, while in 1980 it was 1:1. If these figures are compared to fattened Turopolje pigs, the status of selection according to carcass quality in the remaining population is visible.

Table 2

Carcass weight and composition

Breed/ Crossbred	Carcass	Tissue (%)			LVP	L & DC
	kg	M	F	B	%	%
	$\bar{x}$ ±SD	$\bar{x}$ ±SD	$\bar{x}$ ±SD	$\bar{x}$ ±SD	$\bar{x}$ ±SD	$\bar{x}$ ±SD
Turopolje	79.7±4.4	40.5±1.39	33.8±1.29	9.7±0.74	8.8±0.84	4.0±0.65 3.2±0.82
Mangalitsa[A]	80.1±1.56	28.8±0.65	51.9±1.02	9.5±0.47	9.8±0.63	-
Black Slav[A]	79.5±2.41	32.4±1.31	48.4±1.57	9.9±0.84	9.3±0.79	-
SL[B]	79.0±4.59	49.2±3.42	27.9±4.1	10.4±0.76	9.2±0.59	3.3±0.90
HySL[B]	80.1±5.84	53.1±4.53	25.6±5.18	10.7±0.8	8.1±0.48	2.5±0.95
Hy[B]	78.6±5.16	55.3±3.11	23.9±4.32	11.4±0.84	7.7±0.58	1.7±0.65

Source:A = Kralik and Petričević. 2001; B = Đikić and Jurić. 2003.
M – muscle, F – fat, B – bone, LVP – less valuable parts, L – lard, DC – double chain, SL – Swedish landrace, Hy – hypor.

Tissues composition
Tissue composition of MLD and back fat are showed in the *Table 2* and *Table 3*.

Table 3

Chemical content of MLD and back fat (%)

Content (%)	Tissue	Turopolje*	Wild pig **	Mangalitsa**	Black S. **	Hypor**
		$\bar{x}$ ±SD				
Water	M	74.71±0.56	74.40	70.14±0.90	70.36±0.76	73.12±1.01
	F	7.25±1.59		14.07±1.37	15.10±1.61	19.89±1.85
Protein	M	21.19±0.49	22.11	20.65±0.83	20.70±0.71	23.53±1.41
	F	1.49±0.48		4.39±0.73	4.60±0.71	5.03±0.66
Fat	M	1.46±0.35	1.55	8.21±1.44	7.86±1.09	2.23±0.13
	F	91.76±1.60		81.31±0.75	79.99±1.09	74.64±5.09
Ash	M	1.06±0.03	1.47	1.00±0.09	1.08±0.08	1.12±0.05
	F	0.06±0.03		0.23±0.07	0.31±0.08	0.44±0.14

*NET=MLD=±1.68±0.06; Fat=0.44±0.058. ***Source: Kralik* and *Petričević. 2001.*
M-muscle, F-fat.

The chemical content (*Table 3*) of the MLD indicated that meat of Turopolje breed pig contain low percentage of fat and high percentage of water, while proteins percentage are relatively high. The values of all components are very similar to the wild pig, but different in the comparison to the fatty type Mangalitsa and meaty – fatty Black Slavonian breeds. Deviations are in the content of water and fat. These indicate the specific way of the metabolism and storage of fat in the body and could be one of the reasons of the deviations in share of fat in comparison to other breeds (*Table 2*). Also, these results indicate the need of further of investigation of the other traits of tissues characteristics (iodine number, collagen content etc). Results in the table 4 show the muscle fiber characteristics of MLD of Turopolje pig and some crossbred pigs from literature.

Table 4

Muscle fibre characteristics of MLD

Breed/ crossbred	SO		FG		FOG	
	µm	%	µm	%	µm	%
	$\overline{x}$ ±SD					
Turopolje	38.87±12.06	10.5±1.09	57.7±14.83	52.9±14.86	53.5±14.57	36.7±18.27
LWSLP*	38.81±12.4	6.4±1.72	67.2±15.90	59.5±16.70	55.4±13.07	34.1±17.25
LWHyF**	45.18±4.84	11.74±2.99	53.2±4.38	58.1±3.53	48.84±4.75	30.18±2.46
DBM***	51.7±7.1	15.3±5.4	61.5±9.5	71.3±6.9	49.1±7.6	12.2±4.3

*Source: * LWSLP = (♂Large Whitex♀Swedish Landrace)x♂Pietrain (Đikić et al., 2006). **♂ Large Whitex♂ Hybrid Female.(Maltin et al., 1997). *** ♂Durocx♀Berlin Miniatur. (Fiedler et al., 2003).*

In Turopolje pig breed the fiber diameter and proportion of SO, FG and FOG showed and beside some higher variability's values in a normal range when compared to the general records for the swine as species by *Lawrie* (1998). However, the size of fiber types SO is more less in the Turopolje pig than in crossbred selected pigs LWHyF (average value of crossbred pigs of eight vary known breeding companies from Great Britain, *Maltin et al.,* 1997) and as wells as than DBM. But the diameter was similar to crossbred LWSL pigs. The established values for the size of FG and FOG fiber types in Turopolje pig breed were bigger than in LWHyF and smaller than in LWSL pigs. The differences in the percentages of each fiber types in composition of muscle and especially of FG in Turopolje pigs and crossbred pigs are visible.

The estimated results in the consideration with results of many authors cited by *Pas et al.* (2004) indicated that Turopolje pig breed could be genetically different compared to other breeds, if keep in mind the factors as well as its origin (*Ritzoffy*, 1931, 1933) and no intensive selection for lean muscle growth which in pigs may have caused, a large genetic change in fibre type composition. Investigation of carcass tissues composition need to continue and especially in the relation to the quality traits of meat.

CONCLUSIONS

Turopolje pig breed is in the state of critical endangerment (by FAO standard) but number of gilts suggests the change of that state.

In present population of Turopolje pig breed the some traits of carcass and tissue composition are specific and could be a consequence of specific historical conditions of breeding selection and production in the specific environment of the outdoor system.

The carcass and tissue composition give opportunity to setting up a program which would support reestablishment of the population on the economic base.

REFERENCES

Belić, J., Ognjanović, A., Šterk, V. (1961). Modern pig production. Beograd. Ed. Zadružna knjiga. 69-73.

Croatian Livestock Center (1997). Annual report - pig breeding. Zagreb. 64.

Croatian Livestock Center (2006). Annual report - pig breeding. Zagreb. 63.

Đikić, M., Jurić, I. (2003). Relation and distribution of tissues in pigs as factor of competitiveness on pig meat market. Agronomski glasnik. 3-4. 88-96.

Đikić, M., Jurić, I., Kos, F. (2002). Turopolje pig – autochtonous Croatian breed – turopolka. Velika Gorica. Plemenita opčina turopoljska. 181.

Đikić, M. et al. (2006). Značajke mišićnog tkiva u svinja Turopoljske pasmine. 41. hrvatski &1. međunarodni znanstveni simpozij agronoma. Opatija, 568-600.

Fiedler, I., Nürnberg, K., Hardge, T., Nürnberg, G., Ender, K. (2003). Phenotypic variations of muscle fibre and intramuscular fat traits in Longissimus muscle of F2 population DurocxBerlin Miniature Pig and relationships to meat quality. Meat Science. 63. 131-139.

Harcet, M., Đikić, M., Gamulin, V. (2006). Low genetic diversity in the Turopolje pig breed using microsatellites and mitochondrial D-loop sequencing. Food Technology and Biotechnology. 44. 105-109.

Horvat, B. (1939). Results of controlled fatening of pigs of Turopolje and Bagun breeds. Arhiv Ministarstva poljoprivrede – Smotra naučnih radova. 6. 55-76.

Kralik, G., Petričević, A. (2001). Production traits of Black Slavonian pig. Proceedings: Biological diversity in animal production of Republic of Croatia. Zagreb. 115-122.

Loftus, R., Scherf, B. (1993). World Watch List for Domestic Animal Diversity. 1st Edit. Rome. FAO UNEP. 376.

Lawrie, R.A. (1998). Lawrie's meat science. Woodhead Publ. Ltd. Abingdon. England. 336.

Maltin, C.A., Warkup, C.C., Mattgews, K.R., Grant, C.M., Potter, A.D., Delday, M.I. (1997). Pig Muscle Fibre Characteristics as a Source of Variation in Eating Quality. Meat Science. 47. 237-248.

Pas, M.F.W., Everts, M.E., Haagsman, H.P. (2004). Muscle Development of Livestock Animals. CABI Publishing.

Pearse, A.G.E. (1972). Histochemistry. Theoretical and applied Vol. 2. Ed. Longhman, Edinburgh, London.

Radović, J. (1999) Overview of condition of biological and landscape diversity of Croatia with strategy and action plan for protection. Zagreb. Državna uprava za zaštitu prirode i okoliša. 151.

Reeds, P.Y., Burrin, D.G., Davis, T.A., Fiorotto, M.A., Meremann, H.J., Pond, W.G. (1993). Growth regulation Particular Reference to the Pig. In: Growth of the Pig Eds. Hollis. G.R.. Walingford. CAB International. 1-32.

Ritzoffy, N. (1931). Contribution to knowledge on Turopolje pig. Veterinarski arhiv. 1. 83-134.

Ritzoffy, N. (1933). About inbreeding in general. especially within Turopolje pig breed. Veterinarski arhiv. 12. 533-571.

Robić, Z., Đikić, M., Jurić, I., Stipić, N., Rupić, V., Mužic, S., Božac, R., Liker, B. (1996). The Turopolje pig one of the oldest European races: It is saving and Renewal. Proceedings 4th International Symposium Animal Science Days. 90-94.

Salamon, F.V., Michael, B., Salamon, F. (1981). Grnewitz zur Fasertypisierung an Skelettmuskulen Mh.Vet. Med., 36. 349-353.

SAS Institute. SAS Online Doc® Release 8. SAS Institute Inc. Cary NC. USA. (1999).

Vukina. R. (1961). Practical pig production. Zagreb. Znanje. 191.

Weniger, H.J., Steinkanf, D., Pahl, G. (1963). Musculare topography of carcass BLV. Verlagsgaselleschaft. Munchen.

Corresponding author:

M. Đikić
Faculty of Agriculture University of Zagreb,
Department of Animal Science
Svetošimunska c. 25, 10000 Zagreb, Croatia
e-mail: mdikic@agr.hr