Carcass Composition of Turopolje Pig, the Autochthonous Croatian Breed

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SUMMARY

Objective of this research was to establish carcass composition in Turopolje pig breed by analyzing the percentage of muscle (M), fat (F) and bone (B) tissue, percentage of these tissues in different parts of carcass (ham, loin, back, neck, belly-rib part – BRP), as well as share of the parts in carcass. Animals were divided into two groups of different age and slaughtering weight (T_I 584 ± 20 days and 81,9 kg; T_{II} 679 ± 20 days and 100,3 kg ± 4,9 kg). Purpose of this investigation was to define the standards for traits mentioned for the remainder of the population of Turopolje pig and to set the selection and production programs, as this breed has been under protection since 1993 and re-establishment since 1996 as cultural and biological heritage of Croatia and the World. In order to define Turopolje pig in production sense, we presented characteristics of the old breeds Mongolitza and Black Slavonian and some selected breeds. Pigs were fattened in the outdoor system of flood forests and marsh meadows biocenosis (*Quercus robur – Deschampsietum caespitosae*), according to traditional Croatian technology of low input (Đikić et al., 2002).

Slaughtering weight and weight of warm and cold carcass were measured on the slaughtering line. The halves were separately weight and dissected (tissues and parts) according to Weninger et al., 1963 and by total dissection. Data were processed by statistical-mathematical procedure GSM and SAS software package (1996) and results were compared within and between the groups (t-test).

In groups T_I and T_{II} the percentages tissues in carcass were established to be as follows: M 38.2% and 40.5%, B 10.6% and 9.7%, respectively, and were significantly different ($P< 0.05$), while share of F, 34.2% and 33.8% were not significantly different.

Fattened pigs in group T_I, in relation to T_{II}, had lower relative share of muscle tissue in the carcass of loin, back, neck and BRP and higher share of fat tissue of neck and BRP, as well as bone tissue of leg and loin. Muscle : fat tissue relation established for groups T_I i T_{II} (1.02 :1 and 1.07 :1) are higher than in Mongolitza, but lower than in Black Slavonian pig and selected breeds.

KEY WORDS

Turopolje pig, breed, carcass composition, muscle, fat, bone, tissue

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INTRODUCTION

During the last decade of last century and until now, a number of scientific and expert papers was published on Turopolje pig, as Croatian autochthonous pig breed and one of the older European pigs and breeds (Grunenfelder 1994, Robić 1996, Đikić et al., 1999; 2001; 2002), dealing with the origin, historical economic importance and factors which brought this breed into FAO list of endangered and disappearing breeds (World Watch List for Domestic Animal Diversity, Loftus i Scherf, 1993. This list was formed after signing the Convention on Biological Diversity (CBD) in Rio de Janeiro in June 1992 (Hammond, 1998). Republic of Croatia signed CBD on January 5, 1997 and in 1999 Croatia passes the strategy of biological diversity which includes Turopolje pig (Radović, 1999).

It can be stated that re-establishment and preservation of Turopolje pig started in 1996, by opening a herdbook at Croatian Livestock Center (CLC), as demanded by Universitas Communitas Nobilium Campi Turopolia (UCNCT, V. Gorica). This organization, a former land community (established in 13th century and legally suppressed in 1947, Đikić et al., 2002) renewed its activities and of them was inclusion of a project of re-establishment and preservation of Turopolje pig, as a cultural and biological value, as well as its natural habitat of origin and in vivo 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.

Table 1 gives the records of size of the breeding population owned by UCNCT and family farms (CLSC), registered by CLC in Zagreb.

Number of boars and sows, besides the state subsidies, indicate the state of critical endangerment of this breed, according to FAO standards (Loftus and Scherf, 1993), but number of gilts and piglets gives the opportunity to change the present state.

In the same time, Table 1 shows that the first animals recorded by a heardbook are owned by UCNCT, which owns the majority of the population. It has to be said (fact not mentioned until now in any paper) that UCNCT bought 12 sows and 3 boars from Mr. Blaž Pakos from Železno Desno, in the area of Lonjsko polje, who was among few enthusiasts which kept breeding Turopolje pig after 1960's when this breed lost its economical importance in Croatian pig production. Although these animals were in accordance with the literature standards for the breed (Ritzoffy, 1931 and 1933), there is a question mark over the breeding and selection. Due to rather peculiar personality of Mr. Pakos, we were unable to establish that until today.

However genetic 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 result of nature evolution or by introregression and the true type must be identified before conservation programs be applied.

With this reason, the remainder of Turopolje pig population is under research of biological traits, both on phenotypic and molecular level.

Existing papers are published in monography «Turopolje pig – autochthonous Croatian breed – turopolka» (Đikić et al., 2002) and 1st conference, with a round table, on Turopolje pig was held. Research on genotypization of Turopolje pig is in progress (Harcet et al., 2002) and the research on mtDNA are started in cooperation with Prof. C. A. Pinkert from the University of Rochester, New York (part of samples were mailed to the USA). On the round table mentioned previously it was concluded that UCNCT and Faculty of Agriculture should define a program which would support reestablishment of the population on economical base.

Following this, due to knowledge we have today on characteristics of Turopolje pig, objective of our work is to establish slaughtering properties, share of different body parts in carcass and percentage of muscle, fat and bone tissue in carcass. Results of this research will be used as a base for defining the characteristics (standard) of the present Turopolje pig breed, as well as a starting point for its breeding and economical program of re-establishment and preservation and definition of production type of this breed.

Table 1. Size of breeding population of Turopolje breed

Year	Sows		Boars		Gilt		Y.boar		Piglet	
	UCNCT	CLC	UCNCT	CLC	UCNCT	CLC	UCNCT	CLC	UCNCT	CLC
1996.	12	-	3	-	-	-	-	-	-	-
2002.	65	5	2	2	50	3		3	75	17

Source: CLSC – Annual report – pig breeding

MATERIAL AND METHODS

Investigation of carcass composition in fattened Turopolje pigs was carried out on two groups, T_I (n=10) and T_{II} (n=9).

Pigs were fattened in the outdoor system of production. 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 Turopolje (about 40 km from Zagreb). 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 a mind the environmental balance as well. No industrial feed vitamins or mineral was used nor in piglets rearing neither in fattening.

Average age of fattened pigs in group T_I was 584 ± 20 days (birth June 10-30 2001, slaughtered February 9, 2003) and group T_{II} 679 ± 20 days (birth March 8-31 2001 ± 23 days and slaughtered February 9, 2003).

In the abattior for each hog established the slaughtering and warm carcass weights. The average weights were at T_I 81,9 ± 6,1 kg and 65,6 ± 4,8 kg and T_{II} 100,33 ± 4,9 kg and 80,1 ± 4,6 kg).

After chilling through 24 hours at +4°C established the weights of cold carcass and the single of halves on which rest the tail (during the cutting of carcass) for the dissection. The methods by Weninger et al 1963 used the cutting the halves in a parts (leg, shoulder, loin, neck, belly-rib part (BRP), less value part (LVP) double chain (DC) lard (L). By method of total dissection each part dissected on muscle (M) fat (F) and bone (B) tissues at what the weights were established. The lard and double chain were weigh separately.

On the basis of masses of each tissue in the parts and the masses of halves established the percentage of muscle fat and bone tissues as well as and parts and some tissues of parts in the carcass.

The records were calculated by GSM procedure SAS (1996) and differences between groups analyzed by t-test.

Also in the paper showed the results about carcass composition for old breeds Mangalitza and Black Slavonian by Kralik and Petričević (2001) and Uremović at al (2000) and for the selected swine Swedish Landrace (SL), Hypor (Hy) and crossbred SL x Hy by Đikić and Jurić (2003) that should show the relation of Turopolje pig to other breed.

RESULTS AND DISSCUSION

Carcass composition

Table 2 gives slaughter and carcass (cold) weights and carcass composition of two groups of Turopolje hogs, as well and some results on carcass composition of old breeds Mangalitza, Black Slavonian and selected pigs Swedish Landrace and hybrid Hypor estimated by Kralik and Petričević (2001), Uremović et al., (2000), and Đikić and Jurić (2003).

According to the results (Table 2) for the experimental groups (T_I and T_{II}), established values of slaughtering weight indicate very low daily gain in fattened Turopolje pigs produced in the outdoor system with technology of low feed input and depending on capability of each individual animal to utilize the natural resources of the ecosystem.

Obtained statistically significant differences between groups (T_I i T_{II}) for slaughtering weight and by that for cold and warm carcass weights were expected, due to difference in age. However, high variability of slaughtering weights found within each group indicates an interaction between genotype and environment, in relation to the outdoor system of production.

Table 2. Carcass weight and composition at hogs of Turopolje and some other breeds

	Carcass kg $\bar{x}$ ±SD	Tissue (%) Muscle $\bar{x}$ ±SD	Fat $\bar{x}$ ±SD	Bone $\bar{x}$ ±SD	LVP % $\bar{x}$ ±SD	L and DC % $\bar{x}$ ±SD
Turopolje I	63.9±5.7**	38.2±2.98*	34.2±2.91	10.6±0.94**	8.9±0.88	3.2±0.40** 4.9±0.53**
Turopolje II	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**
Mangolitza+	80.1±1.56	28.8±0.65	51.9±1.02	9.5±0.47	9.8±0.63	-
Black Slav.+	79.5±2.41	32.4±1.31	48.4±1.57	9.9±0.84	9.3±0.79	-
Black Slav.◊	85.2±8.5	42.9±3.6	33.8±4.0	-	-	-
A Sw.Land	79.0±4.59	49.2±3.42	27.9±4.1	10.4±0.76	9.2±0.59	3.3±0.90
B Hy x SL	80.1±5.84	53.1±4.53	25.6±5.18	10.7±0.8	8.1±0.48	2.5±0.95
C Hypor	78.6±5.16	55.3±3.11	23.9±4.3	11.4±0.84	7.7±0.58	1.7±0.65

**P<0.01; *P<0.05; Source: + = Kralik and Petričević. 2001. ◊=Uremović M. et al. 2000.; A, B, C = Đikić and Jurić. 2003.

Analysis of carcass composition (Table 2) within both groups of fattened Turopolje pigs shows that muscle : fat relation in carcass without lard is in favor of muscle tissue. If both fat tissue and lard are included into calculation, than the ratio is 1:1. Pigs in T_I group had significantly lower share of muscle tissue ($p<0.05$) and lard ($p<0.01$) and higher share of bone tissue and double chain ($p<0.01$) than animals in group T_{II}, what could be explained, according to Lawrie, (1998) by different age and slaughtering weights. However, statistically significant differences were not established for percentage of fat tissue in carcass. This indicates that there is a need for investigation of growth and gain dynamics, as wall as relation between body weight and body protein and fat in pigs at different age, which is, according to Reeds et al., (1993), important for regulation of growth processes which are defined as dimensional, compositional and functional changes in pigs.

Regarding muscle : fat tissue relation in carcass, according to Vukina, (1961) and Belić et al., (1961), Turopolje pig is a late-mature fat production type of pig, together with Mongolitza and Bagun. On the contrary, Horvat (1939), based on 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 production of fresh meat and too little fatty for production of fat (which was important at that time).

However, if the established differences (Table 2) for muscle : fat tissue ratio between groups T_I and T_{II} were compared with the recent data on Mangalitza and Black Slavonian (Kralik and Petričević, 2001; Uremović et al., 2002), than present population of Turopolje pig can be defined as a late mature combined type of pig for production in low feed input technology in ecosystem of biocenosis marsh meadows and flood forests (Deschampsietum caespitosae – Quercetum roboris).

Besides that, obtained results (Table 2) indicate that Turopolje pig wasn't influenced by trends in pig selection directed by changes in demand for muscle and fat tissue on pig meat market which resulted in very high share of muscle tissue in carcass, in relation to share of fat tissue, in selected breeds, as shown by Đikić and Jurić (Table 2).

Reeds et al., (1993) reported that in commercial fattened pigs of Landrace and Large White breeds at 210 days and body weight of 90 kg, in 1940 muscle : fat tissue ratio was 0.87:1, while in 1980 it was 1:1. If this figures are compared to fattened Turopolje pigs, it could be concluded that, acording to carcass quality, the remaining population is a combined late-mature type of pig for production in the outdoor system. In the same time, these results rise a question how to set breeding and production program for faster re-establisment ad preservation of Turopolje pig, what is Croatian duty after signing CBD (January 5, 1997, Radović 1999).

Share of different parts and tissues from them in carcass

To help to set the programs mentioned, Table 3 gives the data from the research of Đikić and Jurić (2003) on distribution of tissues and share of parts in carcass in experimental groups T_I i T_{II} and some modern pig genotypes.

In fattened pigs of Turopolje breed, regarding the share of parts in carcass, leg is in the first place, followed by BRP, loin, back and neck. Statistically significant difference ($p<0,01$) is established between groups for the share of BRP, which could be explained by development of gastrointestinal system in pgs at different age (Reeds et al., 1993). Analysis of the results (Table 3) shows that Turopolje pig has a high share of loin and neck (T_I 23.8% and T_{II} 24.3%) and low share of back and BRP in carcass, what could be a consequence of technology of low feed input in the outdoor system throughout the past. Although the data on carcass length are not given, Turopolje pig has relatively short carcass (os pubis – atlas 87.0 cm and os pubis – first rib 68.4 cm) compared to modern pig genotypes (98.5 cm and 88.3 cm, Đikić et al., 2002).

Within the groups of Turopolje pigs, in carcass the percentage (Table 3) of muscle tissue from leg, loin, neck and BRP is low, while percentage of fat tissue is relatively high, when compared to the ratio in selected pigs in groups A, B and C. However, percentage of muscle tissue in carcass was higher than fat in all parts of carcass, except for BRP, in both groups of fattened Turopolje pigs.

Testing of differences between groups T_I i T_{II} showed that heavier and older animals have significantly higher share of muscle tissue in carcass from loin ($p<0,05$), as well as from neck and BRP ($p<0,01$), while share of fat tissue from neck and BRP is significantly lower ($p<0,01$).

Besides that, figures given in Table 3 show that the sequence of parts of carcass, according to percentage of muscle tissue in carcass, is the same for Turopolje pig and for selected pigs from groups A, B i C, except for loin, which is on the second place and BRP on the third.

Analysis of figures for bone tissue from different body parts shows that younger and lighter Turopolje breed hogs have higher share of bone tissue in carcass from leg ($p<0.01$), loin and BRP ($p<0.05$) than older and heavier animals. However, the analysis of data for groups of Turoplje pigs and A, B and C groups (Table 3) showed that percentage of bone tissue in carcass from leg, loin, neck and BRP is lower, in spite the fact that body weights are almost the same.

Table 3. Percentage of parts and tissues of these parts in the carcass

Parts		Turopolje		A_{SL}	$B_{SL}x_{HY}$	C_{HY}
Tissues		I	II			
%		$\bar{x}$ ±SD	$\bar{x}$ ±SD	$\bar{x}$ ±SD	$\bar{x}$ ±SD	$\bar{x}$ ±SD
Leg	Muscle	12.9±0.55	12.7±0.77	18.3±1.44^{BC}	19.8±1.86^{A}	20.9±1.99^{AB}
	Fat	10.1±0.70	10.6±0.95	7.5±1.12^{BC}	6.8±1.29^{AC}	6.10±1.28^{A}
	Bone	3.4±0.62**	2.4±0.26**	3.1±0.29^{C}	3.2±0.29^{C}	3.4±0.37^{AB}
	Total in carcass	26.0±0.85	25.7±0.53	28.9±1.12^{BC}	29.8±1.28^{AC}	30.4±1.35^{AB}
Shoulder	Muscle	7.8±0.19*	8.2±0.52*	8.3±0.78^{c}	8.6±0.65	8.9±0.77^{a}
	Fat	5.3±0.78	5.7±0.58	2.7±0.47^{c}	2.6±0.57	2.5±0.50^{a}
	Bone	2.0±0.19*	1.6±0.48*	1.9±0.16^{c}	1.9±0.15^{C}	2.1±0.17^{AB}
	Total in carcass	15.0±0.75	15.5±0.20	12.9±0.89^{c}	13.1±0.67	13.5±0.67^{a}
Loin	Muscle	5.5±0.46*	6.6±0.57*	7.7±1.00^{BC}	8.4±1.10^{A}	8.7±1.05^{A}
	Fat	5.3±0.81	5.8±0.47	5.5±1.18^{BC}	4.7±1.17^{AC}	3.9±0.95^{AB}
	Bone	2.4±0.36	2.4±0.60	2.1±0.27^{C}	2.2±0.30^{c}	2.5±0.28^{Ab}
	Total in carcass	13.2±0.99	14.8±0.63	15.3±1.24	15.3±0.99	15.1±1.02
Neck	Muscle	4.5±0.44**	5.2±0.44**	4.6±0.38^{bc}	5.0±0.55^{a}	5.0±0.46^{a}
	Fat	2.9±0.39**	2.3±0.33**	1.5±0.33^{c}	1.5±0.38^{c}	1.3±0.30^{ab}
	Bone	1.5±0.27	1.3±0.13	1.4±0.19^{c}	1.4±0.25^{c}	1.5±0.26^{ab}
	Total in carcass	8.8±0.20	8.8±0.48	7.5±0.58^{bc}	7.9±0.77^{a}	7.8±0.59
BRP	Muscle	6.9±0.71**	7.9±0.37**	10.3±1.22^{BC}	11.3±1.56^{A}	11.8±1.56^{A}
	Fat	11.1±0.83**	9.6±0.79**	10.9±1.72^{BC}	8.7±1.65^{AC}	7.9±1.65^{AB}
	Bone	2.2±0.16	1.7±0.15	1.9±0.30^{C}	1.4±0.26^{c}	2.2±0.29^{Ab}
	Total in carcass	20.2±0.68**	19.2±0.54**	23.1±1.33^{BC}	22.1±1.30^{A}	21.9±1.22^{A}

Significance level between groups: Turopolje I : II = **P<0.01. *P<0.05; Selected pigs: A, B, C=P<0.01; a, b, c=P<0.05

Table 4. Ratio of tissues and some parts in the carcass at Turopolje's and other breeds

Ratio	Turopolje		By authors*						Selected pigs over 50 years**		
%	I	II	M	BS	BS	SL	$HyxS_L$	Hy	1940	1980	1987
M : F	1.02	1.07	0.55	0.66	1.27	1.76	2.0	23	0.81	1.0	1.7
(H+L):(S+N)	1.6	1.6	-	-	-	2.2	2.1	2.1	-	-	-

Source: *Kralik and Petričević 2001. Uremović et a. 2001. Đikić and Jurić 2003.; ** Reeds et al 1993.

Based on results from Tables 2 and 3 and figures reported by some authors, in Table 4 we showed relation between tissues in different parts of carcass of Turopolje pig and selected types of pigs.

Records (Table 2 and 3) obtained in fattened Turopolje pigs of present population don't suggest that breeding and selection processes in modern pig production had any influence on this population in sense of increasing muscle : fat tissue ratio in carcass, or in increase in the ratio between back (leg + back) and front (loin +neck) part of carcass.

Obtained values, besides the recent researches (Grunenfelder, 1994; Robić et al., 1996; Đikić et al., 1999, 2002, 2002a) confirm that Turopolje pig is, because of its specific origin (Ritzoffy, 1931 and 1933) and survival, as well as biological characteristics, a valuable cultural and biological resource. Assuming that statements of Sellier (1998), Hammond (1998), Jurić and Đikić (2001) and Grunenfelder (1994) are accepted, this breed could also have an economical value.

CONCLUSION

Turopolje pig is, because of the size of population in 2002, in the state of critical endangerment (FAO standards), but number of gilts and piglets suggests the change of the state.

Present population of Turopolje pig, i.e. breed is, regarding muscle : fat tissue ratio in carcass (1:1), a combined late-mature type, what is a consequence of specific historical conditions of breeding, selection and production in specific environment of the outdoor system.

Turopolje pig is, because of its carcass composition, a valuable biological resource, especially as a model animal for multidisciplinary researches in biodiversity of animals.

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