

DISTRIBUTION OF TISSUES IN THE CARCASS OF TUROPOLJE PIG, AN AUTOCHTHONOUS CROATIAN BREED

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ABSTRACT

Carcass composition and distribution of tissues in the carcass of Turopolje pig were established by analysing the share of muscle (M), fat (F) and bone (B) tissue in the carcass and each of this tissues from parts leg, shoulder, loin, neck and belly-rib part (BRP) in the carcass as well as the same tissue in the parts. Investigation was carried out in two groups of fattened pigs at different age and live weight at slaughtering (T_I $n = 10$, age 584 ± 20 days and $81.9 \text{ kg} \pm 6.1 \text{ kg}$; T_{II} $n = 9$, age 679 ± 20 days and $100.3 \text{ kg} \pm 4.9 \text{ kg}$). 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/day/animal). On the slaughter line the animals and carcasses were separately weighted and cut according to Weniger method and by total dissection. In the groups T_I and T_{II} the percentages of muscle (38.2% and 40.5%, respectively) and bone tissue (10.6% and 9.7%, respectively) were significantly different in the carcass, while the share of fat (34.2% and 33.8%, respectively) was not significantly different. In the groups T_I and T_{II} the distribution of muscle, fat and bone tissue in the body parts leg, shoulder, loin, neck and belly-rib part (BRP) were estimated.

Key words: pigs / autochthonous breeds / Turopolje pig / carcass / muscles / fat / bones / Croatia

PORAZDELIZEV TKIV V KLAVNIH TRUPIH AUTOHTONE HRVAŠKE PASME TUROPOLJSKI PRAŠIČ

IZVLEČEK

Sestavo klavnih trupov in porazdelitev tkiv v klavnih trupih turopoljskega prašiča smo določili z analizo deleža mišičnega, maščobnega in kostnega tkiva v klavnih trupih in v delih noge, pleča, ledja, vrat in trebuh. Raziskavo smo opravili v dveh skupinah pitancev pri dveh različnih starostih in telesnih masah ob klanju (T_I $n = 10$, starost 584 ± 20 dni in $81.9 \text{ kg} \pm 6.1 \text{ kg}$; T_{II} $n = 9$, starost 679 ± 20 dni in $100.3 \text{ kg} \pm 4.9 \text{ kg}$). Prašiče smo pitali po klasični tehnologiji, ki vključuje pašo v gozdovih in na travnikih, ki ju označujeta biocenozi *Quercus robur* in *Deschampsietum caespitose* ob nizki porabi krme (0.5 kg/dan/žival). Na liniji klanja so bile živali posamično stehane in razkosane po metodi popolne disekcije po Wenigerju. Skupini T_I in T_{II} sta se statistično značilno razlikovali po odstotku mišičnega tkiva (38.2 % in 40.5 %) in kosti v trupih (10.6% in 9.7%), medtem ko razlike v deležu maščobe niso bile statistično značilne (34.2 % in 33.8 %). V obeh skupinah smo določili tudi deleže mišičnega, maščobnega in kostnega tkiva v telesnih delih: noge, pleča, ledja, vrat in trebuh.

Ključne besede: prašiči / avtohtone pasme / turopoljski prašič / klavne polovice / mišice / maščoba / kosti / Hrvaška

INTRODUCTION

Turopolje pig breed is Croatian autochthonous breed, belonging to older European pig breeds (Grunenfelder, 1994 and Robić *et al.*, 1996). A number of scientific and professional papers were published about the origin, historical and economic importance and about the factors, which brought this breed into the FAO list of endangered and disappearing breeds (World Watch List for Domestic Animal Diversity, Loftus and Scherf, 1993). This list was formed after signing the Convention on Biological Diversity (CBD) in Rio de Janeiro in June 1992. The Republic of Croatia signed CBD on January 5, 1997 and in 1999. Croatia passes the strategy of biological diversity which includes also Turopolje pig (Radović, 1999).

Table 1 gives the size of breeding population registered in the herdbook of Turopolje pig breed in the years 1996 (the start of the programme of re-establishment and preservation) and 2003 as reported in annual reports of Croatian Livestock Center (CLC, 1997 and 2004).

Table 1. Breeding population of Turopolje pig breed in Croatia
Preglednica 1. Populacija turopoljskega prašiča na Hrvaskem

Year / Leto	Sows / Svinje	Boars Merjasci	Gilts Mladice	Y. boar Mladi merjasci	Piglets Pujski
1996	12	3	-	-	-
2003	99	6	76	3	180

Source: Annual report – pig breeding, CLC (1997, 2004).

The number of sows and boars (Table 1), in addition to the state subsidies, indicates the state of critical endangerment of this breed according to the FAO standards (Loftus and Scherf, 1993), but number of gilts and piglets gives 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. The UCNCT started first in 1996 with preservation by opening herdbook at CLC. This organization, a farmer land community, established in 13th century and legally suppressed in 1947 (Đikić *et al.*, 2002), renewed its activities and included 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, typical for Turopolje pig, is a part of Croatian cultural heritage. Existing research results about characteristics of Turopolje pig are mostly published in the monography “Turopolje pig – autochthonous Croatian breed – turopolka” (Đikić *et al.*, 2002). In 2002 in V. Gorica the 1st symposium with a round table discussion on Turopolje pig was held. There was concluded that UCNCT and Faculty of Agriculture should define a program which would support the re-establishment of the population of Turopolje pig on the economical base.

Following this conclusion and based in the current knowledge about characteristics of Turopolje pig, the objective of this study was to establish slaughtering properties, carcass composition as well as distribution of muscle, fat and bone tissues in parts of carcass of Turopolje pig. Results of this study will be used as a base for defining the characteristics (standards) of today’s Turopolje pig breed, as well as a starting point for breeding and economical program for re-establishment, preservation and definition of production type of this breed.

MATERIAL AND METHODS

Investigation was carried out on two groups of Turopolje breed hogs (T_I $n = 10$ and T_{II} $n = 9$). 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 (about 40 km from 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 in mind the environmental balance as well. No industrial feed, vitamins or minerals were used neither for piglet rearing nor later in the fattening period. The average age of fattened pigs in group T_I was 584 ± 20 days, and in T_{II} 679 ± 20 days.

In the abattoir for each hog the live weight and warm carcass weight were taken. The averages for T_I group were 81.9 ± 6.1 kg and 65.6 ± 4.8 kg, respectively and for T_{II} group 100.3 ± 4.9 kg and 80.1 ± 4.6 kg, respectively. After chilling for 24 hours at $+4^\circ\text{C}$ the weights of cold carcass and of single of halves (the halve on which the tail remained during the cutting of carcass) for the dissection were recorded. The Weniger method (Weninger *et al.*, 1963) was used for cutting the halves into the parts: leg, shoulder, loin, neck, belly-rib part (BRP), less value part (LVP), double chin (DC) and kidney fat (KF). By the method of total dissection each part was dissected into muscle, fat and bone tissues and weights of tissues were recorded. The lard and double chain were weighted separately. On the basis of mass of each tissue in the parts and the mass of halves, the percentage of parts in the carcass and the percentage of tissues in the carcass as well as in the parts of the carcass were established. The descriptive statistics within groups and differences between groups (t-test) were analysed (SAS, 1999).

RESULTS AND DISCUSSION

Carcass composition

According to the results (Table 2) of the experimental groups (T_I and T_{II}), the established values of slaughtering weight indicate very low daily gain in fattened Turopolje pig produced in the outdoor system with technology of low feed input and dependency on capability of each individual animal to utilize the natural resources of the ecosystem. Obtained statistically significant differences between groups (T_I and T_{II}) for slaughtering weight and for cold and warm carcass weights were expected, due to the 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 production system. Analysis of carcass composition (Table 2) within both groups shows that muscle : fat ratio in the carcass without lard is in favour of muscle tissue. If both, fat tissue and lard are included into calculation, than the ratio is 1:1. Pigs in the T_I group had significantly lower share of muscle tissue ($P < 0.05$) and higher share of bone tissue lard and double chain ($P < 0.01$) than animals in the group T_{II} , what could be explained, according to Lawrie (1998), by different age and slaughtering weights. However, statistically significant differences were not found for percentage of fat tissue in the carcass. This indicates that there is a need for the investigation of growth and gain dynamics, and for the 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 ratio in carcass, according to older references (Vukina, 1961, Belić *et al.*, 1961), Turopolje pig is a late-mature fat producing type of pig, together with Mangalitza and Bagun. On the contrary, Horvat (1939), based on own research, concluded 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 not enough fatty for production of fat (which was important at that time). However, if the recorded differences (Table 2) for muscle : fat tissue ratio between groups T_I and T_{II} were compared with the recent data on breeds Mangalitza and Black Slavonian (Kralik and Petričević, 2001; Uremović *et al.*, 2000), than present population of Turopolje pig can be defined as a late mature, combined meatness – fatty type of pig for production in low feed input technology in ecosystem of biocenosis marsh meadows and flood forests (*Deschampsietum caespitosae – Quercetum roboris*). In addition, obtained results (Table 2) indicate that Turopolje pig was not affected 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 the share of fat tissue, in selected breeds. (Đikić and Jurić, 2003). 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 the year 1940 muscle : fat tissue ratio was 0.87:1, while in 1980 it was 1:1. If these figures are compared to the fattened Turopolje pigs, the status of selection according to carcass quality in the remaining population can be illustrated.

Table 2. Carcass (cold) weights and carcass composition of the two groups of Turopolje hogs

Pregladnica 2. Masa (hladnih) trupov in sestava trupov dveh skupin merjascev turipoljske pasme

Group Skupina	Carcass Trup	Tissue, % Tkivo, %			LVP MVD ⁺	KF and DC Ledvična maščoba in podbradek
		kg	M	F		
	$\bar{x} \pm SD$	$\bar{x} \pm SD$	$\bar{x} \pm SD$	$\bar{x} \pm SD$	%	%
T _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**
T _{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**

** = P < 0.01, * = P < 0.05; ⁺ = manj vredni deli

Tissue distribution in the carcass

In the fattened pigs of Turopolje breed, regarding the share of parts in carcass, the leg is in the first place, followed by BRP, shoulder, loin, 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 pigs at different age (Reeds *et al.*, 1993). Analysis of the results (Table 3) shows that Turopolje pig has a higher share of shoulder's and neck (T_I 24.0% and T_{II} 24.3%) and lower share of loin and BRP in carcass, than modern pig genotypes (Đikić and Jurić, 2003, Kralik and Petričević, 2001). Although the data of 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, respectively) (Đikić *et al.*, 2002).

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

Table 3. The tissues distribution and share of parts in the carcass of two groups of Turopolje hogs

Preglednica 3. Porazdelitev tkiv in delež telesnih delov v trupih dveh skupin turopoljskih prašičev

Parts of carcass Deli trupa	Tissue in carcass Tkiva v trupu	Percentage of parts and tissues of these parts in the carcass Odstotek telesnih delov in tkiv v trupu	
		Group / Skupina	
		T _I $\bar{x} \pm SD$	T _{II} $\bar{x} \pm SD$
Leg / Noge	Muscle / Mišice	12.9 ± 0.55	12.7 ± 0.77
	Fat / Maščobno tkivo	10.1 ± 0.70	10.6 ± 0.95
	Bone / Kost	3.0 ± 0.62**	2.4 ± 0.26**
	Total / Skupaj	26.0 ± 0.85	25.7 ± 0.53
Shoulder / Pleča	Muscle / Mišice	7.8 ± 0.19*	8.2 ± 0.52*
	Fat / Maščobno tkivo	5.3 ± 0.78	5.7 ± 0.58
	Bone / Kost	2.0 ± 0.19*	1.6 ± 0.48*
	Total / Skupaj	15.1 ± 0.75	15.5 ± 0.20
Loin / Ledja	Muscle / Mišice	5.5 ± 0.46*	6.6 ± 0.57*
	Fat / Maščobno tkivo	5.3 ± 0.81	5.8 ± 0.47
	Bone / Kost	2.4 ± 0.36	2.4 ± 0.60
	Total / Skupaj	13.2 ± 0.99	14.8 ± 0.63
Neck / Vrat	Muscle / Mišice	4.5 ± 0.44**	5.2 ± 0.44**
	Fat / Maščobno tkivo	2.9 ± 0.39**	2.3 ± 0.33**
	Bone / Kost	1.5 ± 0.27	1.3 ± 0.13
	Total / Skupaj	8.9 ± 0.20	8.8 ± 0.48
BRP Potrebušina z rebri	Muscle / Mišice	6.9 ± 0.71**	7.9 ± 0.37**
	Fat / Maščobno tkivo	11.1 ± 0.83**	9.6 ± 0.79**
	Bone / Kost	2.2 ± 0.16	1.7 ± 0.15
	Total / Skupaj	20.2 ± 0.68**	19.2 ± 0.54**

** = P < 0.01, * = P < 0.05.

Testing of differences between groups T_I and T_{II} showed that heavier and older animals have significantly higher share of muscle tissue in carcass in shoulder (P < 0.05), as well as in the neck and BRP (P < 0.01), while the share of fat tissue from neck and BRP is significantly lower (P < 0.01). Analysis of figures for bone tissue from different body parts shows that younger and lighter Turopolje breed hogs have a higher share of bones from leg (P < 0.01), shoulder and BRP (P < 0.05) than the older and heavier ones. Records (Table 2 and 3) obtained in fattened Turopolje pigs of present population do not suggest that breeding and selection processes in modern pig production had any influence on this population in the sense of increasing muscle : fat tissue ratio in carcass, or in the increase of the ratio between back (leg + back) and front (loin + neck) part of carcass.

The percentage of tissues in some parts of the carcass in two groups of Turopolje hogs are shown in Table 4.

The ratio between muscle and fat tissue in the parts within groups as well as the differences between groups are more than 1 : 1, what indicates the possibilities for utilization for some kind of pork product processing (dry ham, dry loin or various sausages). Obtained values, in addition to the recent results (Grunenfelder, 1994; Robić *et al.*, 1996; Đikić *et al.*, 1999, 2002) confirm

that Turopolje pig is, because of its specific origin (Ritzoffy, 1931 and 1933), 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.

Table 4. Percentage of tissues in the parts of the carcass
Pregladnica 4. Odstotek tkiv v delih trupa

Parts of carcass Deli trupa	Tissue in carcass Tkiva v trupu	Group / Skupina	
		T _I $\bar{x} \pm SD$	T _{II} $\bar{x} \pm SD$
Leg / Noge	Muscle / Mišice	49.2 ± 2.63	49.6 ± 2.90
	Fat / Maščobno tkivo	38.6 ± 2.23	39.7 ± 2.61
	Bone / Kost	12.2 ± 2.35**	10.5 ± 1.45**
Shoulder / Pleča	Muscle / Mišice	52.8 ± 5.15*	54.1 ± 4.39*
	Fat / Maščobno tkivo	34.3 ± 6.37	35.3 ± 4.97
	Bone / Kost	12.9 ± 1.59*	10.6 ± 0.84*
Loin / Ledja	Muscle / Mišice	42.1 ± 4.32*	44.5 ± 2.80*
	Fat / Maščobno tkivo	40.3 ± 4.21	39.7 ± 2.06
	Bone / Kost	17.6 ± 2.99	15.8 ± 1.88
Neck / Vrat	Muscle / Mišice	51.5 ± 4.89**	58.6 ± 3.81**
	Fat / Maščobno tkivo	32.7 ± 5.24**	26.4 ± 3.37**
	Bone / Kost	15.8 ± 2.37	14.9 ± 1.20
BRP Potrebušina z rebri	Muscle / Mišice	37.2 ± 5.83**	40.8 ± 3.04**
	Fat / Maščobno tkivo	52.9 ± .89**	50.7 ± 3.15**
	Bone / Kost	9.9 ± 1.6*	8.5 ± 0.98*

** = P < 0.01, * = P < 0.05.

CONCLUSIONS

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

Present population of Turopolje pig breed is with regard to muscle:fat tissue ratio in the carcass and in each parts of the carcass (1.0–1.2 : 1) late – mature type, what is a consequence of specific historical conditions of selection and production in specific environment of the outdoor system. The carcass composition and the distribution of tissue in single parts of carcass give the opportunity to set up a program which would support re-establishment of the population on the economic base.

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