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Comparison of technological quality of meat and nutritional quality of backfat of Krškopolje pigs and commercial fatteners in Slovenia

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Abstract. Carcass traits, technological quality of *m. longissimus dorsi* and nutritional quality of back subcutaneous adipose tissue of autochthonous Krškopolje pig (KP) and commercial fatteners were compared. Commercial fatteners were classified according to lean meat content in fatty (51.3%), normal (57.9%) and meaty (64.0%) groups. In KP lean meat percentage was 47.8%. *M. Longissimus dorsi* of KP had the lowest pH_{24}, L* and h* and the highest a* values. The backfat in KP had the lowest a* and c*. The highest contents of IMF (1.96 and 1.94%) were observed in KP and fatty groups, respectively. Furthermore, the proportion of saturated fatty acid (SFA) in backfat did not vary between the groups. KP had the highest proportion of monounsaturated fatty acid (50.8%). Lower proportion of polyunsaturated fatty acid (PUFA) was also found in KP compared to the fatty group. Additionally, KP contained 5% less n-6 PUFA than the fatty group. The n-6/n-3 PUFA ratio of the meaty group was significantly higher than in KP. There were no differences in ratio of PUFA to SFA and atherogenic indices among the groups. In conclusion, KP had a better technological quality and nutritional quality of backfat compared to the fatty group of commercial pigs. It was very similar to the normal and meaty groups.

Keywords. Krškopolje pigs – Commercial fatteners – Technological meat quality – Nutritional quality.

Comparaison de la qualité technologique et nutritionnelle de la viande de gras du dos du porc Kraškopolje par rapport à ceux de porcs engraissés industriellement en Slovénie

Résumé. *La qualité de la carcasse, la qualité technologique du muscle Longissimus dorsi et la qualité nutritionnelle de la longe de tissu adipeux sous-cutané du cochon de race Kraškopolje (KP) ont été comparées à celles de porcs engraissés commercialement. La viande engraissée industriellement a été classée en trois groupes suivant la maigreur de la viande : grasse (51,3%), normale (57,9%) et charnue (viandeuse, 64%). Pour le groupe KP, le pourcentage de viande maigre représente 47,8%. Le muscle Longissimus dorsi provenant du groupe KP a les plus faibles valeurs de pH24, L* et h* mais aussi la plus haute valeur pour a*. Le gras du dos dans le groupe KP présente les valeurs a* et c* les plus basses. Les pourcentages plus élevés d'IMF ont été observés respectivement dans les groupes KP (1,96%) et viande grasse (1,94%). Enfin, la proportion d'acides gras saturés (SFA) contenus dans le gras du dos ne varie pas entre les groupes. Le groupe KP est celui qui contient la plus forte proportion d'acides gras mono-insaturés (50,8%). Enfin, il est à noter qu'une plus faible proportion d'acides gras poly-insaturés (PUFA) est retrouvée dans le groupe KP par rapport au groupe viande grasse. C'est le cas pour n-6 PUFA dont la quantité est plus basse de 5% dans le groupe KP que dans le groupe viande grasse. Le rapport n-6/n-3 PUFA est significativement plus élévé dans le groupe viande charnue que dans le groupe KP. Enfin, aucune différence n'a été mise en évidence pour le ratio PUFA/SFA et les indices athérogènes entre les différents groupes. En conclusion, la qualité technologique et nutritionnelle de la longe de tissu adipeux est meilleure dans le groupe KP que dans le groupe viande grasse des porcs élevés industriellement. Enfin, les résultats et les valeurs obtenues pour les groupes viande normale et charnu sont très similaires.*

Mots-clés. *Porc Kraškopolje – Engraisseurs industriels – Qualité technologique de la viande – Qualité nutritionnelle.*

I – Introduction

The Slovenian indigenous Krškopolje pig (KP) is usually under extensive rearing conditions.

Production traits of KP were studied in the past (Ferjan, 1969; Eiselt, 1971). Latter fewer researches were done. In the last decade Kastelic (2001) mentioned meat quality parameters of Krškopolje pigs. Furthermore, Čandek Potokar *et al.* (2003) have compared the carcass traits as well as the technological and sensorial quality of KP with its cross with a modern landrace line – LN 55. However, the composition of KP meat has not yet been investigated.

Technological quality is very important for meat processing. It is determined by technological traits such as pH value, electrical conductivity and colour. Firstly, the effect of pH value and electrical conductivity on technological quality was confirmed by Blendl *et al*. (1991). Further, meat colour, which can be effected by pH value and drip loss, often influences the consumer's choice of product (Ngapo *et al*., 2004). Technological quality of indigenous pig meat is interesting research topic because of its special meat characteristic.

The nutritional quality of meat has been paid considerable attention in research because of its implications for human health. The World Health Organisation (WHO, 2003) recommended an intake of 15-30% energy from fat, with less than 10% of this amount consisting of saturated fatty acids (SFA), 5-8% consisting of n-6 polyunsaturated fatty acids (PUFA) and 1-2% of n-3 PUFA. The nutritional recommendation for the n-6/n-3 PUFA ratio is less than 4:1 (Enser *et al*., 2001). The target ratio of polyunsaturated to saturated fatty acids (P/S) is 0.4 or above and the atherogenic index (AI) should be lower than 0.5 (Ulbricht and Southgate, 1991). To avoid consuming too much fat, people want to purchase lean meat. Therefore, reducing carcass fatness was one of the major breeding goals in farm animals for many years. However, it was likely to be accompanied by lower intramuscular fat levels (De Smet *et al*., 2004), and this had a negative influence on the sensory quality of meat. Dunn (1996) discussed that fattier pigs have more marbling which reflects better meat quality. This is one of the reasons for the better eating quality of meat of indigenous breeds compared to modern breeds.

Very little research has been done on the meat quality of the Slovenian indigenous breed Krškopolje pig. The present study compared the technological of *m. Longissimus dorsi* (LD) and nutritional quality of back subcutaneous fat tissue in Krškopolje pigs and commercial fatteners in Slovenia.

II – Material and methods

Ten KP originating from a small organic farm in the Pomurje region, were fed with organic feed in outdoor conditions. Commercial fatteners were fed with standard fattening feed mixture in a conventional indoor environment. On the slaughter line 43 commercial fatteners were randomly chosen. In order to compare the meat and fat quality, three groups of commercial fatteners were formed according to lean meat content.

Carcass traits for all animals were measured using the standard Slovenian on-line grading system at slaughter (EC, 2005). After slaughter the warm carcasses were weighted. The pH was obtained 24 hrs (pH_{24}) post mortem by pH meter Metter Toledo (MA130 Ion Meter) in LD and *m. semimembranosus* (SM). The electrical conductivity was measured with conductometer LF/PT-STAR (Matthäus) also in LD and SM 24 hrs post mortem ($COND_{24}$). Colour (L*, a*, b*) was measured in LD cut at the last rib 24 hrs post mortem by Minolta Chromameter CR300 (Minolta Camera Co., Osaka, Japan).

Samples of LD and back subcutaneous adipose tissue were taken 24 hrs after slaughter at the last rib. They were packed in vacuum bags and stored frozen at -21°C ± 1°C until chemical analyses. Intramuscular fat content (IMF) in muscle samples was determined by the Weibull-Stoldt method (AOAC, 1997). Fatty acids methyl esters (FAME-s) from samples were prepared using the Park and Goins method (1994). The results were expressed as a percentage of total fatty acids. The statistical model included group effect (G_i) and adjustment for carcass weight. Analysis was carried out using the GLM procedure in SAS/STAT (SAS Inst. Inc., 2001).

III – Results and discussion

The average warm carcass weight varied from 82.5 kg in the meaty group to 93.3 kg in KP (Table 1). The carcass weights of the KP and fatty groups were similar. Lean meat percentage was 47.8% in KP, and 51.3%, 57.9% and 64.0% in the fatty, normal and meaty groups, respectively. Thus, the differences among groups were largely caused by variations in back subcutaneous adipose tissue as well as muscle thickness. Lack of breeding is reflected in thicker backfat and thinner muscle compared to commercial pigs. Although pigs from meaty group were lighter than KP, they have 15 mm thicker muscle, and only one third the back subcutaneous adipose tissue thickness. The carcass weights of KP pigs were similar to those of the fatty group. However, the carcass traits describing body composition were in favour of the fatty group.

Table 1. Carcass traits in experimental groups of pigs

	KP (n=10)		Fatty (n=14)		Normal (n=15)		Meaty (n=14)	
	$\bar{x}$	±SD	$\bar{x}$	±SD	$\bar{x}$	±SD	$\bar{x}$	±SD
Carcass weight (kg)	93.3	±12.8	92.9	±11.1	88.3	±13.2	82.5	±9.4
Backfat thickness (mm)	33	±7	24	±5	16	±5	10	±2
Muscle thickness (mm)	61	±5	67	±7	72	±8	76	±9
Lean meat content (%)	47.8	±2.5	51.3	±2.4	57.9	±4.0	64.0	±3.2

KP – Krškopolje pigs.

Technological quality parameters (Table 2) showed no differences in pH value measured 24 hrs after slaughter between groups. Conductivity after 24 hrs in *m. longissimus dorsi* was smaller in KP (3.77 mS/cm) than by fatty (6.36 mS/cm) and meaty (6.40 mS/cm) commercial fatteners.

Result shows better technological quality of KP, because border threshold for normal quality is under 6 mS/cm (Blendl in sod., 1991). Krškopolje pigs had darker and more red meat in comparison with commercial fatteners (Table 2). The result was nearer to desirable value for pig meat 42 – 46 (PIC, 2003) in KP.

Intramuscular fat content in LD of Krškopolje and fatty pigs was around 2% (Table 2). The lowest content of IMF (1.4%) was observed in the meaty group. There were no differences in IMF between KP and the fatty and normal groups. Although KP had greater amount of adipose tissue pigs (Table 1), they do not accumulate IMF (Table 2), possible because barren environmental condition. Kuhn *et al*. (1997) compared a local German breed, the German Saddle Back with commercial Landrace pigs, finding that the former had twice the IMF content of the latter (2.87% and 1.33%). Result confirmed that indigenous breeds have a higher capacity for lipid deposition and are expected to have higher IMF content (Kuhn *et al*., 1997).

The nutritional quality of subcutaneous adipose tissue is important as backfat is widely used in manufactured meat products (Reichardt *et al*., 2003). In the current study, the proportion of SFA in the back subcutaneous adipose tissue did not vary between the groups (Table 3). The KP had the highest proportion of MUFA (50.8%) and a lower proportion of PUFA than the fatty group. It has been suggested that an adipose tissue of good nutritional quality should contain less than 15% PUFA (Houben and Krol, 1983). With 13% PUFA the subcutaneous adipose tissue of KP was fulfilled these suggested levels.

Table 2. Technological quality parameters of *m longissimus dorsi* and *m. semimembranosus* by KP and commercial pigs

Variable	KP (n=10)	Fatty (n=14)	Normal (n=15)	Meaty (n=14)	SEM	p - value
pH_{24} LD	5.49	5.65	5.57	5.54	0.07	0.3101
pH_{24} SM	5.57	5.87	5.77	5.74	0.09	0.0959
$COND_{24}$ LD (mS/cm)	3.77^{b}	6.36^{a}	5.80^{ab}	6.40^{a}	0.69	0.0222
$COND_{24}$ SM (mS/cm)	8.09	8.53	8.77	7.71	0.88	0.7608
L*	48.10^{b}	51.98^{a}	52.69^{a}	53.83^{a}	1.07	0.0016
a*	9.50^{a}	7.63^{b}	7.36^{b}	7.43^{b}	0.51	0.0085
b*	2.38	3.31	3.35	3.09	0.35	0.1562
c*	9.80	8.37	8.12	8.07	0.56	0.0944
h*	0.25^{b}	0.43^{a}	0.45^{a}	0.42^{a}	0.04	0.0010
IMF content (%)	1.96^{a}	1.94^{a}	1.70^{ab}	1.40^{b}	0.15	0.0462

KP – Krškopolje pigs; SEM – standard error of mean; COND – conductivity; LD – *m. longissimus dorsi*; SM – *m. semimembranosus*; IMF – intramuscular fat; superscripts within the same line are significantly different ($p < 0.05$)

Table 3. Nutritional quality parameters of subcutaneous adipose tissue by KP and commercial pigs

Variable	KP (n=10)	Fatty (n=14)	Normal (n=15)	Meaty (n=14)	SEM	p -value
Saturated fatty acids	36.13	38.48	39.24	37.63	0.97	*0.0781*
Monounsaturated fatty acids	50.81^{a}	43.35^{b}	44.70^{b}	43.96^{b}	0.85	<0.0001
Polyunsaturated fatty acids	12.72^{b}	17.85^{a}	16.05^{ab}	17.02^{ab}	1.40	0.0403
n-6 PUFA	11.64^{b}	16.56^{a}	14.85^{ab}	15.90^{ab}	1.29	0.0289
n-3 PUFA	0.97	1.19	1.08	0.97	0.12	0.5974
n-6 PUFA/n-3 PUFA	12.09^{b}	14.86^{ab}	14.77^{ab}	16.56^{a}	0.93	0.0087
PUFA/SFA	0.35	0.47	0.42	0.44	0.05	0.2522
Atherogenic index	0.44	0.47	0.48	0.48	0.02	0.2648

KP – Krškopolje pigs, SEM – standard error of mean; n-6 – omega 6; n-3 – omega 3; PUFA – polyunsaturated fatty acids; SFA – saturated fatty acids; superscript within the same line are significantly different ($p < 0.05$)

Differences among groups were also found in proportions of n-6 PUFA and in the n-6/n-3 PUFA ratio (Table 3). The KP contained 5% less n-6 PUFA than the fatty group. The n-6/n-3 PUFA ratio of the meaty group was significantly higher than the KP. Furthermore, the n-6/n-3 PUFA ratio of all the groups (Table 3) exceeded the nutritional recommendation of 4:1 (Enser *et al*., 2001). High n-6 PUFA compared to n-3 PUFA proportions in subcutaneous adipose tissue could be explained by the use of feed components rich in C18:2n-6, such us wheat and barley (Souci *et al*., 2000). Fatty acids n-3 PUFA are present in many feed ingredients but at lower levels than n-6 PUFA (Wood *et al*., 2008). There were no differences in P/S and AI indices among the groups (Table 3).

IV – Conclusions

The organically raised Krškopolje pigs had lower electrical conductivity, more dark and red colour of *m. longissimus dorsi* compared to commercial fatteners. Higher intramuscular fat content were observed in KP and fatty than meaty pigs.

Fatty acid composition of back subcutaneous adipose tissue of KP was nearer to the normal and meaty groups than fatty group. Krškopolje pigs had higher MUFA content than commercial fatteners, lower PUFA and n-6 PUFA than fatty group and lower n-6/n-3 index than meaty group.

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