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CARCASS AND MEAT QUALITY TRAITS OF PIG FATTENERS FROM SLOVENIAN BREEDING PROGRAMME

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ABSTRACT

The aim of the present study was the comparison of carcass and meat quality traits of commercial pigs of various crossbreeds from two major Slovenian herds. The analysis is based on phenotypic data from field trials which have been collected in the last past five years within the Slovenian breeding programme. Important differences in carcass traits were observed between two herds and were associated to different crossbreeds used. In spite of that economically important result on the slaughter line (lean meat %) was similar for both herds. Meat quality traits were also significantly different between the two herds. Again, the difference could be ascribed to crossbreeds used. However, since the herd effect is connected with abattoir effect, different *ante-mortem* conditions and/or lower robustness of these animals to premortal stress could also be contributed to the observed differences. The presented results give important information on the state-of-the-art regarding meat quality of Slovenian pigs.

Key words: pigs / carcass quality / meat / breeding programs / Slovenia

KAKOVOST TRUPA IN MESA PRAŠIČEV IZ SLOVENSKEGA REJSKEGA PROGRAMA

IZVLEČEK

Cilj raziskave je bila primerjava lastnosti klavnega trupa in mesa komercialnih prašičev pitancev različnih križanj iz dveh največjih slovenskih čred. Analiza je temeljila na fenotipskih podatkih, ki smo jih zbirali zadnjih pet let v okviru slovenskega rejskega programa. Med čredama smo ugotovili pomembne razlike v lastnostih trupa, ki jih lahko pripišemo razlikam v genotipih prašičev (križanjih), nismo pa ugotovili razlik v ekonomsko pomembnem rezultatu, deležu mesa v trupu, ki je bil podoben v obeh čredah. Lastnosti kakovosti mesa so bile med čredama prav tako statistično značilno različne. Tudi v tem primeru lahko razlike v veliki meri pojasnimo z genotipi prašičev (križanj), vendar pa zaradi povezanosti vpliva črede z vplivom klavnice del razlik lahko izhaja tudi iz različnih razmer *ante-mortem* in/ali manjše robustnosti živali na premortalne stresne dejavnike. Predstavljeni rezultati so pomembna informacija o stanju na področju kakovosti mesa prašičev v Sloveniji.

Ključne besede: prašiči / klavna kakovost / meso / rejski programi / Slovenija

INTRODUCTION

In the past years, Slovenian pig breeding has been characterized by a substantial improvement of carcass leanness (Čandek-Potokar *et al*., 2004; Malovrh *et al*., 2007), while no information is available regarding the possible consequences of the increased lean meat content for the quality of meat. In general, the payment of pigs is based on the carcass quality (carcass weight and lean meat percentage), while no regard is paid to meat quality. Carcass and meat quality are considered to be reversely correlated (Huff-Lonergan *et al*., 2003), meaning that improving leanness would lead to the reduction of meat quality (e.g. high leanness is associated with undesired bright colour, low pH and high drip loss). Both carcass and meat quality are complex and multivariate properties which are influenced by multiple interacting factors. These include breed, genotype (e.g. Halothane gene, RN^- gene), feeding, and other rearing conditions, pre-slaughter handling, stunning and slaughter method, chilling and, storage conditions (Rosenvolt and Andersen, 2003).

In Slovenia, carcass and meat quality traits of pig fatteners of different crossbreeds have been monitored for the last five years in two major herds (with yearly production over 100 000 carcasses). The protocols for data collection and methods of evaluation are still under testing however, the results obtained provide us with some valuable information about the state-of-the-art and will be presented and discussed in this paper.

MATERIAL AND METHODS

Animals and harvesting

Present analysis is based on a phenotypic data collection from field trials conducted over a period of five years (2003–2008). Pigs originate from two herds and were slaughtered in two abattoirs in 28 batches (*i.e.* the effect of herd is linked to the effect of the abattoir). The initial data set consisted of 1 028 pigs. However, for the present analysis we retained only crossbreeds where the following condition was met: at least 50 pigs slaughtered in at least 3 batches giving a total of 871 pigs of various crossbreeds. Herd 1 is represented by 736 pigs of 5 different crossbreeds: Slovenian Landrace (line 11) crossed to Large white (LN11×LW) which is also a female line for crosses sired by Pietrain×Duroc (×PI-DU), Pietrain (×PI), Slovenian Landrace (line 55)×Pietrain (×LN55-PI), Hampshire×Pietrain (×HA-PI). Herd 2 is represented by 135 pigs of only one line (×DU-HA sired pigs). Pigs were approximately 6 months old. Animals were slaughtered according to the routine abattoir procedure *i.e.* CO_2 stunning, vertical exsanguination, vapour scalding, dehairing and evisceration followed by the veterinary inspection and the SEUROP carcass classification. Two abattoirs differed in the chilling conditions (herd/abattoir 1 uses blast chilling).

Carcass and meat quality measurements

Shortly (within 45 minutes) after slaughter, the measurements of muscle (HGP muscle) and fat thickness (HGP fat) using a HGP4 Hennessy grading probe (Hennessy Grading Systems Ltd., Auckland, New Zealand) were taken with a puncture between the 2nd and the 3rd last rib 7 cm laterally from the carcass split line. The carcass lean meat percentage (HGP meat %) was calculated according to the formulae recently approved for Slovenia (Commission decision OJ EU L56/28). One day after slaughter, further carcass and meat quality measurements were performed. The hind leg was cut off the carcass between 6th and 7th lumbar vertebra and shank was removed. The weight of the leg (Ham) was recorded before and after the removal (Ham (m+b)) of the skin and subcutaneous fat. A cross section of carcass was made at the level of the last rib and a digital image of the cross section was taken using digital photo camera (Canon PowerShot G3, Canon Inc., Tokyo, Japan). *Longissimus dorsi* muscle area (LD area), corresponding fat area (Fat over LD) and their ratio (LD meat:fat ratio), belly leanness were determined on images with a support of LUCIA.NET 1.16.5 software (Laboratory Imaging s.r.o, Prague, Czech Republic). The measurements of colour and pH were taken on the freshly cut surface of LD. Colour of LD was assessed using a 6 point Japanese colour scale (Nakai *et al*., 1975). Colour parameter measurements (CIE L*, a* and b*) were taken in triplicate using a Minolta Chroma Meter CR-300 (Minolta Co. Ltd, Osaka, Japan) with an 11 mm diameter aperture, D_{65} illuminant, calibrated against a white tile. Muscle pH was determined in two replicates in the central area of the *LD* using a MP120 Mettler Toledo pH meter (Mettler-Toledo, GmbH, 8603 Schwarzenbach, Switzerland) fitted with a combined glass electrode (InLab427) and previously calibrated at pH 4.0 and 7.0. Also a 2.5 cm thick slice of LD was removed from the loin at the level of the last rib for drip loss determination according to the method (EZ drip loss) published by Christensen (2003). Drip loss was determined after 24 and 48 hours storage at 4 °C and expressed as a percentage of the initial weight.

Statistical analysis

Statistical analysis was performed using a statistical package SAS (SAS Inst., Inc., Cary, NC). The analysis of variance was performed with the MIXED procedure, with a model including the fixed effects of herd/abattoir, crossbreed within herd, gender and carcass weight as a covariate, while slaughter batch within abattoir was included as a random effect. Significant differences between least square means (LSM) were evaluated using the PDIFF option, adjust = Tukey.

RESULTS AND DISCUSSION

Carcass properties

A general observation is that pigs fattened in Slovenia provide high leanness of carcasses (various crosses yielded from 58.3–60.8% of carcass lean meat content). In comparison to the time when SEUROP classification was first introduced in Slovenia (Čandek-Potokar *et al*., 2004; Malovrh *et al*., 2007) this represents an important progress. The differences between two herds and the crossbreed within herd on various carcass traits are presented in Table 1. Overall, the effect of herd was statistically significant ($P < 0.05$) for the following traits: for HGP muscle thickness, muscle, fat area and meat to fat ratio at the cross-section of LD muscle and on ham weight. Pigs from herd 1 were in average more muscular (bigger LD muscle, heavier ham) but had also thicker fat compared to the pigs from herd 2. This explains why in average similar lean meat percentage was consequently observed for both herds. Pigs from herd 2 on the other hand exhibited better LD meat to fat ratio and leaner belly compared to pigs from herd 1. Comparison of differences among crossbreeds within herd (lsmeans adjusted for carcass weight) showed the significance for practically all carcass traits. In herd 1, for which various crossbreeds were tested, ×PI sired pigs, showed highest muscularity and lean meat percentage. Among other crosses, the offspring sired ×LN55-PI yielded the lowest carcass leanness. The crossbreed LN11×LW, which is normally used as female line, was the least muscular (the smallest LD muscle, the lightest ham), however due to relatively low fat thickness the overall lean meat percentage was quite high. Regarding the pigs of herd 2 which were ×DU-HA sired, it is of interest to compare them with the ×PI-DU sired offspring or ×HA-PI sired offspring. Results show that although pigs from herd 2 sired ×DU-HA provided carcasses with lower muscularity and ham weight the overall result on the slaughter line was practically the same due to lower fat thickness (with regard to HGP meat % these pigs are the closest to the most lean ×PI crosses). It is worth noting that this result is calculated with a recently approved formulae for carcass classification and that it is not abattoir (operator) dependent since the measurements with HGP4 probe (as well as other measurements) were always made by the same person. The differences between the herds observed in the present study can, to our opinion, be explained with the crossbreeds used within herds. Namely, in our recent study (Škrlep *et al.*, 2008), 42% of pigs sired ×HA-PI or ×PI from this herd were carriers of ryr1 mutation, which is known for beneficial impact on muscularity.

Table 1. The effect of herd and crossbreed on carcass traits [1]

	† Herd		P	Crossbreed within herd 1					P
	1	2		LN11×LW	×PI-DU	×PI	×LN55-PI	×HA-PI	
N	736	135		94	116	296	65	165	
Carcass weight, kg	87.2 (0.9)	89.9 (2.9)	0.388	89.1 (1.8)	88.3 (1.8)	86.2 (1.1)	86.2 (1.5)	86.2 (1.2)	0.161
[2] HGP fat, mm	15.2 (0.3)	14.2 (0.7)	0.213	14.5ab (0.5)	15.0ab (0.4)	14.4a (0.3)	16.7c (0.5)	15.4b (0.4)	<.000
[2] HGP muscle, mm	59.3 (0.4)	57.4 (0.8)	0.042	56.4a (0.8)	60.7b (0.7)	62.5c (0.4)	57.0a (1.0)	59.8b (0.6)	<.000
[2] HGP meat %	59.7 (0.2)	60.5 (0.7)	0.333	60.1bc (0.5)	60.0b (0.4)	60.8c (0.3)	58.2a (0.5)	59.6b (0.4)	<.000
[3] LD area, cm^2	49.5 (0.3)	47.9 (0.9)	0.107	46.6a (0.7)	50.0b (0.7)	52.6c (0.4)	48.6ab (0.8)	49.8b (0.5)	<.000
[3] Fat over LD, cm^2	15.3 (0.2)	13.6 (0.6)	0.054	15.5b (0.4)	15.0ab (0.4)	14.3a (0.3)	16.9c (0.5)	14.9ab (0.3)	<.000
[3] LD meat : fat ratio	3.40 (0.06)	3.78 (0.15)	0.022	3.20ab (0.12)	3.47b (0.11)	3.81c (0.07)	3.02a (0.14)	3.48b (0.09)	<.000
[3] Belly leanness, %	52.1 (0.9)	63.4 (3.0)	0.021	52.9bc (1.3)	55.0c (1.2)	53.4c (1.0)	48.0a (2.0)	51.0ab (1.4)	0.008
Ham (m+b), kg	9.33 (0.06)	9.08 (0.18)	0.195	8.73a (0.13)	9.35b (0.11)	9.75c (0.07)	9.34b (0.13)	9.48b (0.09)	<.000
Ham, kg	11.28 (0.05)	10.76 (0.15)	0.003	10.89a (0.11)	11.25b (0.10)	11.56c (0.06)	11.34b (0.12)	11.34b (0.08)	<.000

[1] Least squares means (± standard error); [2] measurements taken with HGP4 within 45 minutes *p.m.* probe with puncture between 2nd and 3rd last rib*;* [3] measurements/ notes taken behind the last rib; [a, b] Least squares means followed by a different letter are significantly (P < 0.05) different; † Herd 1 = various crosses, Herd 2 = ×DU-HA cross*A*.

Meat quality

The effect of herd and crossbreed on meat quality traits is presented in Table 2. The differences in meat quality traits between the two herds were significant (P < 0.05) or tended towards significance (P < 0.10). Overall, the pigs of herd 2 (crossbreed ×DU-HA) exhibited better meat quality compared to the pigs of herd 1; they had higher pH_{24}, more intense colour and lower drip loss. Especially impressive were the differences between the two herds for HGP colour and drip loss.

The differences between the crossbreeds within herd1 were also significant for pH_{24} and colour. In that case, it was the LN11×LW crossbreed which was different from others. Given the experimental design (*i.e.* abattoir effect associated with herd effect, difference in number of pigs and crossbreeds between herds) in the present study, it is difficult to point with a certainty at the cause for the observed differences in meat quality between the two herds. Namely, lower meat quality of pigs from herd 1 seems to be associated with the crossbreeds used. As observed in our recent study (Škrlep *et al.*, 2008), pigs sired HA×PI or ×PI from this herd were proven to be carrier of ryr1 (42%) or RN⁻ (17%) mutation, both well known to deteriorate the quality of meat. In the formerly mentioned study, no presence of ryr1 or RN⁻ mutation was proven in herd 2 (pigs sired by DU-HA). In the present study the LN11×LW pigs from herd 1 were also free of detrimental ryr1 and RN⁻ mutations. Indeed, they represent intermediate position (pH_{24}, HGP colour, drip loss) between pigs from herd 2 and other crosses of herd 1 (data not shown). It is worth mentioning that HGP colour of LN11×LW crosses tended ($P < 0.10$) to be different from other crosses within herd 1 while the difference to pigs sired ×DU-HA (herd 2) was insignificant. HGP colour is taken within 45 minutes after slaughter and thus used as an indicator of the intensity of *post-mortem* glycolysis which can induce heat shortening and protein denaturation and reduce the water holding capacity of meat (Honikel, 2004).

Table 2: The effect of herd and crossbreed on meat quality traits [1]

	† Herd		P	Crossbreed within herd 1					P
	1	2		LN11×LW	×PI-DU	×PI	×LN55-PI	×HA-PI	
	736	135		94	116	296	65	165	
pH_{24}	5.51 (0.01)	5.66 (0.04)	0.001	5.58^{b} (0.03)	5.49^{a} (0.02)	5.49^{a} (0.01)	5.51^{ab} (0.02)	5.49^{a} (0.02)	0.029
[2] HGP colour	68.1 (5.1)	42.0 (14.8)	0.108	57.4 (8.1)	72.1 (5.5)	70.5 (5.2)	70.3 (5.4)	70.1 (5.2)	0.419
LD colour (1–6)	3.6 (0.05)	3.9 (0.14)	0.043	3.4^{a} (0.10)	3.7^{ab} (0.08)	3.6^{a} (0.06)	3.7^{ab} (0.10)	3.8^{b} (0.07)	0.002
Minolta L*	50.9 (0.3)	49.0 (0.9)	0.058	49.8^{a} (0.6)	51.1^{ab} (0.5)	51.8^{b} (0.4)	51.3^{ab} (0.6)	50.4^{a} (0.4)	<.000
Minolta a*	7.3 (0.1)	6.5 (0.4)	0.053	6.4^{a} (0.3)	7.1^{b} (0.2)	7.5^{b} (0.2)	7.4^{b} (0.3)	8.2^{c} (0.2)	<.000
Minolta b*	3.4 (0.1)	2.6 (0.4)	0.079	2.7^{a} (0.3)	3.5^{b} (0.2)	3.7^{b} (0.2)	3.6^{b} (0.2)	3.7^{b} (0.2)	0.011
Ratio a*/b*	2.4 (0.1)	3.2 (0.4)	0.045	3.0^{b} (0.3)	2.2^{a} (0.3)	2.2^{a} (0.2)	2.1^{a} (0.3)	2.5^{ab} (0.2)	0.052
[3] Drip 24h, %	3.9 (0.3)	2.0 (0.6)	0.012	3.5 (0.4)	4.0 (0.4)	4.3 (0.3)	3.4 (0.6)	4.1 (0.4)	0.289
[3] Drip 48h, %	5.9 (0.4)	3.6 (0.7)	0.013	5.6 (0.5)	5.3 (0.9)	6.5 (0.5)	5.6 (0.8)	6.4 (0.5)	0.325

[1] Least squares means (± standard error); [2] measurements taken within 45 minutes *p.m.* with HGP4 probe with puncture between 2nd and 3rd last rib; [3] drip loss assessed according to EZ method (Christensen, 2003); [a, b] Least squares means followed by a different letter are significantly ($P < 0.05$) different; † Herd 1 = various crosses, Herd 2 = ×DU-HA cross.

To conclude, the differences in meat quality between commercial pigs from two Slovenian herds can to a certain extent be explained by the differences in crossbreeds used; however since the pigs were slaughtered in two different facilities part of the differences might be due to different *ante-mortem* conditions and/or to lower robustness of these animals to premortal stress.

CONCLUSIONS

Commercial pigs from two Slovenian herds were compared for carcass and meat quality traits. Important differences in carcass traits were found between herds and different crossbreeds; however, the economically important result on the slaughter line (lean meat %) was similar for both herds. The differences between two herds were more important in regard to meat quality and could be related to crossbreeds used. Nevertheless it is probable that results are at least partly due to different *ante-mortem* conditions and/or to lower robustness of these animals to premortal stress. Presented results, although rough, give important information on the state-of-the-art regarding meat quality of Slovenian pigs.

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