MEAT QUALITY IN LITHUANIAN COMMERCIAL PIGS OF DIFFERENT LEANNESS

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Abstract. The objective of the study was to examine and compare meat quality characteristics of Lithuanian commercial pigs of different leanness and estimate relationships between parameters.

Thirty eight animals used were females and castrated males from four large pig units in Lithuania. No genetic information was obtained on the used pigs. All animals were slaughtered according to routine abattoir procedures in conformity with the regulations and guidelines. The increase of carcass leanness was associated with the backfat thickness decrease. Carcass cooling loss positively correlated with the backfat thickness ($P<0.05$) and insignificantly negatively with the lean meat content. There were no significant differences between the levels of carcass leanness in the chemical composition of the longissimus muscle. The colour values representing meat redness and yellowness showed differences between the groups. Thawing loss percentages were negatively correlated ($P<0.01$) with the intramuscular fat content ($r=-0.42$) and pH ($r=-0.49$). The correlation between the drip loss and carcass cooling loss in lean commercial pigs was 0.400 ($P<0.05$).

Keywords: meat quality, leanness, pigs.

Introduction. The quality of meat can be expressed by several quality characteristics such as flavour or nutritional value. Hofmann (1973) defined four groups of quality characteristics such as eating quality, nutritional quality, technological quality and hygienic quality to describe objectively meat quality. Many other authors (Otto et al., 2004) supported this opinion and in general meat quality is defined as the sum of all meat quality characteristics. Traditionally, pig breeding programmes have focused on the genetic improvement of production traits, such as growth rate, lean meat percent, feed efficiency and piglet production, because these traits are economically important. These traits are based on the current and fluctuating market economy and can be considered as a short-term goal (Olesen et al., 2000; Kanis et al., 2005). However, modern pig production could not be any longer focused on just economically efficient pork production. Consumers press pig producers also to take other aspects into account, such as the safety and quality of pork. Although consumers find meat quality to be important, at present most of them do not pay substantially more for better pork quality, and producers are not rewarded for improving the pork quality (Knap et al., 2002). Therefore, if pig breeders decide to select for meat quality, it should be treated predominantly as a trait with non economic value (Kanis et al., 2005). It was shown that the response for the selection for increased pig leanness and improved feed efficiency will increase the incidence of PSE meat and reduce intramuscular fat content (Knapp et al., 1997; Hermesch et al., 2000; Gjerlaug-Enger E. et al., 2011). In order to have a sustainable breeding for carcass and production traits, and to avoid further deterioration as a result of selection for higher leanness and feed efficiency, the meat and fat quality must be taken into consideration (Hermesch et al., 2000; Gjerlaug-Enger E. et al., 2011).

Although Lithuanian pig industry use foreign lean breeds, the pork produced in Lithuania was found to be of higher quality compared to imported meats (Garmienė et al., 2010). Meat quality from different pig breeds bred in Lithuania was evaluated (Stimbirys and Jukna, 2010), however, there is a lack of information about meat quality from the pigs of different leanness. As technological and genetic tools to improve pigs resulted in fat reduce and lean meat yields increase, it is important to understand the relationships between fat, muscling and meat quality. Therefore, the objective of the present study was to examine and compare meat quality characteristics of Lithuanian commercial pigs of different leanness and estimate relationships between parameters.

Materials and methods. Thirty eight animals used were females and castrated males from four large pig units in Lithuania. No genetic information was obtained on the used pigs. All animals were slaughtered according to routine abattoir procedures in conformity with the regulations and guidelines (electrical stunning, vertical exsanguinations, scalding, dehairing (if necessary) and evisceration followed by veterinary inspection and carcass evaluation. The carcass hot weight and leanness were recorded within 45 min post mortem. Carcass weight included head, skin and legs without viscera, internal organs, flare fat, kidneys, diaphragm, genitals and tail. Backfat thickness and lean meat content were measured on the left carcass side at the site "Fat_2" between the third and fourth from the last rib 60 mm off the dorsal midline by one operator using optical device grading - probe with Fat-o-Meat'er S70 (FOM). The carcasses according to their measurements were selected in four leanness categories (<56, 56 to 59.9, 60 to 61.9 and ≥62 % of lean meat content).

Eviscerated carcasses were chilled for 24 h at +2-4^{0}C. After twenty-four hours post-mortem, carcasses were weighed again to determine cold carcass weight. Cooling loss was calculated as difference between warm and chilled carcass weight in percentage. The samples of *M. longissimus dorsi* (LD) were removed from the loin of the left side of the carcasses and transported to the laboratory for meat characteristics and quality assessment.

Technological meat quality was determined approximately 48 h post mortem. Ultimate muscle pH value was determined using pH meter Inolab 3. Meat colour was determined by measuring L*, a* and b* values representing lightness, redness and yellowness, respectively, with a Minolta Chromameter 410. Water holding capacity of LD was determined as drip loss by the method of Honikel (1998). Samples for determination of thawing loss were frozen for 5 days at -20ºC. After thawing at ambient temperature, the thawing loss of LD was determined as weight difference of frozen and defrosted muscles (Heyer et al., 2004). Defrosted samples were also analysed for meat chemical content. Dry matter content was determined by drying sample in an oven at 105˚C until a constant weight was obtained (method No 950.46B; AOAC, 1990). Crude protein content was determined by the Kjeldahl method using the Kjeltec system 1002 apparatus (Foss-Tecator AB), and a conversion factor of 6.25 was used to convert total nitrogen to crude protein (method No 981.10; AOAC, 1990). Intramuscular fat was determined by the Soxhlet extraction method (method No 960.39; AOAC, 1990). Ash was determined by incineration in a muffle furnace at 550˚C for 24 h (method No 920.153; AOAC, 1990). The content of protein, intramuscular fat and ash was expressed as the weight percentage of dry matter from muscle tissues.

Statistical analysis was performed with the general linear model (GLM) procedure in SPSS 17.0. The main carcass data and meat quality parameters were analysed using univariate analysis of variance. The model included the fixed effect of carcass leanness. Tukey`s HSD significance test was used to ascertain the existence of significant differences between the traits and where they occurred. Bivariate correlation (Pearson`s correlation coefficients) was calculated.

Significance was determined at $P<0.05$, but differences of $0.05\leq P<0.10$ would be considered as trends.

Results and discussion. The increase of carcass leanness was associated with the backfat thickness decrease ($P<0.001$; Table 1). Cooling loss (carcass weight loss during chilling) tended to be 0.56% higher ($P=0.083$) in the carcasses with the lean meat content under 55.9 % than in the carcasses with 56.0–59.9% lean meat content. This is in agreement with the data of Müller et al. (2000) who found higher cooling losses in fatty Meishan than in leaner Pietrain carcasses. These authors also reported that the loss percentages were positively correlated with the meat amount in carcass. In the present study carcass cooling loss positively correlated with the backfat thickness ($P<0.05$) and insignificantly negatively with the lean meat content (Table 4). There were no significant differences between the levels of carcass leanness in the chemical composition of the longissimus muscle (Table 2). In the previous studies intramuscular fat content in the meat of fatty Lithuanian indigenous pigs was found higher (2.51-3.45%) (Šveistys et al., 1999). The comparison of the pig breeds showed that the traditional British breeds of pigs tended to have higher muscle lipid concentrations and more tender meat than modern lean breeds (Wood et al. 1997). Regarding the technological meat quality traits, in the present study only the colour values representing meat redness and yellowness showed differences between the groups (Table 3). CIE a* colour score mean of meat redness was higher in the longissimus muscles from leaner carcasses ($P<0.05$). Piao et al. (2004) reported that higher a* value was affected by increased weight. In this study higher a* values were detected in the muscles from lean heavier carcasses and this is in agreement with our previous study (Razmaitė et al., 2011). However, there were no the carcass leanness x weight interactions for the colour scores. In contrast, Čandek-Potokar et al. (1998) did not found any effect of increased weight. CIE b* of meat yellowness was higher in the muscles from the leanest carcasses with 62% and more lean meat content than from the carcasses with 56.0-59.9% lean meat content ($P<0.05$). The main parameters of technological meat quality from current Danish Landrace and unimproved genotype were similar for both pig types (Oksbjerg et al., 2000). In contrast, Stimbirys and Jukna (2010) have found that cooking loss and drip loss in the meat of lower leanness pigs - Lithuanian White old genotype were the lowest in comparison with improved genotype of Lithuanian White pigs and foreign breeds. The unfavourable genetic correlations between the lean meat content and meat quality were reported by Knapp et al. (1997). Although in the present study there were no significant differences between the means of most meat quality traits, thawing loss percentages were negatively correlated ($P<0.01$) with the intramuscular fat content ($r=-0.42$) and pH ($r=-0.49$). Lower intramuscular fat content increases water percentage in the meat, resulting in more water available for drip loss during storage (Klont et al., 2001; Suzuki et al., 2005). The correlation between drip loss and carcass cooling loss in lean commercial pigs was 0.40 ($P<0.05$) (Table 4).

Table 1. **Carcass characteristics by lean meat content**

Variables	Lean meat content			
	Under 55.9 (n=9)	56.0-59.9 (n=9)	60.0-61.9 (n=11)	62.0 and higher (n=9)
Hot carcass weight, kg	77.73±14.84	68.12 ± 8.85^{a}	85.26 ± 8.95^{b}	73.88±12.59
Cold carcass weight, kg	75.77±14.62	66.71 ± 8.71^{a}	83.59 ± 8.98^{b}	72.40±12.39
Cooling loss, %	1.97 ± 0.85^{at}	1.41 ± 0.28^{bt}	1.66±0.24	1.44±0.27
Backfat thickness, mm	19.44 ± 3.13^{e}	12.33 ± 1.00^{f}	$12.55\pm1.04^{a,\ f}$	$10.00\pm0.71^{b,\ f}$
Lean meat content,%	52.23 ± 3.22^{e}	$58.27\pm0.87^{c,\ f}$	$61.33\pm0.68^{d,\ f}$	62.97 ± 0.86^{f}

Means with a different superscript letter within a row differ significantly (a-b=$P<0.05$; c-d=$P<0.01$; e-f=$P<0.001$).
Means with a superscripts at-bt within a row differ at $0.05\leq P<0.10$ level of probability.

Table 2. **Chemical composition of longissimus muscle after thawing from pig carcasses by their lean meat content**

Variables	Lean meat content			
	Under 55.9 (n=9)	56.0-59.9 (n=9)	60.0-61.9 (n=11)	62.0 and higher (n=9)
Thawing loss,%	11.64±2.41	13.21±2.97	12.64±3.13	11.96±3.19
Dry matter, %	27.45±0.46	27.33±0.76	27.46±1.47	27.33±0.61
Protein, %	88.54±0.91	89.00±0.97	88.68±0.94	88.81±1.00
Fat, %	7.70±0.91	7.18±0.96	7.11±0.93	7.19±1.00
Ash, %	3.67±0.08	3.76±0.09	3.18±0.09	3.75±0.09

The content of protein, intramuscular fat and ash is expressed as the weight percentage of dry matter.

Table 3. **Technological meat quality of longissimus muscle from pig carcasses by their lean meat content**

	Lean meat content			
	Under 55.9 (n=9)	56.0-59.9 (n=9)	60.0-61.9 (n=11)	62.0 and higher (n=9)
pH	5.53±0.09	5.50±0.05	5.54±0.10	5.48±0.08
Colour CIE L*	56.69±1.31	56.74±1.56	55.14±2.02	55.86±2.36
a*	13.96±1.38	13.03±0.94$^{a, at}$	14.26±0.94$^{b, bt}$	14.71±1.10^{b}
b*	7.67±1.74	6.17±1.31^{a}	7.14±1.46	8.27±1.13^{b}
Drip loss, %	5.85±1.69	5.86±2.49	5.09±1.67	4.87±1.61

a-b Means with a different superscript letter within a row differ significantly (P<0.05).
at-bt Means with a superscripts t within a row differ at 0.05≤P<0.10 level of probability.

Table 4. **Correlations between carcass leanness, cooling loss and muscle quality traits**

	Cooling loss	Carcass leanness	Thawing loss	pH
Carcass leanness	-0.19 (0.25)	-	0.12 (0.48)	-0.12 (0.47)
Thawing loss	0.11 (0.50)	0.12 (0.48)	-	-0.494 (0.002)
pH	0.10 (0.55)	-0.12 (0.47)	-0.49 (0.002)	-
Backfat thickness	0.39 (0.02)	-0.89 (0.00)	-0.03 (0.85)	0.163 (0.33)
IMF	-0.28 (0.08)	-0.24 (0.14)	-0.42 (0.01)	0.01 (0.94)
Colour CIE L*	0.13 (0.45)	-0.29 (0.08)	0.16 (0.35)	-0.09 (0.59)
CIE a*	0.02 (0.92)	0.20 (0.23)	0.20 (0.24)	-0.39 (0.01)
CIE b*	0.25 (0.13)	0.06 (0.70)	0.13 (0.43)	-0.40 (0.013)
Drip loss	0.40 (0.013)	-0.20 (0.22)	0.28 (0.08)	-0.28 (0.08)

Conclusions. The obtained results show minimal technological meat quality differences between commercial Lithuanian pig groups of different leanness. There were no significant differences between the levels of carcass leanness in the chemical composition of the longissimus muscle. Only the colour values representing meat redness and yellowness showed differences between the groups.

Carcass cooling loss positively correlated with the backfat thickness (P<0.05) and insignificantly negatively with the lean meat content. Thawing loss percentages were negatively correlated with the intramuscular fat content and pH (P<0.01). Drip loss positively correlated with carcass cooling loss in lean commercial pigs (P<0.05).

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