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CULINARY AND TECHNOLOGICAL USEFULNESS OF MEAT FATTENERS, ORIGINATED FROM THE CROSSBREEDING OF DANISH LANDRACE GILTS AND DUROC BOARS, SLAUGHTERED AT DIFFERENT WEIGHTS*

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This study was conducted to estimate the frequency of HAL genotype, lean meat content, the composition of sample joints, and the culinary and technological usefulness of meat of fatteners obtained from crossbred Danish Landrace gilts and imported Denmark boars, slaughtered at different weights. It is possible to gain good quality pork meat for the national meat industry from imported Danish animals (kept under different environmental conditions), slaughtered at higher weights than in Denmark (77.9 kg) but mostly preferred in Poland.

INTRODUCTION

The introduction in the last decade of the EUROP classification system, as a part of ongoing organizational and legal changes, has led to increasing carcass meatiness. However, as it was shown in investigations and reports published by The Meat and Fat Research Institute and different authors [Borzuta, 1998; Piechocki *et al.*, 1997], lean meat content has increased while slaughter weights have decreased. The overproduction of pork meat and growing requirements of consumers, are factors which have made the production of fatteners with high lean meat content, higher output of meat from sample joints and greater technological and culinary usefulness of meat to become increasingly important [Carden, 2000].

The presented study was conducted to estimate the frequency of HAL genotype, lean meat content, composition of sample joints, and the culinary and technological usefulness of meat of fatteners obtained from crossbred Danish Landrace gilts and imported Danish boars, slaughtered at different weights. Moreover, in this work, hot carcass weights higher than in Denmark (according to data of Danska Slaughterier in 2001 – 77.9 kg) but preferable in Poland, were analysed.

MATERIAL AND METHODS

The investigations were carried out on a group of fatteners, crossbred Danish Landrace gilts and imported Danish boars, originating from the Jagodne breeding farm. The animals were kept under the same environmental conditions and fed a full batch feed.

The animals were slaughtered in September of 2001, 12 h after transportation (300 km), following regulations of the Sokołów Meat Plant, using the electrical stunning method and recumbent bleeding out.

From the analysed material (with equal numbers of gilts and boars in groups), originating from 17 litters, three groups of fatteners differentiated by hot carcass weight (HCW) were separated: I 78.0 kg, II 78.1–92.0 kg and III > 92.0 kg. The frequency of HAL genotype was established using the PCR/RFLP method [Kuryl & Korwin-Kossakowska, 1993].

Lean meat content was estimated in accordance with the methodology used in Polish Pig Testing Stations (SKURTCH) [Różycki, 1996].

This experiment focused on factors connected with culinary (*i.e.* lipids, water and dry matter content; drip loss and meat lightness and tenderness expressed by shear force estimated 48 and 144 h *post mortem*), and the technological usefulness of meat (*i.e.* protein content, pH_{35}; pH_{24}; electrical conductivity of meat measured 90 min *post mortem* - EC_{90}, water holding capacity expressed by filter paper and centrifugal method, cooking loss and technological yield in the cured cooked ham processing – RTN). The R_1 (IMP/ATP) value was determined according to the method of Honikel and Fischer [1977] as an ATP breakdown indicator. Meat quality traits were evaluated directly in the carcass (pH_{35}, pH_{24}, EC_{90}) or in the samples of *Longissimus lumborum* (LL) muscle, taken at the level of last rib 24 h

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after slaughter. The pH_{35} and pH_{24} were measured directly in the tissue of the LL muscle, using a pH–meter Master produced by Dramiński (Poland). The electrical conductivity was evaluated using a LF-Star apparatus. The lightness (L*) of the muscle tissue was measured 24 h *post mortem* using a Minolta CR-310 apparatus in CIE L*a*b* colour system. The filter paper water holding capacity (WHC) was defined according to Grau and Hamm [1952] method in Pohja and Niinivaara [1957] modification. The centrifugal drip was determined by centrifuging a 6-g sample for 20 min at 15 000 rpm at 2°C. The centrifugal drip has been expressed as a percentage of the initial sample weight. The drip loss at 48 h *post mortem* was evaluated in accordance with the method of Prange *et al.* [1977]. The cooking loss was evaluated on standardised 3-cm thick (120 g) meat slices which were placed into the 0.85% sodium chloride solution (solution quantity = weight of slices x 2.5l), and cooked to an internal temperature of 70°C. The slices were removed from the water-bath, cooled for 30 min and weighed. The cooking loss was expressed as a percentage of the initial sample weight according to the formula:

$$U_C = 100-(m_2 \times 100)/m_1$$

where: U_C – cooking loss (%); m_1 – weight of meat slices after cooking; m_2 – weight of meat slices before cooking.

The obtained cooked meat slices were used to define the shear force using an Instron 1140 apparatus with Warner-Bratzler device. The PN-75/A04018 norm was used to determine the protein content. The fat content was determined using the PN-73/A-82111 norm while water and dry matter using PN-73/A-82110. The laboratory indicator of technological yield in the cured cooked (72°C internal temperature) ham processing – RTN was evaluated according to Naveau *et al.* [1985], but on the LD muscle. The values of pH_1, R_1 and pH_{24} were used to determine meat quality [Honikel & Fisher, 1977, Koćwin-Podsiadła *et al.*, 1998].

The data was analysed using a one-way analysis of variance in a non-orthogonal scheme. The significance of differences between means of groups for the investigated

TABLE 1. Carcass composition and traits characterising culinary and technological usefulness of pork meat, in groups of fatteners differentiated by hot carcass weight.

Trait	Hot carcass weight class			Average n=122	F-emp.
	I MTC≤78.0 kg n=46	II MTC 78.1-92.0 kg n=46	III MTC>92.0 kg n=30		
Hot carcass weight (kg)	74.57±2.49	85.99±3.83	99.18±4.00	84.93±10.16	
Lean meat content (%)	56.50±2.25	55.79±2.05	56.91±2.68	56.34±2.32	2.356 NS
Average backfat thickness (cm)	$1.78^{A}\pm0.27$	$2.03^{B}\pm0.22$	$2.49^{C}\pm0.28$	2.05±0.37	70.893**
Tenderloin without fat and skin (kg)	$5.70^{A}\pm0.60$	$7.02^{B}\pm0.49$	$7.48^{C}\pm0.56$	6.63±0.93	113.546**
Ham without fat and skin (kg)	$7.32^{A}\pm0.49$	$8.34^{B}\pm0.55$	$9.97^{C}\pm0.77$	8.36±1.18	179.868**
Loin eye area (cm^2)	$47.08^{A}\pm5.11$	$50.89^{B}\pm6.40$	$57.04^{C}\pm6.57$	50.97±7.08	25.135**
Neck (kg)	$4.61^{A}\pm1.17$	$5.89^{B}\pm0.51$	$6.36^{C}\pm0.51$	5.89±0.83	31.228**
Shoulder (kg)	$5.40^{A}\pm0.43$	$6.00^{B}\pm0.39$	$6.50^{C}\pm0.37$	6.10±0.53	34.329**
Backfat (kg)	$5.57^{A}\pm0.41$	$6.76^{B}\pm0.68$	$7.52^{C}\pm0.57$	6.88±0.87	42.111**
Culinary usefulness					
Protein content (%)	$21.93^{A}\pm0.54$	$22.08^{A}\pm0.46$	$22.43^{B}\pm0.47$	22.11±0.54	7.733**
Fat content (%)	$1.61^{a}\pm0.49$	$1.82^{ab}\pm0.60$	$2.03^{b}\pm0.68$	1.80±0.60	4.100*
Water content (%)	$75.39^{B}\pm0.63$	$75.06^{B}\pm0.68$	$74.63^{A}\pm0.63$	75.08±0.71	10.604**
Dry matter content (%)	$22.95^{A}\pm0.48$	$23.09^{AB}\pm0.49$	$23.35^{B}\pm0.38$	23.11±0.48	5.823**
Shear force 48 h (N/cm^2)	$59.12^{b}\pm18.93$	$58.13^{b}\pm0.49$	$45.70^{a}\pm9.94$	53.39±14.83	3.411*
Shear force 144 h (N/cm^2)	37.27±6.41	36.63±5.98	34.54±3.77	35.98±5.31	0.833 NS
Meat lightness (L*) of LL	53.11±2.79	54.06±3.08	52.88±2.24	53.41±2.81	2.057 NS
Drip loss (%)	$7.14^{B}\pm2.45$	$7.53^{B}\pm2.35$	$3.85^{A}\pm2.51$	6.48±2.84	23.628**
Technological usefulness					
Protein content (%)	$21.93^{A}\pm0.54$	$22.08^{A}\pm0.46$	$22.43^{B}\pm0.47$	22.11±0.54	7.733**
pH_{35}	$6.61^{b}\pm0.18$	$6.51^{a}\pm0.21$	$6.56^{ab}\pm0.16$	6.56±0.19	3.390*
R_1	$0.91^{b}\pm0.04$	$0.89^{a}\pm0.03$	$0.89^{a}\pm0.02$	0.90±0.04	3.484*
pH_{24}	$5.57^{a}\pm0.10$	$5.57^{a}\pm0.11$	$5.62^{b}\pm0.08$	5.58±0.10	3.578*
$pH_{35} - pH_{24}$	$1.04^{b}\pm0.20$	$0.94^{a}\pm0.22$	$0.93^{a}\pm0.19$	0.98±0.21	4.033*
Electrical conductivity (mS/cm)	$3.76^{B}\pm0.73$	$3.80^{B}\pm0.95$	$2.88^{A}\pm0.73$	3.55±0.90	13.644**
Water Holding Capacity tested by centrifugal method (%)	$23.45^{B}\pm1.78$	$23.49^{B}\pm2.03$	$20.32^{A}\pm2.15$	22.19±2.50	9.476**
WHC (cm^2)	$6.27^{B}\pm1.32$	$5.62^{B}\pm1.68$	$4.55^{A}\pm1.83$	5.60±1.72	10.595**
Cooking loss (%)	$29.67^{AB}\pm1.68$	$31.73^{B}\pm3.72$	$24.10^{A}\pm7.94$	27.99±6.33	5.699**
RTN (%)	$99.30^{A}\pm5.68$	$102.18^{B}\pm4.76$	$106.09^{C}\pm3.58$	102.05±5.51	17.545**

The data shown in the table are arithmetic means ± standard deviation; a, b – significant difference for the analysed traits at $p<0.05$; A,B, C – significant difference for the analysed traits at $p<0.01$

traits, were calculated using Tukey's test [Luszniewicz & Słaby, 2001].

RESULTS AND DISCUSSION

As it was mentioned in the introduction, the production of fatteners with lean meat content, high output of meat from sample joints and greater technological and culinary usefulness of meat are becoming increasingly important.

The average lean meat content estimated according to the methodology used in Polish Pig Testing Stations reached 56.34±2.32% (Table 1). Together with a hot carcass weight increase, a growth in sample joint weight without statistically confirmed changes in lean meat content was observed. However, this hot carcass weight increase was accompanied, as supported by both Polish [Migdał *et al.*, 1999; Łyczyński *et al.*, 2000] and foreign [Ellis *et al.*, 1996; Garcia-Macias *et al.*, 1996] authors, by an increase in adipose tissue.

There was good meat quality, both culinary and technological, without known quality defects. Moreover, no HAL^n carriers, were noted among the analysed fatteners.

For meat of both groups of fatteners with hot carcass weights up to 92.0 kg, less profitable, but correct, values of the analysed traits for both the culinary and technological usefulness of meat were observed. The described raw material in comparison to meat of the heaviest fatteners (HCW>92.0 kg) had a lower fat and protein content, higher shear force 48 h after slaughter and higher drip loss. The tendency for fat and protein content to increase with increasing carcass weight is in agreement with the results of Garcia-Macias *et al.* [1996] and Beattie *et al.* [1999]. However, no effect of hot carcass weight on drip loss was found in the investigations of Sutton *et al.* [1997] and Candek-Potokar *et al.* [1998].

The effect of a deeper range of pH fall to 24 h *post mortem* in the meat of fatteners with hot carcass weights up to 92.0 kg, was a lower technological usefulness, as reflected by a lower water holding capacity (evaluated both with filter paper and centrifugal method) while the cooking loss was higher.

In the investigations of Beattie *et al.* [1999] conducted on four groups of fatteners differentiated by slaughter weight (hot carcass weights of 70, 80, 90 and 100 kg, respectively), a similar dependence between hot carcass weight increase and cooking loss was found. The authors showed that the cooking loss decreased when carcass weight increased above 90 kg (HCW 90 and 100 kg).

In this experiment, the meat of lighter fatteners (in both groups of animals with hot carcass weights below 92.0 kg) had higher electrical conductivity (EC_{90}) than the heaviest fatteners (III group), however, in the investigations of Garcia-Macias *et al.* [1996] the effect of hot carcass weight on electrical conductivity was not found.

No significant differences were found between both groups of fatteners with hot carcass weights up to 92.0 kg in terms of meat quality. It may indicate no weight effect on the changes in meat quality traits at hot carcass weight increase by *ca*. 10 kg (from 74.57 to 85.99 kg). Meat lightness has been shown to be unrelated to carcass weight, which is in agreement with studies by different authors [Garcia-Macias *et al.*, 1996; Sutton *et al.* 1997].

The growth of hot carcass weight above 92.0 kg, was profitable for both the culinary and technological usefulness of meat. The meat of the heaviest fatteners (in comparison to the raw material obtained from both groups of lighter animals – I and II group) had higher protein (at about 0.5%) and intramuscular fat content, a lower shear force measured 48 h *post mortem* (13.42 and 12.43 N/cm^2, respectively), and a lower range of pH decrease in LL muscle 24 h after slaughter. The effect of a slower rate and range of pH drop 24 h *post mortem* was the highest water holding capacity (estimated with both filter paper and centrifugal method), the lowest drip loss and cooking loss (at 5.57 and 7.63%, respectively) and growth of technological yield in the cured cooked ham processing – RTN (at 6.79 and 3.91%, respectively).

In the investigations of Beattie *et al.* [1999], a reverse tendency of pH fall was observed. The pH_u values of the m. LL were significantly higher at 70 and 80 kg than 90 and 100 kg. However, Cisneros *et al.* [1994], Candek-Potokar [1996], Garcia-Macias *et al.* [1996] and Sutton *et al.* [1997] reported no effect of hot carcass weight on pH_{45} or pH_{24}.

CONCLUSIONS

In the analysed material, the high average lean content (56.34%) and good culinary and technological quality of meat were noted.

There were no carriers of the HAL^n gene, and no meat with known quality defects.

Meat from lighter fatteners with hot carcass weights below 92.0 kg (I and II group) had insignificantly lower culinary and technological usefulness, however, there were no statistical differences (without pH_{35}) in terms of meat quality.

Together with hot carcass weight increase, a growth in sample joint weights without statistically confirmed changes in lean meat content was observed. However, an unacceptably significant increase in adipose tissue hot carcass weight increase (especially above 92.0 kg), was observed.

The growth of hot carcass weight above 92.0 kg was profitable on meat quality. In terms of culinary usefulness, there was a higher intramuscular fat and protein content, lower water content, higher tenderness and lower drip loss measured 48 h after slaughter. The effect on meat quality was a lower rate and range of pH decrease 24 h *post mortem*, the highest water holding capacity (determined with filter paper and centrifugal method), lower cooking loss and an increase in technological yield indicator – RTN.

It is possible to gain good quality pork meat for the national meat industry from imported Danish animals (kept under different environmental conditiones), slaughtered at higher weights than in Denmark (77.9 kg) but mostly preferred in Poland.

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OCENA WARTOŚCI KULINARNEJ I PRZETWÓRCZEJ MIĘSA TUCZNIKÓW POCHODZĄCYCH Z KRZYŻOWANIA LOCH DUŃSKIEJ LANDRACE Z KNURAMI DUROC, UBIJANYCH PRZY RÓŻNEJ MASIE CIAŁA

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Celem niniejszej pracy była ocena mieszańców pochodzących z krzyżowania loch duńskiej Landrace z importowanymi z Danii knurami rasy Duroc w zakresie obciążenia genem wrażliwości na stres, mięsności, składu podstawowego oraz wartości kulinarnej i przetwórczej mięsa ubijanych przy różnej masie ciała. Uzyskane i przedstawione w niniejszej pracy wyniki wskazują na możliwość pozyskania dla krajowego przemysłu mięsnego bardzo dobrej jakości surowca wieprzowego, pochodzącego z krzyżowania zwierząt importowanych z Danii (a więc utrzymywanych w odmiennych warunkach środowiskowych), ubijanych przy wyższej niż aktualnie występująca w Danii, a jednocześnie preferowanej w Polsce masie ciała (tab. 1).