SWINE BREED INFLUENCE ON PORK PROXIMATE COMPOSITION AND ENERGETIC VALUE

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Abstract

In order to test whether swine breed influences pork proximal composition and other nutritional traits, such as collagen, cholesterol and gross energy content, 60 carcasses from Duroc and Landrace pigs were sampled from loin and ham cut regions (15 males and 15 females from each breed). Samples were subsequently introduced to proximate analysis, using conventional AOAC protocols, enzymatic assay for cholesterol content and NIR Spectroscopy for collagen content then the data were submitted to multiple comparison analysing to test the differences between influential factors (breed, gender and cut part) on the reasoning criteria. Breed significantly influenced the total lipids content, as well as the gross energy content ($P < 0.05$). In all situation, Duroc samples were richer in lipids, cholesterol and energy, compared to Landrace and the same rule applied for females vs. males and for ham vs. loin comparisons. Therefore, swine breed, gender and carcass cut are factors interfering with pork chemical composition and with certain nutritional and dietetic traits, when the animals are raised within the same farm and benefit of the same rearing and nutrition conditions.

Key words: *swine breed, loin, ham, proximate composition, gross energy, cholesterol*

INTRODUCTION

Pork is one of the most occurring animal products in human diet and its global consumption increased by 58% in the last 25 years (Whitnall and Pitts, 2019). Meat quality is defined as a combination of direct traits, such as the technological ones, the sensorial and consumer acceptance ones, the sanogenic ones, as well as the nutritional ones and, lately, of some indirect traits, such the rearing system environmental impact and welfare aspects (Lee et al., 2012). Pig performance, represented by the growth rate, feed conversion efficiency, and lean meat content in carcasses, has been improved in conventional breeds by intensive selection. However, intensive selection has resulted in different negative side effects including poorer meat quality and lower resistance to pig diseases (Eggert et al., 2009, Merlot et al., 2012). As meat quality has a multifactorial background and can be associated with monogenic and polygenic effects, these effects comprise the differences among breeds (Pugliese and Sirtori, 2012). Therefore, the breed and diversity of breeds is one of the important factors influencing meat quality traits (Lebret et al., 2014). When using a particular breed, it seems that gender and carcass weight (Trefan et al, 2014), rearing system (Bonneau and Lebret, 2010), nutrition (Dugan et al., 2004) and welfare level (Gentry et al., 2002) affects the ultimate quality of pork, especially related to nutritional and sensorial features. While the main sensorial qualities of meat (tenderness, juiciness and other textural descriptors) are influenced by the ultimate meat pH (Richardson et al., 2018), it seems that proximate composition and nutritional quality, within the same breed originated meat, is influenced by carcass cut (Wójciak et al, 2021). Within such context, our study aimed to assess the influence of breed on the proximate composition of pork from two carcass regions: loin and ham, issued from both gender individuals of Duroc and Landrace breeds, slaughtered at the same live weight and reared within the same farm, to avoid any other influential factors.

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MATERIAL AND METHOD

Biological material: 60 carcasses of pigs slaughtered at 110 kg live weight, allocated in two groups, in relation with breed origin: D group (Duroc) and L group (Landrace). Out of each group, we have chosen 15 carcasses originated from males and 15 carcasses originated from females.

Meat sampling: approximately 100 g of meat were taken from each carcass from middle loin region (*Longissimus dorsi* muscles) and from ham region (*Semimembranosus* muscles), to form homogenous minced/blended mixtures from each breed/gender and region that were subsequently introduced to analysis for proximate composition, cholesterol, collagen content and gross energy levels.

Analytical protocols: AOAC standards were used to measure proximate composition: dry matter (DM) - water content AOAC 950.46, minerals content (TM) AOAC 920.153; ether extract (EE), ie. Total fat AOAC 960.39; total protein (TP) derived from total nitrogen content AOAC 929.08.

Nitrogen-Free Extract (NFE) was calculated by difference as NFE (g/100 g) = DM (g/100 g) − EE (g/100 g) − TP (g/100 g).

Gross energy content was calculated using the Atwater relation (FAO, 2003):

Gross energy (Kcal/100g) = 5,70 Kcal X g% TP + 9,50Kcal X g% EE + 4,20 Kcal X g% NFE.

Cholesterol content was assessed by the enzymatic colorimetric method (Li et al., 2019) while collagen native meat contents were assessed using an Omega Bruins Food-Check Near InfraRed (NIR) spectrophotometer (Frunză et al., 2023).

Data processing: Each type of analysis was carried on in 12 repetitions and gathered data were subsequently analysed to obtain the main statistical descriptors (means, standard deviations) and to run comparisons between the influential factors (breed, gender, and cut part) via the Graph Pad Prism 9.4.1. software, using the unpaired 2-tailed *t* test when (2 groups of data for each comparison).

RESULTS AND DISCUSSIONS

Loin meat proximate composition varied slightly in accordance with breed and gender (table 1). In Duroc females, water content reached 73.54 g/100g, crude ash was measured at 0.98 g/100 g, ether extract (total lipids) reached 2.58 g/100 g while total protein was assessed at 22.07 g/100 g. Collagen proportion reached 0.17 g/100 g, cholesterol content was measured at 38.17 g/100 g meat, while gross energy reached 153.79 Kcal/100 g. In Duroc males' meat, total dry matter reached 26.55 g/100 g, out of which crude ash reached 1.05 g/100 g, ether extract 2.49 g/100 g and total protein content 22.14 g/100 g. Collagen content was assessed at 0.19 g/100 g, cholesterol content at 37.61 g/100 g and gross energy at 153.51 Kcal/100 g.

In Landrace loin samples, water content ranged from 73.31 g/100 g in males to 73.59 g/100 g in females. Ether extract was higher in females than in males (2.17 vs. 2.08 g/100 g). Males' loin was richer in collagen but lower in cholesterol. Due to the richest protein content, the gross energy value was higher in males' loin meat than in females.

The comparative analysis of breed influence on meat quality, revealed significant differences for ether extract content (total lipids) in both genders, with higher values in Duroc samples, compared to Landrace ones (+19%) (P <0.05) (table 2). This situation led to differences related to cholesterol content, that was higher in Duroc, compared to Landrace (+1.4% in males, P<0.05; +2.6% in females, P < 0.01) and also in gross energy content (+0.5%…+1.4%, P<0.05).

Related to inter-genders comparisons, the samples were significantly different in protein and gross energy content in Landrace (P < 0.05, with males' loins more energetic, due to higher protein content) and significantly for cholesterol content in Duroc samples (P < 0.05, +1.5% more cholesterol in females loin samples).

Table 1 Loin meat quality traits, in relation with breed and gender

Proximate composition and quality traits	Duroc carcasses				Landrace carcasses			
	Females (Mean ±StDev)		Males (Mean ±StDev)		Females (Mean ±StDev)		Males (Mean ±StDev)	
Water (g/100g)	73.54	5.96	73.45	4.57	73.59	5.67	73.31	5.38
Dry matter (g/100g)	26.46	2.15	26.55	1.65	26.41	2.03	26.69	1.96
Crude ash (g/100g)	0.98	0.06	1.05	0.06	1.03	0.06	1.05	0.06
Ether extract (g/100g)	2.58	0.24	2.49	0.10	2.17	0.19	2.08	0.15
Total protein (g/100g)	22.07	1.41	22.14	1.13	22.36	1.35	22.65	1.32
Nitrogen free extract (g/100g)	0.83	0.07	0.87	0.06	0.85	0.07	0.91	0.07
Collagen (g/100g)	0.17	0.02	0.19	0.02	0.22	0.02	0.24	0.02
Cholesterol (mg/100 g)	38.17	3.51	37.61	2.46	37.22	3.25	37.08	3.02
Gross energy (Kcal/100 g)	153.79	11.75	153.51	12.57	151.64	11.01	152.69	11.75

Table 2 Analysis of variance between certain loin meat quality traits, in relation with breed and gender

Quality trait compared	Gender	Duroc means	Landrace means	*P* values & significance
Ether extract (g/100 g)	Males	2.49	2.08	0.0321 *
	Females	2.58	2.17	0.0307 *
	P values & significance	0.6183 ns	0.5492 ns	-
Total protein (g/100 g)	Males	22.14	22.65	0.0765 ns
	Females	22.07	22.36	0.0893 ns
	P values & significance	0.0962 ns	0.0415 *	-
Cholesterol (mg/100 g)	Males	37.61	37.08	0.0261 *
	Females	38.17	37.22	0.0053 **
	P values & significance	0.0383 *	0.3874 ns	-
Gross energy (Kcal/100 g)	Males	153.51	152.69	0.0492 *
	Females	153.79	151.64	0.0151 *
	P values & significance	0.2851 ns	0.0437 *	-

Ham meat proximate composition also varied in accordance with breed and gender (table 3). In Duroc females, water content reached 73.50 g/100g, crude ash was measured at 1.08 g/100 g, ether extract (total lipids) reached 2.93 g/100 g while total protein was assessed at 21.84 g/100 g. Collagen proportion reached 0.17 g/100 g, cholesterol content was measured at 43.18 g/100 g meat, while gross energy reached 155.05 Kcal/100 g. In Duroc males, total dry matter reached 26.67 g/100 g, out of which crude ash reached 1.09 g/100 g, ether extract 2.61 g/100 g and total protein content 22.26 g/100 g. Collagen content was assessed at 0.20 g/100 g, cholesterol content at 42.61 g/100 g and gross energy at 154.66 Kcal/100 g. In Landrace loin samples, water content ranged from 73.52 g/100 g in males to 73.61 g/100 g in females. Ether extract was higher

in females than in males (2.48 vs. 2.33 g/100 g). Males ham was richer in collagen (0.21 mg/100g) but lower in cholesterol (40,11 mg/100 g), compared to females. The gross energy value was higher in females ham meat than in males.

The comparative analysis of breed influence on meat quality, revealed significant differences for ether extract content (total lipids) in both genders, with higher values in Duroc samples, compared to Landrace ones (+12% in males, +18% in females) (P <0.05) (table 4).

Table 3 Loin meat quality traits, in relation with breed and gender

Proximate composition and quality traits	Duroc carcasses				Landrace carcasses			
	Females (Mean ±StDev)		Males (Mean ±StDev)		Females (Mean ±StDev)		Males (Mean ±StDev)	
Water (g/100g)	73.50	5.96	73.33	4.56	73.61	5.67	73.52	5.40
Dry matter (g/100g)	26.50	2.15	26.67	1.66	26.39	2.03	26.48	1.94
Crude ash (g/100g)	1.08	0.07	1.09	0.06	1.07	0.06	1.12	0.07
Ether extract (g/100g)	2.93	0.27	2.61	0.11	2.48	0.22	2.33	0.17
Total protein (g/100g)	21.84	1.39	22.26	1.13	22.18	1.34	22.31	1.30
Nitrogen free extract (g/100g)	0.65	0.06	0.71	0.05	0.66	0.05	0.72	0.06
Collagen (g/100g)	0.17	0.02	0.20	0.02	0.19	0.02	0.21	0.02
Cholesterol (mg/100 g)	43.18	3.97	42.61	2.79	40.75	3.56	40.11	3.27
Gross energy (Kcal/100 g)	155.05	11.85	154.66	12.67	152.76	11.09	152.32	11.72

Table 4 Analysis of variance between certain ham meat quality traits, in relation with breed and gender

Quality trait compared	Gender	Duroc means	Landrace means	P values & significance
Ether extract (g/100 g)	Males	2.61	2.33	0.0418 *
	Females	2.93	2.48	0.0226 *
	P values & significance	0.0417 8	0.3835 ns	-
Total protein (g/100 g)	Males	22.26	22.31	0.0584 ns
	Females	21.84	22.18	0.0415 *
	P values & significance	0.0866 ns	0.0951 ns	-
Cholesterol (mg/100 g)	Males	42.61	40.11	0.0034 **
	Females	43.18	40.75	0.0081 **
	P values & significance	0.0383 *	0.3874 ns	-
Gross energy (Kcal/100 g)	Males	154.66	152.32	0.0418 *
	Females	155.05	152.76	0.0397 *
	P values & significance	0.0748 ns	0.0917 ns	-

This situation led to differences related to cholesterol content, that was higher in Duroc, compared to Landrace (+6.2% in males, $P<0.01$; +5.1% in females, $P<0.01$). Significant differences also occurred for females ham total protein content in Duroc vs. Landrace comparisons ($P < 0.05$), +1.5% more protein in Landrace meat.

The data also lead to differences related to gross energy content in both males and females from the compared breeds (+1.5% in Duroc, $P < 0.05$). Related to inter-genders comparisons, the samples were significantly different for cholesterol content just in Duroc samples, that presented 1.3% more cholesterol in females' ham than in males. In all situations, females' meat was richer in fat and cholesterol but poorer in proteins and collagen than the male's meat.

Acquired data on loin and ham proximate composition were comparable with those found by Razmaite et al., 2021 and by Wójciak et al., 2021, in terms of water/dry matter and protein content, while total lipids were lower in our samples, probably due to the influence of feeding, knowing the ether extract is mostly influences by diets fed to animals (Witte et al., 2000; Lin et al., 2013).

CONCLUSIONS

Swine breed significantly interfered with meat proximate composition, especially related to ether extract content.

Duroc samples were richer in lipids, cholesterol and gross energy than Landrace samples, for the same carcass cut region.

Meat from males' carcasses were richer in protein and collagen, whilst samples from females' carcasses were richer in lipids and cholesterol.

In all situations, ham samples were richer in total lipids, cholesterol and gross energy than loin samples.

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