Effects of lysine concentration of the diet on growth performance and meat quality in finishing pigs with high slaughter weights

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Abstract

The present study aimed to investigate the feasibility of using a diet low in lysine content as a means for increasing the intramuscular fat (IMF) content and pork muscle quality of finishing pigs. Thirty-two crossbred gilts and barrows weighing approximately 80 kg were fed either a low-lysine diet (0.60%; **Low-lys**) or a control diet (0.80% lysine; **Med-lys**) under a 2 × 2 factorial arrangement of treatments. The animals were slaughtered at a 132-kg body weight (BW) on average, followed by physicochemical analyses and sensory evaluation on *Longissimus lumborum* (**LL**) and *Semitendinosus* (**ST**) muscles. The average daily gain (ADG) did not differ between the Med-lys and Low-lys groups. However, ADG exhibited a tendency of sex × diet interaction ($p = 0.09$), being greater for barrows vs. gilts on the Low-lys diet ($p < 0.05$), but not on the Med-lys diet. Backfat thickness adjusted for 132-kg BW also exhibited the interaction; it was greater for the Low-lys vs. Med-lys group within gilts but tended to be less for the former in barrows ($p = 0.08$). The IMF content was not influenced by the diet or sex in either LL or ST. The a*, b*, and Warner-Bratzler Shear Force values and fatty acid composition were influenced by the sex or diet in either or both of the muscles, but the treatment effects did not apparently influence the meat quality. Sensory scores for the flavor, juiciness, tenderness, umami, and palatability of cooked muscle were not influenced by the diet in either LL or ST. When the LL and ST data were pooled, scores for those sensory attributes were positively correlated with the IMF content, which was associated with overall greater IMF contents and greater sensory scores for ST vs. LL. Collectively, the Low-lysine diet seemingly elicited the intended lysine deficiency in gilts as indicated by the increased BFT due to the diet. However, the Low-lys diet was not effective for increasing the IMF deposition or eating quality of the pork muscle of finishing pigs slaughtered at high BW probably because its lysine content was not low enough to elicit either outcome.

Keywords: Finishing pig**,** Dietary lysine, Growth, Meat quality, Physicochemical characteristics, Sensory attributes

INTRODUCTION

Meat quality is judged primarily by appearance such as color, marbling, and texture and subsequently by sensory attributes including flavor, juiciness, tenderness, and others [1,2]. The intramuscular fat (IMF) is a very important determinant of meat quality because IMF, in general, enhances marbling of fresh meat and the tenderness, flavor, and juiciness of cooked meat as well [1,3,4]. In pigs, IMF is known to be determined primarily by genetics with a medium to high heritability; however, modern meat-producing pigs have been bred preferentially for maximum lean gain for the past several decades, which has frequently resulted in production of pork low in IMF content accompanied by decreased eating quality [4-8].

It has been well documented that provision of a diet deficient in essential amino acid(s), especially the first limiting amino acid lysine, to grow-finish pigs results in an increased deposition of backfat and IMF as well as a decreased weight gain rate to varying extents depending on the severity and duration of the amino acid deficiency [3,9-15]. The increased deposition of backfat and IMF due to the amino acid deficiency is thought to result from decreased protein synthesis and consequently increased partitioning of net energy for fat synthesis, because the energy or feed intake is known to barely change or slightly increase [14] due to the dietary amino acid restriction. Moreover, the dietary amino acid restriction of finishing pigs, which brings about a reduced production efficiency as mentioned above, has been reported to improve the eating quality of pork from the amino acid-restricted pigs in some studies [3,12,15,16]. Little information is available, however, as to the effects of the amino acid deficiency on meat quality of the ham, the largest lean cut of the pig carcass, or in heavier pigs, which are known to have greater IMF contents and often render pork meat exhibiting improved eating quality compared to those of the pigs slaughtered at lower body weights [BW; 17-21]. As such, the present study was initiated to examine if the IMF deposition and eating quality of the loin and ham could be enhanced by use of a moderately lysine-deficient diet in finishing pigs over-fattening beyond 130-kg BW.

MATERIALS AND METHODS

Animals and diets

All experimental protocols involving animals of the present study were approved by the Institutional Animal Care and Use Committee (IACUC) of Gyeongsang National University (GNU-221011-P0122). All animals used in the present study were (Landrace × Yorkshire) × Duroc progeny which had been reared on a commercial farm up to 80 kg of BW on commercial diets as described previously [15,23], with the nutritional planes of the animals comparable to those of the NRC [22] recommendations for grow-finish pigs with a medium-high lean growth rate.

A total of 32 barrows and gilts aged 141 days and weighing approximately 80 kg were placed on a feeding trial under a 2 (sex) × 2 (diet) factorial arrangement of treatments. The dietary treatments were a low-lysine diet (0.60%; **Low-lys**) and a control diet [medium-level lysine (0.80%); **Med-lys**], which were formulated to have a same crude protein concentration and a greater ME content for the former by 0.12 Mcal/kg (Table 1). The experimental animals were allocated to four pens, with eight animals per pen, in such a way that the Low-lys gilts were penned on day 0 of the experiment followed sequentially by Med-lys gilts and Low-lys barrows on day 7 and finally by Med-lys barrows on day 14, with an aim to get to a targeted final BW on a same day, thereby precluding the otherwise inevitable between-day variation of the results of subsequent physicochemical analyses and sensory evaluation on pork muscles described below.

All experimental animals were transported to a local abattoir upon termination of the feeding trial at a 132-kg final BW on average and slaughtered the following day. After overnight chilling and fabrication of the carcass, the left-side loin and ham from each carcass were transported to the laboratory in a refrigerator car. The backfat thickness (BFT) reported from the abattoir was adjusted for the 132-kg live weight as described previously [15,23].

Physicochemical analysis

The *Longissimus lumborum* muscle (**LL**) was prepared by removing the subcutaneous fat from the loin, the *Semitendinosus* muscle (**ST**) being dissected from the ham. The color of the muscle was measured using a Minolta chromameter (CR -300, Minolta Co., Ltd., Tokyo, Japan) standardized with white plates (Y = 93.5, X = 0.312, and y = 0.3198) as described previously [21]. The pH of the muscle was measured using a pH meter (MP 230, Mettler-Toledo, Schwerzenbach, Switzerland) after homogenization of 3-g sample in 27-mL deionized water for 30 seconds also as described [21]. Drip loss, cooking loss, and Warner-Bratzler Shear force (WBSF) were measured following the procedures described by Joo et al. [24] and Hwang et al. [21]. As for a quick assessment of the water holding capacity of the muscle, weight of water released from 3-g muscle squeezed between two thin plastic films pressed by a 2.5-kg weight for five minutes was measured following the procedure described by Joo [25].

The fat content of the muscle was determined by the method of the Soxhlet extraction following the procedure of AOAC [26] as described previously [21]. Composition of fatty acids (FA) of the muscle was determined by gas chromatography (HP6890N, Hewlett-Packard, Santa Clara, CA, USA) after extraction of total lipids by the method of Folch et al. [27] as described by Hwang and Joo [28].

Sensory evaluation

The sensory attributes of the muscle were evaluated by a sensory panel according to the modified Spectrum

TM method [29] as described previously [21,23]. The sensory panel consisted of three males and two females who had been trained in the on-campus Meat Science Laboratory and had at least 50 hours of experience in pork sensory evaluation [30]. Briefly, marbling, color, texture, drip, and overall acceptability of fresh muscle were scored according to a 5-tier hedonic scale ranging from 1 for ‘extremely bad’ to 5 for ‘extremely good’; for cooked pork muscle, flavor, juiciness, tenderness, umami, and overall palatability were scored with a 9-tier scale, with ‘extremely dislike’ and ‘extremely like’ assigned 1 and 9, respectively. The present sensory evaluation protocol was approved by the Institutional Review Board (GIRB-G21-Y-0059).

Statistical analysis

All data were analyzed as a 2 × 2 factorial design using the General Linear Model procedure of SAS (SAS/STAT Software for PC. Release 9.2, SAS Institute, Cary, NC, USA). The model included the sex and diet as main effects as well as their interaction. In sensory evaluation, the experimental animal nested within the sex × diet combinatorial as well as the panelist was included in the model in addition to the main effects and their interaction. The animal, irrespective of the nesting, was used as the error term to test the hypothesis for the main effects and their interaction. The probability (p) values of $0.05 \leq p$ and $0.05 < p \leq 0.10$ were used as criteria for the ‘significance’ and ‘tendency,’ respectively.

RESULTS

Growth performance

The present feeding trial had been planned to continue to approximately 135 kg of final BW across the treatments, but it was terminated at 132 kg on average because the Low-lys group gilts grew much faster than expected. The average daily gain (ADG) was greater ($p < 0.05$) for barrows than for gilts (1,010 vs. 912 g with SEM = 33 g), but it did not differ between the Med-lys and Low-lys groups (Table 2). Moreover, ADG exhibited a tendency of sex × diet interaction ($p = 0.09$), being greater for barrows vs. gilts on the Low-lys diet, but not on the Med-lys diet. The dressing percentage was not affected by either sex or diet. The BFT adjusted for the 132-kg BW did not differ between the two sex or diet groups. The adjusted BFT, however, exhibited a significant sex × diet interaction; it was greater for the Low-lys vs. Med-lys group within gilts, but, within barrows, it tended to be greater for the latter ($p = 0.08$).

Physicochemical properties of the muscle

The lightness (L*) of **LL** did not differ between the two sexes or between the Med-lys and Low-lys groups (Table 3). The redness (a*) and yellowness (b*) of LL were greater for gilts vs. barrows (7.84 vs. 7.11 with SEM = 0.15 for a*; 2.61 vs. 1.79 with SEM = 0.13 for b*). None of the ultimate pH value and percentages of drip loss, released water, and cooking loss, and IMF was influenced by either sex or diet ($p > 0.05$). The WBSF value was greater for the barrow and Med-lys groups than for the gilt and Low-lys, respectively, with an interaction between the two main effects, but the numerical differentials were rather small. The IMF content was not influenced by either sex or diet. In **ST**, none of the physicochemical properties measured in the present study was affected significantly by either sex or diet, except for a greater a* value for barrows vs. gilts (16.8 vs. 14.4; SEM = 0.7). When the LL and ST data were pooled, the L* value and DL and RW percentages were greater for LL, whereas the a*, b*, pH WBSF values and IMF content were greater for ST.

FA composition

The percentage of 14:0 (myristic acid) out of total FA was greater for the Low-lys than for the Med-lys group in **LL** (1.89 vs. 1.78%; SEM = 0.03%; Table 4). The 16:0 (palmitic acid) percentage was greater for barrows than for gilts (26.9 vs. 26.1%; SEM = 0.2%) and for the Low-lys vs. Med-lys group (26.9 vs. 26.1%; SEM = 0.2%), whereas the percentage of another saturated FA (SFA) 18:0 (stearic acid) was not influenced by either sex or diet. Percentages of unsaturated fatty acids (UFA) 16:1 (palmitoleic acid), 18:1 (oleic acid), 18:2 (linoleic acid), 18:3 (linolenic acid), and 20:4 (arachidonic acid) did not differ between the two sex or diet groups, except for a greater 18:2 percentage for gilts vs. barrows (8.21 vs. 7.35%; SEM = 0.28%) and a greater 20:4 percentage for the Med-lys vs. Low-lys group (1.47 vs. 1.15%; SEM = 0.09%). The SFA percentage was greater for the Low-lys group than for the Med-lys group in total animals (41.6 vs. 40.1%; SEM = 0.4%) as well as within barrows, but not within gilts. However, percentages of mono-

UFA (MUFA) and poly-UFA (PUFA) were not influenced by either sex or diet. In **ST**, none of the percentages of the fatty acids, including those of SFA, MUFA, and PUFA, differed between the two sex or diet groups.

Sensory attributes of the pork muscle

None of the sensory scores for marbling, color, texture, drip, and overall acceptability was influenced by either sex or diet in either fresh **LL** or **ST**, except for a greater drip score for barrows than for gilts in LL (4.03 vs. 3.66; SEM = 0.08) which means less exudation in the former. Without a greater juiciness score for gilts than for barrows in ST (5.64 vs. 5.13; SEM = 0.14), sensory scores for the cooked pork muscle, including flavor, juiciness, tenderness, umami, and palatability, also would not have differed between the two sex or diet groups in either LL or ST. When the LL and ST data were pooled, fresh LL exhibited greater scores than fresh ST in all the sensory attributes but drip, the score of which was greater for ST vs. LT. In cooked pork, by contrast, ST was superior to LL in scores for all the sensory attributes evaluated.

The IMF content was not correlated with any of the scores for marbling, drip, and acceptability of fresh pork muscle, or with any of the flavor, juiciness, tenderness, umami, and palatability scores of cooked pork muscle in either LL or ST, with an only exception of a negative correlation with the palatability score in ST (Table 6). When all the LL and ST data were pooled, however, the IMF content was positively correlated with the drip score and scores for all the five attributes of cooked pork and also was negatively correlated with the acceptability score of fresh pork.

DISCUSSION

As for the optimum lysine content of the diet for finishing barrows and gilts with a high-to-medium lean growth rate, the NRC [22] recommends 0.80% and 0.89% of total lysine, respectively, during the phase between 75- and 100-kg BW and 0.67% and 0.74%, respectively, during the phase between 100- and 135-kg BW. Inasmuch as the estimated lean gain rate of the present experimental pigs during the entire grow-finish period as assessed from their weight gain rate and BFT [31,32] is judged to fall on the medium level [22], the optimum lysine contents of the diets for the present barrows and gilts are thought to be slightly less than the NRC recommendations for those growing at the high-to-medium lean gain rate. In this context, the lysine content of the Med-lys diet (0.80%) was comparable to the NRC recommendation for gilts but was greater than the latter for barrows, whereas the lysine content of the Low-lys diet (0.60%), which was designed to induce a lysine deficiency in both sexes, was substantially less than the NRC recommendation.

Barrows did not exhibit the expected feature of growth performance associated with the lysine deficiency due to the provision of the Low-lys diet [3, 9-12], as was indicated by the tendency of decreased BFT with no decrease in ADG in response to the Low-lys vs. Med-Lys diet. In gilts, by contrast, the Low-lys group exhibited the known consequences of the amino acid deficiency in growth performance as expected [3, 9-12], i.e. the increased BFT and lesser ADG, relative to those for the Med-lys control group. Moreover, the greater ADG for barrows vs. gilts on the Low-lys diet, but not on the Med-lys diet, implicates that the present Low-lys diet was adequate for supporting the maximal lean and weight gains in barrows, but that in gilts, it was suboptimal for supporting the lean gain maximally.

The IMF content, which, like BFT, is known to increase in dietary lysine deficiency depending on its severity in grow-finish pigs [3, 9-12], did not change due to the Low-lys diet in the present study. This apparently does not match with the increased BFT due to the Low-lys diet in gilts, but such differential responses of finishing pigs in BFT and IMF on a moderately-low-lysine diet have also been observed in the previous studies reported by Yang et al. [15,33]. It thus seems likely that the lysine content of the present Low-lys diet was low enough to cause an increased deposition of backfat in gilts, but was not low enough to influence the IMF deposition.

The pork meat quality is commonly evaluated on LL/L *thoracis* (LT) as well as ST or *Semimembranosus* muscle of the ham according to the physicochemical and sensory attributes of the muscle [34-36]. In the present study, ST was chosen for its high IMF content [37] in addition to the most widely used LL/LT for the meat quality evaluation. The LL and ST of the present experimental animals met the physicochemical and appearance standards for the RFN (reddish, firm, and non-exudative; 5.0 < pH < 6.0; L* < 50; drip loss < 5.0%) pork [38,39] across the treatments, except for overall high pH for ST (6.19) for unknown reason(s) falling on the DFD (dark, firm, and dry) by this criterion alone (pH > 6.0-6.2). Other physicochemical measurements were within the normal ranges, with a few small treatment effects being detected in a*, b*, and WBSF of LL. Moreover, the greater a*, b*, WBSF, and pH values and greater IMF content for ST than for LL, as well as the lower L* value for the former, were consistent with the results reported by Seong et al. [37] and Cheng et al. [40]. The FA composition, especially percentages of SFA, oleic acid, and PUFA, also are known to exert significant influences on meat quality including the sensory attributes [41,42]. In the present study, however, the treatment effects on percentages of some FA including oleic and arachidonic acids in LL, as well as those in a*, b*, and WBSF mentioned above, are deemed not to have been big enough to affect the quality of the pork muscle.

The pork meat quality was not improved as anticipated by use of the Low-lys diet, as was revealed by the absence of the diet effect on any of the sensory attributes evaluated. Instead, it was apparent in the present study that IMF is a major determinant of pork quality, which was indicated by positive correlations of the sensory scores of cooked muscles with the IMF content in the pooled LL plus ST data as well as greater scores for the drip and all sensory attributes of cooked muscle for ST vs. LL having greater IMF contents. In this regard, even the negative correlation between the IMF content and palatability score in ST was turned into a positive correlation upon pooling the data of LL and ST, implicating that the negative influence of IMF on this attribute in ST rich in IMF was overshadowed by the greater palatability score for ST vs. LL owing to its greater IMF content.

In conclusion, use of the Low-lys diet was not effective for increasing the IMF content or eating quality of the pork muscle of finishing pigs slaughtered at high BW. Seemingly, the lysine content of the Low-lys diet was not low enough to elicit an increased IMF deposition although the intended lysine deficiency was evident in the Low-lys group gilts as indicated by their increased BFT in response to the Low-lys vs. Med-lys diet. It hence remains to be further studied to formulate a low-lysine finisher diet suitable for on-farm swine production as part of a strategy for increasing IMF and pork meat quality of 'big' pigs fattening over 130 kg, which have reduced requirements of essential amino acids.

Competing interests

No potential conflict of interest relevant to this article was reported.

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Authors' contributions

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Ethics approval and consent to participate

The present study was approved by the Institutional Review Board (GIRB-G21-Y-0059) and Institutional Animal Care and Use Committee (GNU-221011-P0122) of Gyeongsang National University.

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Table 1. Composition of the experimental diets (as-fed basis)

Item	Medium-lysine[1)]	Low-lysine
Ingredients (%)		
Corn		52.09
Wheat		10.00
Barley		6.00
Soybean meal		2.40
Rapeseed meal		5.00
Palm kernel meal		10.00
DDGS		10.00
Animal fat		2.50
Salt		0.40
Limestone		0.36
Tricalcium phosphate		0.85
L-lysine (56%)		0.20
Vitamin premix		0.10
Mineral premix		0.10
Total		100.00
Chemical composition		
ME (Mcal/kg)	3.20	3.32
Crude protein (%)	13.50	13.50
Total lysine (%)	0.80	0.60

[1)]It was a commercial diet whose composition of ingredients was not allowed to be publicized by the manufacturer; information on chemical composition of the diet was kindly provided by the manufacturer.

DDGS, dried distillers grains with solubles; ME, metabolizable energy.

Table 2. Effects of the lysine concentration of the diet on growth performance in finishing pigs slaughtered at high body weights[1)]

Item	Barrows		Gilts		SEM	*p*-value		
	Med-lys	Low-lys	Med-lys	Low-lys		Sex (S)	Diet (D)	S×D
Initial wt (kg)	83.0	81.4	80.2	81.1	1.5	0.31	0.82	0.43
Final wt (kg)	127.4	137.4	130.4	133.6	2.7	0.90	0.02	0.22
Days on feed	46	53	53	60				
ADG (g)	964	1,056	948	876	46	0.05	0.83	0.09
ADFI (kg)	3.56	3.78	3.16	3.19				
Carcass wt (kg)	94.3	102.8	97.9	99.4	2.2	0.96	0.03	0.11
Dressing (%)	74.1	74.8	75.0	74.5	0.9	0.74	0.91	0.49
BFT (mm)								
Measurement	20.0	20.1	19.3	22.6	0.9	0.37	0.08	0.10
Adjusted[2)]	21.2	18.8	19.6	22.2	0.9	0.35	0.90	0.01

[1)]Data are means of eight animals, except for ADFI which is a single measurement for one group-fed unit of animals.

[2)]Corrected for a 132-kg final weight.

Med, medium; Wt, weight; ADG, average daily gain; ADFI, average daily feed intake; BFT, backfat thickness.

Table 3. Effects of the lysine concentration of the diet of finishing pigs slaughtered at high body weights on physicochemical characteristics of their muscles *postmortem*[1)]

Item	Barrows		Gilts		SEM	*p*-value		
	Med-lys	Low-lys	Med-lys	Low-lys		Sex (S)	Diet (D)	S×D
Longissimus lumborum muscle								
CIE L*	49.8	49.3	49.3	49.7	0.6	0.96	0.89	0.50
CIE a*	7.40	6.82	7.76	7.93	0.21	<0.01	0.32	0.09
CIE b*	1.86	1.73	2.55	2.66	0.18	<0.01	0.96	0.52
pH	5.86	5.79	5.77	5.74	0.05	0.20	0.40	0.69
Drip loss (%)	1.17	1.12	1.06	1.28	0.17	0.87	0.61	0.41
RW[2)] (%)	10.00	9.37	9.65	9.84	0.95	0.95	0.82	0.67
Cooking loss (%)	26.8	26.4	26.0	26.2	0.9	0.58	0.90	0.73
WBSF (kg/cm^2)	3.66	3.21	3.30	3.21	0.09	0.04	<0.01	0.04
IMF (%)	3.33	3.17	2.91	3.35	0.29	0.68	0.63	0.30
Semitendinosus muscle								
CIE L*	43.7	46.2	46.4	47.3	1.0	0.07	0.11	0.43
CIE a*	17.6	16.1	14.1	14.6	1.0	0.03	0.64	0.36
CIE b*	5.71	5.47	4.93	5.92	0.45	0.71	0.41	0.18
pH	6.22	6.24	6.23	6.06	0.06	0.17	0.22	0.11
Drip loss (%)	0.82	0.82	0.79	0.68	0.07	0.21	0.46	0.42
RW[2)] (%)	4.68	6.81	4.45	5.73	0.86	0.45	0.06	0.62
Cooking loss (%)	24.5	25.3	24.6	26.8	1.1	0.49	0.19	0.56
WBSF (kg/cm^2)	3.90	4.04	4.07	4.16	0.07	0.05	0.13	0.72
IMF (%)	6.14	5.80	6.05	6.10	0.45	0.82	0.74	0.67

[1)]Data are means of eight animals.

[2)]Percentage of water released from a muscle sample (w/w) squeezed between two thin plastic films pressed by a certain weight load as a quick assessment of the water holding capacity.

Med, medium; RW, released water; IMF, intramuscular fat; WBSF, Warner-Bratzler shear force.

Table 4. Effects of the lysine concentration of the diet of finishing pigs slaughtered at high body weights on composition of fatty acids of their muscles *postmortem*[1)]

Item	Barrows		Gilts		SEM	*p*-value		
	Med-lys	Low-lys	Med-lys	Low-lys		Sex (S)	Diet (D)	S×D
Longissimus lumborum muscle								
14:0	1.74	1.90	1.83	1.89	0.05	0.45	0.03	0.32
16:0	26.1	27.7	26.1	26.1	0.3	0.01	0.01	0.01
18:0	12.0	12.9	12.1	12.3	0.3	0.43	0.08	0.34
16:1	4.07	4.28	4.36	4.16	0.17	0.58	0.97	0.23
18:1	46.1	44.4	45.0	45.3	0.5	0.77	0.18	0.04
18:2n6	7.70	7.01	8.34	8.08	0.39	0.04	0.24	0.58
18:3n3	0.34	0.27	0.29	0.31	0.04	0.82	0.54	0.24
20:4n6	1.42	1.05	1.52	1.25	0.13	0.26	0.02	0.69
Others	0.47	0.45	0.46	0.48	0.01	0.36	1.00	0.14
Total	100.0	100.0	100.0	100.0				
SFA	40.1	42.7	40.2	40.5	0.5	0.07	0.01	0.04
MUFA	50.2	48.8	49.4	49.5	0.5	0.93	0.22	0.13
PUFA	9.5	8.4	10.2	9.7	0.5	0.06	0.12	0.55
Semitendinosus muscle								
14:0	1.98	1.97	2.01	1.97	0.05	0.79	0.71	0.83
16:0	25.7	25.4	24.9	25.2	0.3	0.07	0.90	0.21
18:0	11.4	11.3	11.3	11.9	0.3	0.45	0.37	0.28
16:1	3.85	3.86	3.83	3.64	0.12	0.34	0.45	0.42
18:1	46.9	46.7	47.1	46.3	0.7	0.89	0.47	0.65
18:2n6	8.36	8.76	8.95	8.92	0.41	0.37	0.66	0.60
18:3n3	0.37	0.35	0.37	0.36	0.01	0.61	0.24	0.87
20:4n6	0.95	1.12	1.08	1.13	0.15	0.65	0.46	0.70
Others	0.57	0.55	0.55	0.57	0.02	0.82	0.88	0.18
Total	100.0	100.0	100.0	100.0				
SFA	39.2	38.8	38.3	39.4	0.5	0.70	0.45	0.13
MUFA	50.8	50.6	51.0	50.0	0.7	0.75	0.40	0.54
PUFA	9.7	10.3	10.4	10.5	0.5	0.43	0.61	0.63

[1)]Data are means of eight animals.

Med, medium; SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids.

Table 5. Effects of the lysine concentration of the diet of finishing pigs slaughtered at high body weights on sensory quality attributes of their pork muscles

Item	Barrows		Gilts		SEM	*p*-value		
	Med-lys	Low-lys	Med-lys	Low-lys		Sex (S)	Diet (D)	S×D
Fresh muscle[1]								
Longissimus lumborum muscle								
Marbling	3.98	4.38	4.13	4.20	0.18	0.94	0.19	0.36
Color	3.25	3.45	3.33	3.18	0.16	0.53	0.88	0.28
Texture	3.83	4.08	3.80	3.80	0.12	0.24	0.32	0.32
Drip	4.08	3.98	3.63	3.70	0.11	<0.01	0.91	0.45
Acceptability	3.73	3.93	3.73	3.78	0.09	0.40	0.16	0.40
Semitendinosus muscle								
Marbling	3.58	4.23	3.75	3.80	0.23	0.60	0.15	0.21
Color	2.83	3.08	3.05	3.33	0.21	0.27	0.23	0.95
Texture	2.60	2.60	2.83	2.88	0.12	0.05	0.84	0.84
Drip	5.00	5.00	5.00	5.00	IE	IE	IE	IE
Acceptability	3.60	3.70	3.50	3.60	0.11	0.37	0.37	1.00
Cooked muscle[2]								
Longissimus lumborum muscle								
Flavor	6.43	6.43	6.33	6.50	0.10	0.90	0.38	0.38
Juiciness	3.15	3.13	3.15	3.35	0.13	0.41	0.52	0.41
Tenderness	2.95	3.50	3.15	3.45	0.21	0.73	0.05	0.56
Umami	6.30	6.30	6.25	6.43	0.09	0.68	0.34	0.34
Palatability	6.23	6.28	6.03	6.33	0.15	0.61	0.24	0.40
Semitendinosus muscle								
Flavor	7.18	7.28	7.40	7.35	0.13	0.25	0.85	0.56
Juiciness	5.10	5.15	5.60	5.68	0.20	0.02	0.76	0.95
Tenderness	4.95	5.05	5.20	5.00	0.28	0.72	0.86	0.59
Umami	7.08	7.30	7.18	7.20	0.14	1.00	0.39	0.49
Palatability	7.18	7.40	7.03	6.88	0.19	0.08	0.84	0.32

[1)]The sensory attribute was scored according to a 5-tier hedonic scale ranging from 1 for the ‘extremely bad’ to 5 for the ‘extremely good.’

[2)]Scored according to a 9-tier hedonic scale ranging from 1 for the ‘extremely dislike’ to 9 for the ‘extremely like.’

[1),2)]Data are means for eight animals.

Med, medium; IE, inestimable.

Table 6. Pearson′s correlation coefficients between the IMF content and sensory scores for the fresh and cooked *Longissimus lumborum* (LL) and *Semitendinosus* (ST) muscles[1)]

	Fresh pork muscle			Cooked pork muscle				
	Marbling	**Drip**	**Acceptability**	**Flavor**	**Juiciness**	**Tenderness**	**Umami**	**Palatability**
Within LL	0.24	0.09	0.18	0.00	0.31	0.27	0.22	0.19
(N = 32)	(0.19)	(0.61)	(0.32)	(1.00)	(0.09)	(0.14)	(0.23)	(0.29)
Within ST	-0.05	IE	-0.25	-0.12	0.18	0.09	-0.30	-0.41
(N = 32)	(0.77)		(0.17)	(0.52)	(0.32)	(0.63)	(0.09)	(0.02)
LL + ST	-0.20	0.73	-0.32	0.62	0.77	0.68	0.57	0.45
(N = 64)	(0.12)	(<0.01)	(0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)

[1)]See Tables 3 and 5 for the IMF contents and sensory scores, respectively. The *p*-values are shown in parentheses.

IE, inestimable.