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Effects of an extra-high slaughter weight and a low-lysine diet on growth and meat quality of finishing gilts

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Abstract

The present study aimed to find out the feasibility of increasing the meat quality of finishing gilts by increasing their slaughter weight (SW) to an extra-high (XH) level and also by using a low-lysine (lys) diet in XH-weight pig production. Twenty-four gilts and eights barrows were divided into four treatments (T) by gender, SW, and diet: T1 (barrow; 116-kg SW; Medium [Med]-lys [0.80%] diet), T2 (gilt; 116-kg SW; Med-lys), T3 (gilt; XH [150 kg] SW; Med-lys), and T4 (gilt; XH SW, Low-lys [0.60%]). Growth performance from 85 kg of body weight to SW was measured only for T3 and T4. All animals were slaughtered at their target SW, followed by physicochemical analyses and sensory evaluation on the *Longissimus lumborum* muscle (LL). Average daily gain did not differ between T3 and T4. Dressing percentage was greater for T3 vs. T2. Backfat thickness was greater for T1 vs. T2 and T3 vs. T2, not being different between T3 and T4. The LL pH was lower and Warner-Bratzler Shear force value was greater for T3 vs. T2. Other physicochemical measurements including the intramuscular fat content were not different or different narrowly if different at all ($p < 0.05$) between T3 and T2 or T4, but not between T1 and T2. The percentages of major fatty acids including 16:0, 18:0, 18:1, and 18:2 in LL, which did not differ between T2 and T3, differed between T3 and T4 apparently resulting from a difference in composition of the ingredients of the two diets. The sensory texture score was greater for T3 vs. T2 in fresh LL; in cooked LL, juiciness and umami scores were greater for T3 vs. T2, flavor score being less for T4 vs. T3. The gender effects on physicochemical and sensory pork quality were small, if any. Overall, the meat quality of finishing gilts could be improved by increasing the SW to the XH level, but not by using the Low-lys diet, suggesting that it will be feasible to produce XH-weight market gilts if the increased meat quality can make up for the expected decrease in production efficiency accompanying the increased SW.

Keywords: Finishing gilt, Dietary lysine, Slaughter weight, Weight gain, Backfat thickness, Pork quality

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

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Availability of data and material
Upon reasonable request, the datasets of this study can be available from the corresponding author.

Authors' contributions
Conceptualization: Lee CY, Park TW, Jang JC.
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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.

INTRODUCTION

The slaughter weight (SW) of market pigs is determined by a number of factors including the genetic lineage and nutrition of the animals, production efficiency, consumers' demands, carcass grading standards, and others [1–4]. Increasing the SW, in general, causes a decreased daily gain, an increased daily feed intake, and steady fat deposition eventually resulting in a decreased gain-to-feed ratio [5–8]. Most meat-producing pigs are therefore harvested between 100- and 130-kg body weight (BW) worldwide, for which reason only limited information is available as to the effects of heavy market weight on production efficiency and pork quality, especially in pigs slaughtered at an 'extra-high' (XH) BW over 140 kg [8].

With increasing SW, the content of the intramuscular fat (IMF), which is generally believed to enhance the eating quality of pork [9–11], also increases at a rate ranging approximately from 0.01%/kg to 0.04%/kg SW in the *Longissimus* muscle (LM) primarily depending on the genetic background of the pigs [12–16]. In line with this, in our recent study reported by Hwang et al. [14], the LM IMF content, which increased at a rate of 0.04%/kg approximately between 110 and 135 kg of SW, was highly correlated with sensory scores for the juiciness, flavor, and palatability. By contrast, in our earlier studies with lean finisher pigs where the LM IMF content increased only at 0.012%/kg within a similar interval of SW, the eating quality of LM did not change due to the increase of SW [12,13]. It needs to be noted, however, that the relationship between the IMF content and sensory quality traits of meat can be influenced by other factors including the breed, physicochemical properties of the muscle other than IMF, socio-cultural factors, etc. [9,10,17].

Use of a diet having a low lysine (lys) content is known to elicit an increase in IMF deposition accompanied by an increased backfat thickness (BFT) [18–20]. In a companion study of ours preceding the present one [21], gilts fed a low-lysine (0.60%) vs. control (0.80% lysine) diet from 81-kg BW to slaughter at 132 kg exhibited the known consequence of the lysine deficiency indicated by an increased BFT whereas in barrows such a diet effect was not detected. The gilts fed the low-lysine diet, however, did not have a greater IMF content or better eating quality of LM than those fed the control diet. These results were different from those of the studies cited above [18,19], where the LM IMF content increased by as much as 1%–2% depending on the harshness and duration of the lysine deficiency. The present study therefore aimed to find out if it would be feasible to increase the meat quality of finishing gilts by increasing their SW to a 150-kg XH level vs. the 116-kg domestic average (Av) [22] and also by using the Low-lys diet in the production of XH-weight pigs. XH-weight barrows were excluded from the present study because of their over-fatness at 130-kg or greater BW [2,3,5,6], barrows with Av SW being included only as for the gender control of gilts.

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). The animals used in the present study were Duroc-sired, Landrace × Yorkshire progeny which had the same genetic lineage as those used in the companion study [21], whose feeding trial mostly overlapped temporally with that of the present study. The animals had been reared on commercial grower diets with medium nutritional planes followed by a medium-nutritional plane finisher diet containing 0.80% lysine by the NRC [23] standard approximately from 80-kg BW before the present feeding trial as previously described [20,21,24].

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Sixteen finishing gilts aged 140 ± 1 days and weighing approximately 85 kg were randomly allotted to two pens, with eight animals per pen, and fed to 150-kg target SW either of the medium-lys (XHSW group) and low-lys (0.60%; XHSW-LowLys group) diets (Table 1) which had been used as experimental diets in the companion study [21]. Eight gilts, as well as eight barrows as for the control with respect to the gender, weighing approximately 116 kg (AvSW and [B]AvSW groups, respectively) were selected at trucking from the market pigs which had been raised as for the pigs of the XHSW group but with no weight gain record. All experimental animals were transported to a local abattoir at their target BW and slaughtered the following day. The carcasses were chilled overnight and fabricated, following which the left-side loin was collected from each carcass and transported to the laboratory in a refrigerator car. The BFT measurement reported from the abattoir was adjusted for the 116- or 150-kg target liveweight as described previously [20,24].

Physicochemical analysis

The *Longissimus lumborum* muscle (LL) was dissected from the loin followed by removal of the subcutaneous fat. Physicochemical properties of trimmed LL, including the color, pH, Warner-Bratzler Shear force (WBSF), and others pertaining to the water holding capacity were measured as previously described [14,21,25]. The fat content and fatty acid (FA) composition of LL were determined by Soxhlet extraction following the procedure of AOAC [26] and by gas chromatography after extraction of total lipids [27], respectively, also as described previously [21,28].

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

Item	Lysine level of the diet	
	Medium1)	Low
Ingredients (%)		100.00
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
Chemical composition		
ME (Mcal/kg)	3.20	3.32
Crude protein (%)	13.50	13.50
Crude fat (%)	6.50	8.50
Total lysine (%)	0.80	0.60

1)It was a commercial diet whose ingredient composition 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.

Sensory evaluation

The present sensory evaluation protocol was approved by the Institutional Review Board (GIRB-G21-Y-0059). In brief, the sensory attribute was evaluated according to the modified Spectrum TM method [29] by five panelists who had been trained in the intramural Meat Science Laboratory. Fresh LL was scored according to a 5-tier hedonic scale ranging from 1 for 'extremely bad' to 5 for 'extremely good' for its marbling, color, texture, drip referring to the moisture on the meat surface, and overall acceptability; cooked LL was scored for its flavor, juiciness, tenderness, umami referring to the meaty, savory deliciousness deepening the flavor, and overall palatability according to a 9-tier hedonic scale ranging from 1 for 'extremely dislike' to 9 for 'extremely like' as previously described [14,21].

Statistical analysis

All data, except for those of growth performance, were analyzed by the preplanned contrast using the General Linear Model procedure of SAS (SAS/STAT Software for PC. Release 9.2, SAS Institute, Cary, NC, USA); growth performance data were analyzed by t test. In all analyses, the animal was the experimental unit. In the analysis of sensory evaluation, the panelist was included in the model in addition to the animal nested within the treatment, which was used as the error term to test the effect of the treatment. The probability (p) value of $0.05 \leq p$ derived from the preplanned contrast or t test was judged to be 'significant.'

RESULTS

Growth performance

Average daily gains (ADG) for the XHSW and XHSW-LowLys groups, respectively, did not differ from each other during the first 28 days (D), the period between D 28 and slaughter, or the entire experimental period (Table 2). Dressing percentage, which did not differ between the (B)AvSW and AvSW groups, was much greater for XHSW than for AvSW, with no difference between XHSW and XHSW-LowLys. The BFT adjusted for 116-kg SW for the AvSW group was less than those for (B)AvSW and XHSW adjusted for their target SW, respectively, not being different between XHSW and XHSW-LowLys.

Physicochemical characteristics of the muscle

Neither L* nor b* value of LL was different between (B)AvSW and AvSW, but both color values were greater for XHSW than for AvSW; the a* value did not differ between (B)AvSW and AvSW, between AvSW and XHSW, or between XHSW and XHSW-LowLys (Table 3). The pH was lower for XHSW vs. AvSW, with no difference between (B)AvSW and AvSW or between XHSW and XHSW-LowLys. Drip loss did not differ between any two groups of interest. The percentage of released water (RW) was less for XHSW-LowLys vs. XHSW whereas cooking loss was greater for XHSW than for AvSW or XHSW-LowLys. The WBSF value was greater for XHSW than for AvSW, with no difference between (B)AvSW and AvSW or between XHSW and XHSW-LowLys. The IMF percentage did not differ between (B)AvSW and AvSW, AvSW and XHSW, or XHSW and XHSW-LowLys.

FA composition of the muscle

No difference was detected between (B)AvSW and AvSW or between AvSW and XHSW in the percentage for each FA out of total FA determined in the present study (Table 4). However, percentages of myristic acid (14:0), oleic acid (18:1), linoleic acid (18:2), and linolenic acid (18:3)

Table 2. **Effects of the extra-high (XH) slaughter weight (SW) and low-lysine (Lys) diet on growth performance of finishing gilts1)**

Item	AverageSW		XHSW		SEM	*p*-value2)		
	B-Med3)	G-Med	G-Med	G-Low		T 1:	T 2:	T 3:
	T1	T2	T3	T4		T 2	T 3	T 4
Growth performance4)								
BW at D 0 (kg)			84.3 ± 1.5	85.9 ± 1.5				0.27
BW at D 28			113.5 ± 2.0	112.7 ± 1.4				0.75
ADG (kg)								
D 0–28			1.07 ± 0.05	0.96 ± 0.05				0.12
D 28–67 or 745)			0.85 ± 0.05	0.88 ± 0.04				0.67
Overall			0.95 ± 0.04	0.91 ± 0.03				0.54
Final BW (SW; kg)	116.4	115.4	146.8	153.5	1.9.	0.72	< 0.01	0.02
Carcass characteristics								
Carcass weight (kg)	85.1	85.9	117.0	121.3	1.3	0.70	< 0.01	0.02
Dressing (%)	73.2	74.4	79.7	79.0	0.4	0.10	< 0.01	0.20
Backfat thickness (mm)								
Measurement	21.9	18.3	26.6	28.1	1.1	0.03	< 0.01	0.32
Adjusted6)	21.9	18.4	27.3	27.4	1.0	0.03	< 0.01	0.92

1) Data are means or means ± standard errors of eight animals.

2) Derived from the preplanned contrast except for days 0 and 28 body weights (BW) and ADG which were derived from t test.

3) Barrows fed the medium-lysine (0.80%) diet, gilts fed the medium-lysine diet, and gilts fed the low-lysine (0.60%) diet, respectively.

4) T1 and T2 were not measured. Average daily feed intakes for T3 and T4 were 3.23 and 2.87 kg, respectively, during the first 28days and 3.60 and 3.44 kg, respectively, during the subsequent period to slaughter.

5) Days 67 and 74 were when final weights (SW) for T3 and T4, respectively, were measured.

6) Corrected for 116- and 150-kg final weights for the AV- and XH-SW groups, respectively.

T, treatment; B-Med, barrow-medium; G-Med, gilt-medium; BW, body weight; D, day; ADG, average daily gain.

Table 3. **Effects of the extra-high (XH) slaughter weight (SW) and low-lysine (Lys) diet on physicochemical characteristics of *Longissimus lumborum* muscle of finishing gilts1)**

Item	Average SW		XHSW		SEM	Contrast: *p*-value		
	B-Med2)	G-Med	G-Med	G-Low		T 1:	T 2:	T 3:
	T1	T2	T3	T4		T 2	T 3	T 4
CIE L*	50.9	50.4	51.7	50.4	0.4	0.43	0.04	0.05
CIE a*	7.49	7.45	8.12	7.61	0.33	0.93	0.17	0.29
CIE b*	1.76	1.88	2.94	1.02	0.18	0.65	< 0.01	< 0.01
pH	5.83	5.82	5.65	5.74	0.03	0.81	< 0.01	0.09
Drip loss (%)	1.29	1.20	1.47	1.28	0.12	0.61	0.12	0.27
RW3) (%)	11.1	9.8	11.4	8.8	0.8	0.29	0.20	0.04
Cooking loss (%)	28.9	23.1	26.9	25.0	0.6	0.38	< 0.01	0.04
WBSF	2.90	2.86	3.08	3.11	0.06	0.63	< 0.01	0.78
IMF (%)	3.02	2.54	2.98	2.76	0.20	0.11	0.14	0.43

1) Data are means of eight animals.

2) Barrows fed the medium-lysine (0.80%) diet, gilts fed the medium-lysine diet, and gilts fed the low-lysine (0.60%) diet, respectively.

3) 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.

T, treatment; B-Med, barrow-medium; G-Med, gilt-medium; RW, released water; WBSF, Warner-Bratzler shear force; IMF, intramuscular fat.

Table 4. Effects of the extra-high (XH) slaughter weight (SW) and low-lysine (Lys) diet on fatty acid composition of *Longissimus lumborum* muscle of finishing gilts[1]

Item	Average SW		XHSW		SEM	Contrast: *p*-value		
	B-Med[2]	G-Med	G-Med	G-Low		T 1:	T 2:	T 3:
	T1	T2	T3	T4		T 2	T 3	T 4
14:0	1.84	1.85	1.76	2.23	0.07	0.94	0.39	< 0.01
16:0	26.1	25.9	26.4	24.7	0.5	0.75	0.32	0.01
18:0	11.8	12.1	13.0	11.3	0.5	0.64	0.25	0.04
16:1	4.35	4.15	3.79	4.06	0.20	0.49	0.22	0.35
18:1	45.8	45.5	44.8	47.0	0.7	0.71	0.55	0.05
18:2n6	8.01	8.34	7.83	8.85	0.36	0.52	0.31	0.05
18:3n3	0.32	0.34	0.30	0.40	0.01	0.29	0.07	< 0.01
20:4n6	1.22	1.34	1.43	0.80	0.12	0.48	0.57	< 0.01
Others	0.53	0.53	0.51	0.67	0.03	0.95	0.77	< 0.01
Total	100.0	100.0	100.0	100.0				
SFA	40.2	40.3	41.7	38.8	0.9	0.93	0.28	0.03
MUFA	50.2	49.6	48.7	51.1	0.9	0.63	0.41	0.05
PUFA	9.60	10.07	9.63	10.09	0.47	0.48	0.51	0.50

[1] Data are means of eight animals.

[2] Barrows fed the medium-lysine (0.80%) diet, gilts fed the medium-lysine diet, and gilts fed the low-lysine (0.60%) diet, respectively.

T, treatment; B-Med, barrow-medium; G-Med, gilt-medium; SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids.

were greater for XHSW-LowLys vs. XHSW, but the opposite was true for palmitic acid (16:0), stearic acid (18:0), and arachidonic acid (20:4); only the palmitoleic acid (16:1) percentage did not differ between XHSW and XHSW-LowLys. Consequently, the percentage of saturated fatty acids (SFA) was less for XHSW-LowLys vs. XHSW, but the percentage of monounsaturated FA (MUFA) was greater for the latter, with no difference between these two groups in the percentage of polyunsaturated FA (PUFA).

Sensory evaluation

The marbling score of fresh LL, which did not differ between AvSW and XHSW, was greater for AvSW vs. (B)AvSW and less for XHSW-LowLys vs. XHSW (Table 5). The color score did not differ between (B)AvSW and AvSW, AvSW and XHSW, or XHSW and XHSW-LowLys. The texture score was greater for XHSW vs. AvSW. In drip and acceptability, no difference was detected in any preplanned contrast of two groups. In cooked LL, no difference was detected between (B) AvSW and AvSW in any of the sensory scores for the flavor, juiciness, tenderness, umami, and overall palatability. The juiciness and umami scores were greater for XHSW vs. AvSW, the flavor score being less for XHSW-LowLys vs. XHSW, except which no other difference was detected between XHSW vs. AvSW or XHSW-LowLys.

DISCUSSION

The BFT, as expected, was greater for barrows vs. gilts at 116-kg Av SW and also for the 150-kg XH-SW vs. Av-SW group gilts, which was consistent with published results regarding the effects of the gender [2,3,5,12,13] and SW between 100 and 165 kg [6,15]. Moreover, the BFT of the gilts increased between Av and XH SW by 8.9 mm at a rate of 0.26 mm/kg SW, which was much greater than 0.19 mm/kg at 114 ± 6 kg of SW observed in a previous study [20] in gilts having a leanness similar to that of the present ones. Of note, the dressing percentage increased by as much

Table 5. Effects of the extra-high (XH) slaughter weight (SW) and low-lysine (Lys) diet on sensory attributes of fresh and cooked *Longissimus lumborum* pork muscle of finishing gilts[1)]

Item	Average SW		XHSW		SEM	Contrast: *p*-value		
	B-Med[2)]	G-Med	G-Med	G-Low		T 1:	T 2:	T 3:
	T1	T2	T3	T4		T 2	T 3	T 4
Fresh pork[3)]								
Marbling	3.75	4.38	4.13	3.43	0.21	0.04	0.50	0.02
Color	3.23	3.05	3.10	3.08	0.18	0.50	0.85	0.92
Texture	3.15	3.40	3.93	3.88	0.13	0.18	0.01	0.79
Drip	2.85	3.03	3.23	2.90	0.13	0.37	0.30	0.10
Acceptability	3.60	3.90	3.78	3.55	0.12	0.08	0.08	0.18
Cooked pork[4)]								
Flavor	6.12	6.18	6.45	6.00	0.11	0.72	0.09	0.01
Juiciness	3.14	3.00	3.48	3.43	0.10	0.31	< 0.01	0.71
Tenderness	2.99	3.13	2.85	3.33	0.18	0.60	0.09	0.07
Umami	6.16	6.05	6.38	6.23	0.08	0.31	< 0.01	0.17
Palatability	5.85	6.10	6.13	6.15	0.14	0.22	0.90	0.90

[1)] Data are means for eight animals.

[2)] Barrows fed the medium-lysine (0.80%) diet, gilts fed the medium-lysine diet, and gilts fed the low-lysine (0.60%) diet, respectively.

[3)] 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’; the greater score indicates the better.

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

T, treatment; B-Med, barrow-medium; G-Med, gilt-medium.

as 5% between Av and XH SW concomitant with the increase of BFT. These results conform to the known fact that with increasing SW, the ratio of the carcass per live weight increases due largely to an increase in subcutaneous and muscle fats [7,8]. It will thus be necessary to watch for over-fattening when producing heavy market pigs.

Regarding the effects of the Low-lys diet, it needs to be noted that ADG for the XHSW-LowLys vs. XHSW group was substantially less during the first 28 days but was slightly greater during the subsequent period to XHSW, albeit not significant statistically. This suggests that the XHSW-LowLys group probably grew faster than normal during the latter experimental period by virtue of the compensatory growth, which refers to a normal biological process whereby the animals previously under nutritional restriction grow at an accelerated rate to achieve a target BW and composition [30–32]. There’s also experimental evidence, if not proven, that in compensatory growth of previously lysine-restricted pigs, excess body fat which has accrued from the lysine deficiency is mobilized during the recovery period to make up for the delayed lean growth incurred by the lysine deficiency [31]. In this regard, the BFT, which was 2.6-mm greater for the low-lys vs. medium-lys diet group at 132-kg SW ($p < 0.05$) due to a presumptive lysine deficiency in the companion study [21] temporally overlapping with the present one, was equal for both groups at XH SW, suggesting that the disappearance of the BFT gap between the two SW groups probably resulted from lipid mobilization for compensatory growth. Likewise, the lack of effect of the low-lys diet on the IMF content of LL is also thought to be partly related to the presumptive compensatory growth in the XHSW-LowLys group. It is also known that compensatory growth occurs only when the previously restricted energy or amino acid is provided sufficiently during the recovery period [31,32]. In this connection, the calculated standardized ileal digestible (SID) lysine content of the low-lys diet (0.49%) was less than the requirements of 0.56% and 0.51% of dietary SID lysine concentrations for 125–140-kg and 140-160-kg pigs, respectively, estimated by the NRC [23] model [4] and Manini et al. [33], respectively. Nevertheless, the present results suggest that the low-lys diet was adequate in its lysine content to elicit the presumptive compensatory growth of the gilts during the later experimental period, which is not much surprising though, considering that the dietary lysine requirement is variable depending on the assumptions or estimates on the lean gain rate, efficiency of the amino acid utilization, feed intake and wastage of the animals, etc. [23].

In physicochemical properties of LL, the greater a* value for the XHSW vs. AvSW, albeit insignificant, was seemingly reflective of the known correlation between this color variable and SW [2,8]; results of the other color variables L* and b*, as well as those of the drip loss and RW percentages, were within normal ranges [2,8,14] irrespectively of a few detected differences between the experimental groups. The increase of the WBSF value for LL between Av and XH SW was also consistent with published results [14,34,35], but the SW-associated WBSF increase, which has been reported to cause a negative [14] or no [34] effect on the tenderness of cooked pork, apparently exerted no significant influence on the tenderness in the present study. The IMF content of LL increased between Av and XH SW at a rate of 0.014%/kg, which was close to 0.012%/kg between 110 and 133 ± 5 kg of SW obtained from previous studies in lean pigs [12,13]; effects of the SW-associated change of the IMF content, as well as those of the lower pH and greater cooking loss for the XHSW vs. AvSW group, on eating quality of pork muscle will be discussed in the following paragraph. As for the FA composition of LL, the unaltered percentages of major FA between Av and XH SW, including those of palmitic acid, stearic acid, oleic acid, and linoleic acids, were consistent with the results for a composite carcass muscle of finishing pigs between 91 and 127 kg of SW reported by Apple et al. [36]. Moreover, the lower percentages in palmitic acid and stearic acid and the greater oleic acid percentage for the XHSW-LowLys vs. XHSW group, which is presumed to have resulted from a few-percent greater content of animal fat mostly consisting of beef tallow in the Low-lys diet (personal communication with the manufacturer of the diet), were also consistent with the results of Apples et al. [36].

The sensory attributes associated with pork quality are influenced by a number of factors [10,11]. The IMF usually enhances the sensory pork quality attributes including the flavor, juiciness, and tenderness [9,10,11,37]; the pH also influences the sensory attributes of meat through its effects primarily on water holding capacity and myofibril fragmentation, the higher pH between 5.0 and 6.0 being the better in overall pork quality [11,38,39]. As related to the present results, the 0.44% greater IMF content for the XHSW vs. AvSW group, albeit insignificant (p = 0.14), is likely to have contributed, in part, to the increased juiciness and umami for the former group, whereas the 0.17-unit lower pH for the former is likely to have exerted a negative influence on the meat quality indirectly. The lower marbling and flavor scores for the XHSW vs. XHSW-LowLys group, however, were not seemingly related much to either IMF or pH, because differences in these factors between the two groups were relatively small. It was apparently paradoxical that the juiciness of cooked LL, which is known to be negatively correlated with the cooking loss [11], was greater for the XH vs. Av SW group with a greater cooking loss for the former. However, it is also known that the juiciness increases with the increase of SW and IMF [10,11,38], and the cooking loss has been reported to be increased [15], unchanged [14,24] or even decreased [2] by the increase of SW. Moreover, the relationships among SW, cooking loss, and juiciness were not clear in our previous study [14]. It is thus seemingly likely that the difference in cooking loss between the Av and HX SW groups was not significant enough to influence the sensory trait whereas other effects such as those associated with the increased SW and IMF outweighed the negative influence of the cooking loss if any. Obviously, more studies are necessary to elaborate the influences of XH SW on the cooking loss and juiciness of pork.

Linoleic acid and linolenic acid, which are prone to oxidation during storage, can cause off-flavor of meat [40,41], but the increases in these FA percentages in the XHSW-LowLys vs. XHSW group were not big enough to influence the flavor in the present study. Similarly, the increased 18:1 and MUFA percentages and a decreased 18:0 percentage of the LL FA composition for the XHSW-LowLys vs. XHSW group also appear not to have been big enough to influence the meat quality in the present study, although the former FA and 18:0 are reportedly related with good and undesirable eating experiences of beef, respectively [28,42]. With respect to the gender effects, the small differences between barrows and gilts in some quality attributes observed in the present study were similar to the results reported by Trefan et al. [43]. Pork quality is also known to be influenced by a number of water-soluble compounds such as sugars and free amino acids as well as those derived from lipids [10]. However, only limited information is available as to how the contents of those compounds in pork change with increasing SW as related to meat quality [44]. More studies in this area are therefore awaited to better understand the effects of increasing SW of finishing pigs on their meat quality.

CONCLUSION

The meat quality of gilts was improved by increasing their SW from 116 kg to the 150-kg XH level. It will be hence feasible to produce XH-weight market gilts if the increased meat quality can make up for the decrease in production efficiency resulting from the accelerated fat deposition following the increased SW. The low-lys diet, however, neither elicited an increase in the IMF content nor improved the meat quality of the gilts at XH SW. Therefore, use of the low-lys or similar finisher diet for the entire finishing period of the pigs raised to XH SW won't be effective for increasing their meat quality. Instead, the low-lysine diet may well be a proper choice for heavy pigs near XH SW which have a reduced lysine requirement.

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