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Effects of a Dietary Fermented Mushroom (*Flammulina velutipes*) By-Product Diet on Pork Meat Quality in Growing-Fattening Berkshire Pigs

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ABSTRACT

This study was carried out to investigate the effects of fermented mushroom (*Flammulina velutipes*) by-products on meat quality characteristics in fattening Berkshire pigs. The fermented diet mainly contained 40.0% mushroom by-products, 26.0% rice bran, and 20.0% formula feed and was fermented for 5 d. The basal diet for the control (C) was substituted with 10% (T1), 30% (T2), 50% (T3), and 70% (T4) fermented diet. Warner-Bratzler shear forces (WBSF) were significantly lower ($P < 0.05$) in treatments than that in C. The meat color (lightness, redness, and yellowness) was significantly lower ($P < 0.05$) in treatments than that in C, whereas fat color (redness and yellowness) was significantly higher in treatments than that in C ($P < 0.05$). The compositions of palmitoleic acid and arachidonic acid were significantly higher ($P < 0.05$) in T4 than that in C. The amino acid composition of *longissimus dorsi* (LD) and the sensory evaluation of cooked meat were not affected by diet type. In conclusion, a diet of fermented mushroom by-products increased pH and backfat color, but decreased cooking loss, WBSF, and meat color of LD in growing-fattening Berkshire pigs.

(**Key words :** Berkshire pigs, Fermented diet, Meat quality, Mushroom by-products)

INTRODUCTION

Mushroom by-products have increased rapidly because of the increase in the Korean mushroom industry and it has been estimated to be more than 1.90 million ton per year (Kim et al., 2007). The media used for mushroom cultivation mainly contains cotton waste, corn cobs, and rice straw with a small amount of rice bran, wheat bran, beet pulp, cotton seed hull, cotton seed meal, and dried okra (Bae et al., 2006). Williams et al. (2001) reported that mushroom composition has approximately 80% nutrients available, because the mushroom growing process uses 20% of the nutrients in the cultivation media. Therefore, it is possible to use mushroom compost as an animal feedstuff.

Mushroom by-products can easily become contaminated by fungi and bacteria (Kim et al., 2007). These by-products start to decompose and grow harmful fungi after 2 to 3 d and 1 wk after disposal, respectively. They rapidly deteriorate because of the high content of moisture, which causes the growth of harmful microorganisms (Kwak et al., 2008). Hence, mushroom by-products can be used as animal feedstuff when storage conditions are improved. Anaerobic fermentation using lactic acid bacteria improves storability, palatability, and nutrient values of feedstuff (Gao et al., 2008). The fermentation of mushroom by-products mixed with molasses, *Lactobacillus plantarum*, and *Saccharomyces cervisiae* decreases pH and increases lactic acid concentration and populations of lactic acid bacteria and yeast (Kwak et al., 2009). A fermented mushroom by-products diet using *L. plantarium* and *S. cerevisiae* increases crude protein (CP) concentration and total calories (Chu et al., 2012). Therefore, the mushroom by-products show improved storability and nutrient values when fermented by lactic acid bacteria and yeast.

Chu et al. (2012) found that a fermented mushroom by-product diet decreases growth performance and improves carcass grade in growing-fattening Berkshire pigs due to its low energy levels. Chu et al. (2012) studied the growth performance and carcass traits, but they did not study the effects of a fermented mushroom by-product diet on meat

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quality in Berkshire pigs. Therefore, this study was conducted as an extension experiment of the study of Chu et al. (2012) to investigate the effects of a fermented mushroom (*F. velutipes*) by-product diet on the meat quality characteristics in growing-fattening Berkshire pigs.

MATERIALS AND METHODS

1. Fermented diets and feeding experiment

The feeding experimental design was described by Chu et al. (2012). The fermented mushroom by-product diet contained 40.0% mushroom by-products, 26.0% rice bran, 20.0% formula feed 2.0% barley stems, 2.0% sagebrush, 2.0% loess, 2.0% illite, 1.0% sweet potato vines, 1.0% purple sweet potato, 1.0% seame oil dregs, 1.0% perilla oil dregs, 1.0% balloon flower, 0.9% rye cobs, and 0.1% probiotics, respectively. These ingredients were mixed using a fermenter (Bio-Rea, Tong yang, Seoul, Korea) and the fermenting conditions were 40℃ for 24 h. The probiotics contained approximately 3.0×10^7 colony forming unit (cfu)/g *L. plantarium* and 2.0×10^7 cfu/g *S. cerevisiae*. Then the mixture was transferred to anaerobic plastic containers and was fermented at room temperature for 4 d. The average body weight (BW) of the Berkshire pigs (n = 225) used was 50.1 ± 3.0 kg and they were fed the experimental diet until they reached an average BW of 105 ± 2.8 kg. Berkshire pigs were assigned to five dietary treatments such as the basal diet (C) and that substituted with 10% (T1), 30% (T2), 50% (T3) or 70% (T4) fermented mushroom by-products. The nutritional values of the experimental diets are shown in Table 1.

2. Meat sampling

The 12 *longissimus dorsi* (LD) per treatment were chosen randomly. The LD (ribs 613) was cut off and kept at 5℃ before being transported to the laboratory to determine meat quality.

3. pH, cooking loss, and Warner-Bratzler shear force (WBSF)

A 5 g sample of LD was homogenized about 24 h postmortem in 10 volumes of distilled water using a Polytron homogenizer (MSE). pH values were determined using a Hanna HI 9025 pH meter (Woonsocket, RI, USA) with an Orion 8163 glass electrode (Beverley, MA, USA).

Cooking loss was determined as described by Honikel (1998). A 1.5 cm thick and about 80 g LD muscle samples were put into polyethylene bags. The packages were heated in a water bath at 75℃ for 1 h and then cooled at room temperature for 30 min. The cooking loss percentage was determined using muscle weights taken before and after cooking.

WBSF was determined as described by Honikel (1998). The LD was cut into approximate cubes of 4 cm × 2.5 cm × 1.5 cm (i.e. length × width × height), and the WBSF of fresh samples was determined immediately. The samples were cooked in a water bath at 75℃ until the internal temperature of the LD reached 70℃. Then the samples were cooled for 4 h at 25℃. The WBSF was measured using an Instron 3343 instrument (US/MX50, A&D Co., Milpitas, CA, USA) equipped with one Warner-Bratzler shear blade (crosshead speed of 1 mm/sec).

4. Meat and fat color

Meat and fat color of LD were evaluated on freshly or cooked cut surfaces (3 cm thick slice) using a chroma meter CR-300 (Minolta, Osaka, Japan) after placing the samples at room temperature for 20 min. Five color measurements were carried out across individual sample surfaces and the average of five replicates was expressed as CIE L*, CIE a*, CIE b*, chroma and hue angle. The chroma meter was calibrated against a white tile (L* = 93.30, a* = 0.32, and b* = 0.33). The aperture was 8 mm, illuminant D65 and 10° standard observer. Chroma (saturation) was calculated as $(a^{*2} + b^{*2})^{1/2}$, and hue angle was calculated as arctan b*/a* (Wyszecki and Stiles, 1982).

5. Fatty acid composition

Meat fat was extracted from ground muscle using a modified Folch wash method as described by Ways and Hanahan (1964). Fatty acids were quantified as their fatty acid methyl esters and prepared by acid catalyzed methanolysis (Stantos et al., 1997). The fatty acid methyl esters in the hexane layer were analyzed on an Agilent chromatograph (Agilent 6890+, Agilent Technologies, Palo Alto, CA, USA) with a mass spectrometry detector and split (50:1) injector. The samples were methylated in duplicate

and were injected twice into the gas liquid chromatography (GLC) column. The separation of the fatty acid methyl esters was performed on a HP-5MS capillary GLC column (HP, 30 m × 0.32 mm i.d.; 0.25 mm film thickness) using helium as the carrier gas. The mass spectrometry interface and injector temperature were fixed at 270℃ and 260℃, respectively. Oven temperature was 160℃ at 2.5 min, 160~260℃ at 4℃ /min and 260℃ at 5 min. Data were recorded and analyzed on a ChemStation (G1701Ca version C.00).

6. Amino acid composition

A 100 mg LD sample was added to 3 mL 6 N hydrochloric acid then packed in nitrogen gas. The packed samples were hydrolyzed at 110℃ for 24 h and then removed from the hydrochloric acid gas. The enriched samples were added to 5 mL sodium citrate buffer and filtered through 0.2 μm membrane filters. The amino acid composition was measured with an amino acid auto analyzer (Biochrom 20, Olympus, Tokyo, Japan).

7. Sensory evaluation

A total of 35 panelists were used, consisted mainly of students and staff members (Meat Science Laboratory, Gyeongnam National University of Science and Technology, Jinju, Korea) to evaluate sensory quality of the cooked samples. The sensory evaluations were performed in duplicate on each sample by the sensory panelists. Training of panelists was performed according to a sensory evaluation procedure (Meilgaard et al., 1991). The meat samples were cooked to an internal temperature 70℃ in a water bath and were then cut into 10 × 3 × 25 mm^3 pieces, placed on white plastic trays covered with aluminum foil, and served immediately to each panelist.

The cooked meat samples were evaluated for color (1 = very unacceptable; 9 = very acceptable), off-flavor (1 = very weak; 9 = very strong), juiciness (1 = very dry; 9 = very juicy), flavor (1 = very unacceptable; 9 = very acceptable), tenderness (1 = very tough; 9 = very tender), and total acceptability (1 = very unacceptable; 9 = very acceptable).

8. Statistical Analyses

Data were analyzed using the General Linear Model (GLM) procedure of SAS (1999) and significant differences among the means were determined using Duncan's multiple range test at $P < 0.05$ (Duncan, 1955).

RESULTS

1. Proximate composition

The fermented mushroom by-product diet decreased the nutritional values as dry matter (DM), crude protein (CP) and crude fat concentrations and metabolism energy (ME) values and increased crude fiber and ash concentrations of the feedstuff (Table 1).

2. Physical-chemical characteristics

The results of pH, cooking loss and WBSF in LD are

Table 1. Chemical composition of the fermented mushroom by-product diets

Items	Treatments[1)]									
	C		T1		T2		T3		T4	
	Growing	Fattening	Growing	Fattening	Growing	Fattening	Growing	Fattening	Growing	Fattening
DM[2)]	87.44	87.49	83.31	83.36	75.06	75.10	66.81	66.84	58.56	58.57
CP[2)]	14.15	15.34	13.38	14.45	11.85	12.68	10.31	10.91	8.78	9.14
Crude fat[2)]	6.27	6.41	5.91	6.04	5.19	5.29	4.47	4.54	3.76	3.80
Crude fiber[2)]	3.06	2.98	3.30	3.23	3.78	3.72	4.25	4.21	4.73	4.71
Ash[2)]	4.97	4.78	5.03	4.86	5.15	5.01	5.26	5.17	5.38	5.32
ME[3)], Mcal/Kg	3.26	3.28	3.10	3.12	2.77	2.79	2.45	2.42	2.13	2.13

[1)] The basal diet was substituted with fermented mushroom (*F. velutipes*) by-products: C, no substitution; T1, 10%; T2, 30%; T3 50%; and T4 70%.

[2)] Analytical values.

shown in Table 2. The pH was significantly higher ($P < 0.05$) in T1, T2, and T3 than that in C and T4 as well as in T2 and T3 than that in T1. Cooking loss was significantly lower ($P < 0.05$) in T2, T3, and T4 than that in C. Although WBSF of fresh meat and fresh fat were affected by the fermented diet, no effects were observed on WBSF of cooked meat. The WBSF of fresh meat was significantly ($P < 0.05$) lower in treated groups than that in C, whereas no difference was observed among the treated groups. Moreover, WBSF of fresh meat was significantly lower ($P < 0.05$) in T2, T3, and T4 than that in C and was significantly lower ($P < 0.05$) in T4 than that in T2 and T3.

3. Meat color

The results of meat and fat surface color are shown in Table 3. The overall parameter of meat surface color was significantly affected ($P < 0.05$) by the fermented diet. The CIE L* (lightness) was significantly lower ($P < 0.05$) in the fermented diet, and T1 and T2 were not significantly

Table 2. The effects of the fermented mushroom by-product diet on pH, cooking loss, and Warner-Bratzler shear force in the *longissimus dorsi* (LD) of Berkshire pigs[1)]

Item	Treatment[2)]					SEM
	C	T1	T2	T3	T4	
pH	5.64^{c}	5.73^{b}	5.89^{a}	5.84^{a}	5.68^{c}	0.06
Cooking loss, %	45.27^{a}	42.22^{ab}	41.27^{b}	41.10^{b}	38.89^{c}	1.37
Warner-Bratzler shear force, kg/cm^2						
Fresh meat	5.91^{a}	2.78^{b}	2.49^{b}	2.81^{b}	2.06^{b}	0.83
Cooked meat	7.49	7.68	7.51	7.98	7.52	0.88
Fresh fat	8.86^{a}	8.47^{ab}	8.17^{b}	7.98^{b}	7.70^{c}	3.44

[1)] Twelve LD were analyzed in each treatment.
[2)] The basal diet was substituted with fermented mushroom (*F. velutipes*) by-products: C, no substitution; T1, 10%; T2, 30%; T3, 50%, and T4, 70%.
[a,b,c] Values in the same row with different superscripts differ at $P < 0.05$.

Table 3. The effects of the fermented mushroom by-product diet on the color of meat and backfat surface in *longissimus dorsi* (LD) of Berkshire pigs[1)]

Item	Treatment[2)]					SEM
	C	T1	T2	T3	T4	
Meat surface color[3)]						
CIE L*	64.07^{a}	55.07^{c}	59.40^{b}	58.00^{bc}	57.15^{bc}	3.57
CIE a*	10.77^{a}	7.93^{bc}	8.69^{b}	7.08^{c}	7.84^{bc}	1.64
CIE b*	5.95^{a}	2.76^{c}	4.18^{b}	3.74^{bc}	3.17^{bc}	1.36
Chroma	12.33^{a}	8.42^{b}	9.73^{b}	8.03^{b}	8.50^{b}	1.99
Hue angle	28.51^{a}	19.57^{c}	25.08^{ab}	27.49^{a}	21.17^{bc}	4.95
Backfat surface color[3)]						
CIE L*	86.76	84.38	86.06	85.77	85.37	1.90
CIE a*	2.74^{b}	2.69^{b}	3.67^{a}	3.57^{a}	3.24^{ab}	0.58
CIE b*	3.19^{b}	2.99^{b}	5.28^{a}	5.31^{a}	5.35^{a}	0.80
Chroma	4.22^{b}	4.06^{b}	6.44^{a}	6.40^{a}	6.26^{a}	0.93
Hue angle	49.16^{bc}	48.56^{c}	55.13^{ab}	56.14^{a}	58.54^{a}	3.98

[1)] Twelve LD were analyzed in each treatment.
[2)] The basal diet was substituted with fermented mushroom (*F. velutipes*) by-products: C, no substitution; T1, 10%; T2, 30%; T3, 50% and T4, 70%.
[3)] CIE L*, black (0) to white (100) color scale; CIE a*, red (+) to green (−) color scale; CIE b*, yellow (+) to blue (−) color scale; Chroma, $(a^{*2}+b^{*2})^{1/2}$ and hue angle, b*/a*.
[a,b,c] Values in the same row with different superscripts differ at $P < 0.05$.

different from T3 and T4. The CIE a* (redness) was significantly lower ($P < 0.05$) in the treated groups than that in C and it was not different between T2 or T3 and T1 or T4. The CIE b* (yellowness) was significantly lower ($P < 0.05$) in the treated groups compared with that in C and it was not different among the treated groups. The CIE L* of backfat surface color was similar across all treatments. CIE a* was significantly higher ($P < 0.05$) in T2 and T3 than that in C and it was not different in T4 compared with that in the other groups. CIE b* and Chroma were significantly higher ($P < 0.05$) in T2, T3, and T4 than that in C. Hue angle was significantly higher ($P < 0.05$) in T3 and T4 than that in C, and T2 was not different from the other groups.

4. Fatty acid composition

The results of fatty acid composition are shown in Table 4. Compositions of myristic acid, palmitic acid, stearic acid, oleic acid, linoleic acid, and linolinic acid were similar in all treatments. The proportion of palmitoleic acid and arachidonic acid were significantly higher ($P < 0.05$) in T4 than that in C. Although the proportions of saturated fatty acid (SFA), unsaturated fatty acid (USFA), USFA/SFA, and SFA/USFA were not affected by diet type, the essential fatty acid composition was affected. Essential fatty acid composition was significantly higher ($P < 0.05$) in T4 than that in T1 and T2.

5. Amino acid composition

The fermented mushroom by-product diet did not affect the composition of essential amino acids such as arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threnonine, or valine. Additionally, the composition of unessential amino acids such as alanine, aspartic acid, cysteine, glutamic acid, glycine, proline, serine, and tyrosine were not affected by diet type (Table 5).

6. Sensory evaluation

The fermented mushroom by-products diet did not affect the sensory evaluation parameters such as, color, aroma, taste, tenderness, texture, juiciness, or acceptability (Table 6).

Table 4. The effects of the fermented mushroom by-product diet on the fatty acid composition in *longissimus dorsi* (LD) of Berkshire pigs[1)]

Item	Treatment[2)]					SEM
	C	T1	T2	T3	T4	
Fatty acid composition, %						
Myristic acid	1.34	1.43	1.53	1.39	1.58	0.28
Plamitic acid	24.68	24.92	24.34	24.51	24.34	1.08
Palmitoleic acid	2.76^{b}	2.84^{ab}	2.89^{ab}	2.67^{b}	3.14^{a}	0.41
Stearic acid	11.09	11.27	11.04	11.36	11.02	0.62
Oleic acid	43.17	43.28	43.95	43.35	42.38	1.56
Linoleic acid	15.27	14.32	14.28	14.67	15.34	1.45
Linolenic acid	0.53	0.67	0.76	0.68	0.69	0.02
Arachidonic acid	1.06^{b}	1.27^{ab}	1.21^{ab}	1.37^{ab}	1.51^{a}	0.08
Saturated fatty acid (SFA)	37.11	37.62	36.91	37.26	36.94	1.32
Unsaturated fatty acid (USFA)	62.89	62.38	63.09	62.73	63.06	1.16
Essential fatty acid	16.86^{ab}	16.26^{b}	16.25^{b}	16.72^{ab}	17.54^{a}	0.68
USFA/SFA	1.69	1.66	1.71	1.68	1.71	0.29
SFA/USFA	0.27	0.26	0.26	0.27	0.28	0.02

[1)] Twelve LD were analyzed in each treatment.

[2)] The basal diet was substituted with fermented mushroom (*F. velutipes*) by-products: C, no substitution; T1, 10%; T2, 30%; T3, 50% and T4, 70%.

[a,b] Values in the same row with different superscripts differ at $P < 0.05$.

Table 5. The effects of the fermented mushroom by-products diet on the amino acid concentration in *longissimus dorsi* (LD) of Berkshire pigs[1)]

Item	Treatment[2)]					SEM
	C	T1	T2	T3	T4	
Essential amino acid, %	9.73	9.78	9.78	9.75	9.75	0.11
Arginine	1.27	1.23	1.25	1.21	1.26	0.08
Histidine	0.83	0.83	0.89	0.90	0.91	0.05
Isoleucine	1.03	1.04	1.04	0.98	0.96	0.06
Leucine	1.63	1.64	1.54	1.56	1.56	0.08
Lysine	1.69	1.79	1.80	1.82	1.83	0.07
Methionine	0.45	0.44	0.48	0.49	0.42	0.02
Phenylalanine	0.83	0.82	0.82	0.80	0.81	0.04
Threnonine	0.87	0.81	0.81	0.83	0.84	0.04
Valine	1.13	1.18	1.15	1.16	1.16	0.07
Unessential amino acid, %	9.08	9.03	9.05	9.12	9.26	0.16
Alanine	1.09	1.05	1.06	1.06	1.09	0.08
Aspartic acid	1.80	1.81	1.72	1.78	1.80	0.09
Cystine	0.15	0.20	0.21	0.18	0.15	0.01
Glutamic acid	3.14	3.12	3.15	3.17	3.16	0.12
Glysine	0.84	0.82	0.80	0.86	0.95	0.02
Proline	0.73	0.75	0.73	0.76	0.76	0.01
Serine	0.71	0.66	0.71	0.67	0.69	0.01
Tyrosine	0.62	0.62	0.67	0.67	0.66	0.01
Total amino acid, %	18.81	18.81	18.83	18.87	19.01	2.84

[1)] Twelve LD were analysed in each treatment.

[2)] The basal diet was substituted with fermented mushroom (*F. velutipes*) by-products: C, no substitution; T1, 10%; T2, 30%; T3, 50% and T4, 70%.

Table 6. The effects of the fermented mushroom by-products diet on the sensory evaluation[1)] in *longissimus dorsi* (LD) of Berkshire pigs[2)]

Item	Treatment[3)]					SEM
	C	T1	T2	T3	T4	
Cooked meat						
Color	5.33	5.13	5.47	5.33	5.38	0.68
Aroma	6.00	6.00	6.40	6.50	6.04	0.67
Taste	6.50	6.46	6.67	6.90	6.85	0.77
Tenderness	6.17	6.00	6.00	6.33	6.23	1.33
Texture	6.50	6.47	6.67	6.83	6.92	0.74
Juiciness	6.67	6.73	6.83	6.83	6.85	0.91
Acceptability	6.92	6.67	6.63	7.00	6.92	1.35

[1)] Sensory evaluation was scored on 9 point scale based on 1 (extremely bad or slight) to 9 (extremely good or much).

[2)] Twelve LD were analyzed in each treatment.

[3)] The basal diet was substituted with fermented mushroom (*F. velutipes*) by-products: C, no substitution; T1, 10%; T2, 30%; T3, 50% and T4, 70%.

DISCUSSION

Chu et al. (2012) studied the effects of a fermented mushroom (*F. velutipes*) by-products diet on the growth performance and carcass traits in growing-fattening Berkshire pigs. According to their results, CP concentration and total calories in the fermented diet increased at the end of fermentation (5 d) compared with those at the initial fermentation day (0 d). The fermented mushroom by-products diet decreased ADG, feed efficiency, and carcass weight, and improved carcass grades and ratio of high grade (1 plus 2 grades) due to its low energy levels. Although a diet of fermented mushroom by-products decreases growth performance and feed efficiency, it improves carcass grade in Berkshire pigs (Chu et al., 2012).

This experiment also indicated that the supplementing with < 50% fermented mushroom by-products increased pH, and decreased cooking loss of LD in fattening Berkshire pigs. The pH of LD increases with a fermented apple diet (Lee et al., 2009). The pH of LD decreased with a fermented oyster mushroom by-product diet (Song et al., 2007) and fermented persimmon shell diet (Kim et al., 2006). A high level of a soluble carbohydrate diet increases glycogen concentration and decreases pH at 24 h post-slaughter in muscles (Gallway et al., 1977). The high fiber level in the fermented mushroom by-product diet decreased pH of the LD in present experiment. The pH of LD increases by suppressing lactate accumulation due to low concentrations of glycogenand creatine phosphate (Hamm, 1960). Rosenvold (2003) reported that high fat and low soluble carbohydrate affects the pH at 45 min after slaughter but not at 48 h after slaughter. Kang et al. (2010) reported that a supplemental high carbohydrate-low fat fermented diet decreases cooking loss due to changes in glycolysis at 24 h post-slaughter in pigs. Therefore, the pH and cooking loss of meat may be affected by the fermented mushroom by-product diet.

Our experiment also showed that the fermented mushroom by-product diet decreased CIE L* (lightness), CIE a* (redness), and CIE b* (yellowness) of meat color and increased CIE a* and CIE b* of backfat color. Kang et al. (2010) reported that a high carbohydrate-low fat fermented diet increases lightness and redness, but does not affect yellowness in fattening pigs. Meat color is influenced greatly by a variety of factors, such as animal (breed, sex and age), environment (feeding, transporting and slaughter condition), processing (storing time, temperature condition, and etc.), particularly fresh meat color is influenced by the initial pH and temperature of slaughter processing (Lindahl et al., 2006). Moreover, the lightness of meat decreases by controlled posthumous processing due a diet low in soluble carbohydrate fed to fattening pigs (Tikk et al., 2006).

Our experiment indicated that the 70% fermented mushroom by-product diet increased the composition of palmitoleic acid and arachidonic acid in LD of fattening Berkshire pigs. Song et al. (2007) reported that a diet of fermented oyster mushroom by-product increased the composition of palmitoleic acid and arachidonic acid in the LD of Berkshire pigs. Moreover, some researchers have reported that fatty acid composition of meat can be improved by diet (French et al., 2000; Hsia and Lu, 2004; Nuernberg et al., 2005).

The fermented mushroom by-product diet did not affect amino acid composition of the LD or the sensory evaluation of cooked meat in fattening Berkshire pigs. Kang et al. (2010) reported that a fermented high carbohydrate-low fat diet using agro by-products does not affect amino acid composition of LD in agreement with the results from this study. A sensory evaluation is an important factor to judge meat quality because of its importance to the consumer. The sensory evaluation of cooked LD meat improves by red clover silage (Jonsall et al., 2000), fermented persimmon shell (Kim et al., 2006) and fermented apple diets (Lee et al., 2009). Our results showed that the sensory evaluation of cooked meat was not affected by the fermented mushroom by-product diet in fattening Berkshire pigs.

CONCLUSION

Although a diet of fermented mushroom by-products decreases growth performance and feed efficiency, it improves carcass grade (Chu et al., 2012). In this study, the fermented mushroom (*F. velutipes*) by-product diet did not affect chemical composition, amino acid composition of the LD, or a sensory evaluation of cooked meat. However, it clearly increased the pH, backfat color (redness and yellowness) and essential fatty acid composition, and decreased cooking loss, WBSF of fresh meat, and meat color (lightness, redness and yellowness) of LD in fattening Berkshire pigs. Further investigations are required to clarify the effects of a fermented mushroom by-product diet on the mechanisms of meat quality in Berkshire pigs.

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