EFFECTS OF DIETARY OF FERMENTED *FLAMMULINA VELUTIPES* BY-PRODUCT SUPPLEMENTERS ON PORK CHARACTERISTICS IN GROWING-FATTENING BERKSHIRE PIGS

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***Abstract*—The objective of the present study was to investigative the effect of dietary of *flammulina velutipes* by-product on the pork characteristics in growing-fattening Berkshire pigs. The fermented *flammulina velutipes* by-product was mixed with rice bran and supplemental 0.1 % probiotics. Two-hundred twenty five heads Berkshires were divided 5 groups and 3 replications (15 heads per a pens). The pigs fed experimental diet from 50 to 112 kg of body weight. The pigs in control group were fed basal diet and the pigs in treatments groups were 10 % (T1), 30 % (T2), 50 % (T3) and 70 % (T4) fermented diet substituted control diet. The live body weight and carcass weight were significantly (P<0.05) higher in the control group than in the treatment groups. On the other hand, the backfat thinkness and ration of high grade were not differed between control group and treatment groups. The proximately analysis in *longissimus dorsi* did not affects by dietary types. Shear force in fresh meat and fresh fat were significantly (P<0.05) lower in the treatment groups than in the control group. Cooking loss was significantly (P<0.05) lower in the T2, T3 and T4 groups than in the control and T1 groups. The CIE L* in meat surface (lightless) was significantly (P<0.05) higher in the treatment groups than in the control group and CIE a* in meat surface was significantly (P<0.05) decreased in the treatment groups compared with control group. Therefore, although dietary of fermented *flammulina velutipes* by-products decreased carcass weight, it was changed the meat quality characteristics.**

***Key words*— Fermented diet, *flammulina velutipes* by-product, pork quality, pigs.**

I. INTRODUCTION

Mushrooms are macroscopic fungi, which are tranditional used as Chinese medicines or functional food Asian countries (Kawagishi et al., 2000). Mushrooms have a high quantity of proteins, carbohydrates, minerals and vitamins as well as low fat (Manzi et al., 1999). Many researchers have reported that muxhrooms are an ideal food for the dietetic prevention of atherosclerosis due to their high content of fiber, protein and low fat content (Kurasawa et al., 1982; Wong et al., 2003)

Many researchers have worked on the biological activities and medicine of *flammulina velutipes*. However, there are few works on use of *flammulina velutipes* by-products as supplements in animal diets. The present study aimed to prepared a fermented diet using *flammulina velutipes* by-products and to examine the effects of the fermented on the characteristics of carcass and meat according to the level of fermented *flammulina velutipes* by-products in Berkshire pigs.

II. MATERIALS AND METHODS

A. Experimental diet

The fermented *flammulina velutipes* by-products diet was made by mixing *flammulina velutipes* by-products, rice bran and so on and fermenting this mixture for 1 week (Table 1). The experimental diet in the control group was formula feed (Table 2) and the T1, T2, T3 and T4 groups were 10 %, 30 %, 50 % and 70 % fermented diet substituted control diet.

B. Animals

Two-hundred twenty five heads Berkshires aged approximately 112 ± 1 days were used in this study. At 50 ± 2 kg body weight the pigs were randomly allocated in the 15 pens with 15 pigs per pen in front-open building with three replicates pens per treatment. Growing diets was given to pigs until 61 ± 1 kg body weight. The control, T1, T2, T3 and T4 diets were added to end of experimental periods. The pigs had *ad libitum* access to water and diets.

C. Carcass traits and chemical composition

The pigs were slaughtered 12 hours from the time of food withdrawal. They were stunned electrically (300 V for 3 second) with a pair of stunning tongs, shackled by the right leg and exsanguinated while hanging.

Carcass weight and back-fat thickness at the 10th rib were measured. For the determination of chemical compositions and meat quality parameters, the longissimus dorsi muscle was cut off and kept at 4 ℃, and then transported to the laboratory.

D. Meat quality parameters and Sesory evaluation

pH was measured using a Hanna HI 9025 (Woonsocket, Rhode Island, USA). Water holding capacity was determined by method by Jauregui et al. (1981). Meat and back-fat color was measured using a Minolta chromameter CR-300 (Minolta, Osaka, Japan).

E. Statistical analyzes

The data were analyzed using the General Linear Model (GLM) procedures of SAS (1999) and significant differences among the means were determined using the Duncan's Multiple Range Test method (Duncan 1955).

III. RESULTS AND DISCUSSION

The live body weight and carcass weight were significantly ($P<0.05$) higher in the control group than in the treatment groups. On the other hand, the backfat thinkness and ration of high grade were not differed between control group and treatment groups (Table 3).

The proximately analysis in *longissimus dorsi* did not affects by dietary types (Table 4). Shear force in fresh meat and fresh fat were significantly ($P<0.05$) lower in the treatment groups than in the control group. Moreover, cooking loss was significantly ($P<0.05$) lower in the T2, T3 and T4 groups than in the control and T1 groups (Table 5).

Although meat lightness (CIE L*) was higher in the treatment groups than in the control group, treatment groups was lower redness (CIE a*) compared with control group (Table 6).

IV. CONCLUSION

As conclusion, although dietary of *flammulina velutipes* by-products decreased liver body weight, carcass weight and dressing, it was changed the pork quality characteristics.

ACKNOWLEDGEMENT

This work was supported by Priority Research Centers Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (2009-0093813). This work was presented as a part of a master dissertation by Jeong Mo Yang.

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Table 1. Compositions of fermented diet of *Flammulina velutipes* by-product

Ingregients	Contain, %
Flammulina velutipes by-products	30
Rice bran	26
Barley stem	2
Sagebrush	2
Loess	2
Illite	2
Sweet potato vines	1
Purple sweet potato	1
Perilla oil dregs	1
Balloonflower	1
Rye cobs	1
Formula feed	30
Total	100

Table 2. Compositions of formula diets

Ingradients	Grower	Finisher
Corn	51.51	51.43
Wheat-12%	15.00	15.00
Wheat bran	6.00	3.72
Soybean meal 44%	0.52	19.08
Molasses	16.44	4.00
Fat animal	4.00	4.00
Calcium Phosphate 18%	3.80	1.16
Limestone	1.00	0.48
Salt 98%	1.00	0.32
$CuSO_4$ (Cu-10%)	0.32	0.08
Methionine 50%	0.01	0.03
Lysine 98%	0.16	0.15
Antibiotic	-	0.20
Mix-Vitamin[1)]	0.08	0.11
Mix-Mineral[2)]	0.08	0.10
Etc	0.09	0.14
Total	100	100.00
Chemical composition (%) ;		
Dry Matter	87.44	87.49
Crude protein	14.53	15.34
Crude fat	6.27	6.41
Crude fiber	3.06	2.98
Crude ash	4.97	4.78
Calcium	0.82	0.70
Phosphous	0.50	0.52
Total Lysine	0.80	0.86
Total Methionine	0.24	0.26
Total Methionine+Cysteine	0.50	0.53
Total Threonine	0.53	0.56
Total Tryptophan	0.16	0.17
DE (kcal/kg)	3,462	3,493
ME (kcal/kg)	3,255	3,277

[1)] Supplied per kg diets : Vitamin A, 8,000,000IU; Vitamin D, 1,500,000IU; Vitamin E, 40,000ppm; Vitamin K, 1,500ppm; Thiamin, 1,000ppm; Riboflavin, 4,000ppm; Vitamin B_{12}, 20ppb; Pyridoxine, 2,000ppm; Niacin, 20,000ppm; Biotin, 30ppm; Folic acid, 600ppm.
[2)] Supplied per kg diet : Se, 250mg; I, 200mg; Fe, 60,000mg; Mn, 25,000mg; Zn, 60,000; Cu, 15,000mg.

Table 3. Effect of dietary fermented diet of *Flammulina velutipes* by-product on the carcass characteristics in Berkshire pigs

Items	Treatments[1)]				
	C	T1	T2	T3	T4
Body weight (kg)	105.75±2.75[a]	104.40±2.70[b]	102.75±2.50[b]	102.20±2.86[b]	102.75±2.50[b]
Carcass weight (kg)	79.00±6.48[a]	79.80±3.27[a]	77.75±1.71[b]	76.25±2.75[b]	76.25±1.26[b]
Dressing (%)	77.99±1.58[a]	76.43±1.78[a]	76.65±0.89[a]	75.85±1.79[ab]	74.82±2.28[b]
Backfat thickness (mm)	22.75±3.59	22.40±3.21	22.00±2.16	22.25±3.30	21.25±0.96
Grade (B:C:D, %)	25:50:25	30:45:25	35:40:25	40:35:25	50:30:20
High grade rate (B+C, %)	75	75	75	75	80

[1)] The experimental diets were substituted fermented diet of Flammulina velutipes by-product; C, 0% fermented diet; T1, 10% fermented diet; T2, 30% fermented diets; T3, 50% fermented diets and T4, 70% fermented diet.
[a,b,c] Means values within the same row with different letters are significantly different (P<0.05).

Table 4. Effect of dietary fermented diet of *Flammulina velutipes* by-product on the chemical composition in *longissimus dorsi* of Berkshire pigs

Items	Treatments[1)]				
	C	T1	T2	T3	T4
Moisture	27.61±0.30	72.92±0.59	73.11±0.58	73.20±0.62	73.23±0.63
Crude protein	22.48±0.55	22.65±0.59	23.15±0.53	23.20±0.52	23.13±0.53
Ether extract	4.00±0.42	3.97±0.48	3.96±0.41	3.82±0.56	3.74±0.54
Crude ash	1.18±0.07	1.26±0.08	1.18±0.12	1.10±0.29	1.23±0.08

[1)] The experimental diets were substituted dist of Flammulina velutipes by-product; C, 0% fermented diet; T1, 10% fermented diet; T2, 30% fermented diets; T3, 50% fermented diets and T4, 70% fermented diet.

Table 5. Effect of dietary fermented diet of *Falammulina velutipes* by-product on the pH, Warner-Bratzler shear force and cooking loss in *longissimus dorsi* of Berkshire pigs

Items	Treatments[1)]				
	C	T1	T2	T3	T4
pH	5.64±0.07[c]	5.73±0.07[c]	5.79±0.08[a]	5.84±0.07[a]	5.68±0.04[bc]
Warner-Bratzler shear force (kg/cm^2)					
Fresh meat	5.91±1.49[a]	2.78±0.47[b]	2.49±0.84[b]	2.81±0.79[b]	2.06±0.67[b]
Fresh fat	8.86±1.48[a]	8.47±2.73[ab]	8.17±8.06[b]	7.98±3.02[b]	7.70±1.91[c]
Cooked meat	7.49±1.06	7.68±1.0	7.51±1.04	7.98±0.39	7.52±0.88
Cooking loss (%)	43.27±8.80[a]	42.22±2.00[a]	41.27±1.63[b]	41.10±2.58[b]	38.89±1.86[c]

[1)] The experimental diets were substituted dist of Flammulina velutipes by-product; C, 0% fermented diet; T1, 10% fermented diet; T2, 30% fermented diets; T3, 50% fermented diets and T4, 70% fermented diet.
[a,b,c] Means values within the same row with different letters are significantly different (P<0.05).

Table 6. Effect of dietary fermented diet of *Flammulina velutipes* by-product ong the meat surface and backfat surface color in *longissimus dorsi* of Berkshire pigs

Items	Treatments[1)]				
	C	T1	T2	T3	T4
Meat surface					
CIE L*	64.07±4.52[a]	55.07±3.41[c]	59.40±5.01[b]	58.00±2.55[bc]	57.15±2.37[bc]
CIE a*	10.77±2.60[a]	7.93±1.79[bc]	8.69±0.90[b]	7.08±1.00[c]	7.84±1.92[bc]
CIE b*	5.95±1.98[a]	2.76±0.66[c]	4.18±1.79[b]	3.74±1.00[bc]	3.17±1.38[bc]
Chroma	12.33±3.20[a]	8.42±1.80[b]	9.73±1.46[b]	8.03±1.27[b]	8.50±2.24[b]
Hue angle	28.51±3.46[a]	19.57±4.36[c]	25.08±7.72[ab]	27.49±4.39[a]	21.17±4.80[bc]
Backfat surface					
CIE L*	86.76±2.15	84.38±2.86	86.06±1.84	85.77±0.70	85.37±1.95
CIE a*	2.74±0.59[b]	2.69±0.72[b]	3.67±0.55[a]	3.57±0.79[a]	3.24±0.25[ab]
CIE b*	3.19±0.81[b]	2.99±0.51[b]	5.28±0.81[a]	5.31±1.00[a]	5.35±0.86[a]
Chroma	4.22±0.96[b]	4.06±0.68[b]	6.44±0.92[a]	6.40±1.25[a]	6.26±0.86[a]
Hue angle	49.16±4.35[bc]	48.56±7.75[c]	55.13±2.94[ab]	56.14±2.49[a]	58.54±2.36[a]

[1)] The experimental diets were substituted fermented diet of Flammulina velutipes by-product; C, 0% fermented diet; T1, 10% fermented diet; T2, 30% fermented diets; T3, 50% fermented diets; and T4, 70% fermented diet.
[a,b,c] Means values within the same row with different letters are significantly different (P<0.05).