The Effect of Change in Meat Quality Parameters on Pig *Longissimus dorsi* Muscle by the Addition of Fermented Persimmon Shell Diet

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ABSTRACT : The objective of the present study was to investigate the effects of growth performance, chemical composition and meat quality parameters by the addition of fermented persimmon shell diets (FPSD). The experimental animals were ninety-six Berkshires. The pigs were allotted at 8 per pen in front-open building with three replicate pens per treatment. Until 61±1 kg live weight at 140 days, the animals were fed growing diet, after which, experimental samples were fixed at 0, 3, 5 and 7% FPSD as C, T1, T2 and T3 in the finishing diets. Pigs of 103±1 kg live weight were slaughtered by electrical stunning. In growth performance, ADG increased more ($p<0.05$) in T2 than C and T1. ADFI (kg/day) was higher ($p<0.05$) in T2 than in other groups. Feed conversion ratio was lower ($p<0.05$) in T2 than in other groups. On *longissimus dorsi* muscle (LM), the content of moisture was lower ($p<0.05$) in T3 than in other treatments. Crude fat increased ($p<0.05$) by addition of FPSD. pH at 24 h (pH_{24}) decreased more ($p<0.05$) in T2 and T3 than C and T1 by addition of FPSD. WHC decreased ($p<0.05$) by addition of FPSD. In meat, Hunter L* and a* were lower ($p<0.05$) in C than in other treatments. Hunter b* was higher ($p<0.05$) in T3 than in other treatments. In back-fat, Hunter L* was higher ($p<0.05$) in C than in other treatments. Hunter a* was not different in C and T1 but increased ($p<0.05$) in treatments by addition of FPSD. Hunter b* increased ($p<0.05$) by addition of FPSD. In sensory evaluation scores, for fresh meat, the value of meat color was higher ($p<0.05$) in T2 and T3 than in C and T1. The value of marbling was lower ($p<0.05$) in C than in other treatments. The value of drip loss was higher ($p<0.05$) in C than in other treatments and was lower ($p<0.05$) in T2 and T3 than in other treatments. The results of cooked meat, the value of tenderness was not different in C and T1 but increased ($p<0.05$) in other treatments. The value of flavor was significantly higher ($p<0.05$) in T2 and T3 than in C and T1. The value of overall acceptability was increased ($p<0.05$) by addition of FPSD. Hence we can conclude that addition of FPSD affected growth performance and meat quality parameters, in particular, it improved crude fat, hunter L* and b*, and sensory evaluation on pork and was also seen to affect pH_{24} and WHC. FPSD can be used for improvement of meat quality parameters. ***(Asian-Aust. J. Anim. Sci. 2006. Vol 19, No. 2 : 286-291)***

Key Words : Fermented Persimmon Shell, Berkshires, WHC, Meat Color, Sensory Evaluation

INTRODUCTION

The habitat of persimmon (*Diospyros kaki* Thumb) in Asia is in temperate areas of Korea, Japan and China. In Japan and Korea there are about 190 species of shrubs, forest, deciduous and evergreen persimmon, also the production and consumption is high.

Persimmon in an alkaline fruit, which includes, grape sugar, fructose, vitamin A and vitamin C. Persimmon needs to be processed for the separation of tannin since it includes about 1-2% of tannin. There is also a need for the production of red-ripe persimmon for consumption (Kitagawa and Glucina, 1984; Taira and Itamura, 1990; Matsuo et al., 1991), since this fruit affects the function of hemostatic and cease of tissue and also affects the acceleration of secretion of intestinal juice and intestinal contraction (Yu, 1976). The astringent taste in persimmon is due to the water-soluble tannin. Haslam (1981) reported that tannin possesses the characteristics to bind with proteins. Moreover, tannin also has antibiotic, anti-oxidant and anti-tumor functions (Nose and Fujino, 1982; Chibata et al., 1986; Kim et al., 1993; Seo et al., 2000).

Products of persimmon are produced by several processes and are marketed in Korea, Japan and China. Among the processes, include the process of sun drying, which causes changes in persimmon one of which is to remove astringency of persimmon. In addition to the changes in taste and palatability, softening of persimmon occurs during the sun-drying process. Fruit softening, which characterizes ripening, involves structural and compositional changes of the cell wall carbohydrates, mainly as a result of the action of cell wall degrading enzymes (Ali et al., 1998). Dennis (1987) reported that tannins inactivate cell wall degrading enzymes. These enzyme activities can be enhanced in persimmon during the sun drying process due to insolubilization of tannins (Asgar et al., 2003). Persimmon shell is separated during processing of sun drying. If this shell is made into fermented diet, we think that shell-fermented diet could improve meat.

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Table 1. Ingredient composition and chemical composition (%) of the experiment diets

Ingredients	Grower	Finisher
Corn	53.00	33.50
Wheat	9.50	30.00
Soybean meal	26.00	12.50
Wheat bran	-	4.00
Rice bran	-	1.00
Rapeseed meal	-	3.00
Palm kernel meal	-	2.00
Cotton seed meal	-	3.00
Limestone	1.24	1.45
Tri calcium phas	0.82	0.60
Animal fat	5.10	4.20
Molasses	3.50	4.00
Salt	0.30	0.30
L-lysine HCl	0.20	0.20
DL-mathionine	0.04	-
Vitamin premix[1]	0.10	0.10
Mineral premix[2]	0.10	0.10
Phytase	0.10	0.05
Total	100.00	100.00
Chemical composition (%)[3]		
DE (kcal/kg)	3,350	3,220
Crude protein	17.50	15.50
Lysine	1.05	0.87
Calcium	0.90	0.92
Total phosphous	0.50	0.50

[1] Supplied per kg diet: Vitamin A, 4,000 IU; Vitamin D, 3,800 IU; Vitamin E, 1,500 IU; Vitamin K, 320 mg; Vitamin B_{12}, 16 mg; Thiamin, 8 mg; Riboflavin, 2 mg; Pantothenicacid, 11 mg; Niacin, 20 mg; Biotin, 0.02 mg.

[2] Supplied per kg diet: Cu, 30 mg; Fe, 175 mg; Zn, 100 mg; Mn, 90 mg; I, 0.3 mg; Co, 0.5 mg; Se, 0.2 mg.

[3] Chemical composition was calculated from ingredient proportion.

The objective of the present study was to investigate the effects of growth performance, chemical compositions and meat quality parameters by the addition of fermented persimmon shell diets (FPSD).

MATERIALS AND METHODS

Fermented diet and experimental animals

The FPSD was made from persimmon shell and mixed with rice bran and barley bran for 60 days. Experimental samples were analyzed for moisture content before making silo, and the moisture content was regulated to about 60% by the addition of water. Experimental samples were mixed at 50, 25 and 25% with persimmon shell, rice bran and barley bran in fresh condition silo form in 600 L plastic containers.

Ninety-six pigs (Berkshire) were used to determine the effects of FPSD supplementation on the growth performance, chemical composition and meat quality parameters. They were randomly allotted 61±1 kg live weight at 8 per pen (3.6 m×8.1 m pens with solid concrete flooring) in a front-open building with three replicate pens per treatment. They were not separated by sex but the ratio of sex was similar in each allotment. Growing diet was given to pigs until 61±1 kg live weight. The experimental diets were 0, 3, 5 and 7% of FPSD added as C, T1, T2 and T3 in the finishing diet for 65 days. The pigs had *ad libitum* access to water and diets. Ingredients and chemical composition of growing and finishing diets used in this experiment are shown in Table 1. All other nutrient requirements met or exceeded that of NRC for growing and finishing pigs (NRC, 1998). FPSD was produced in the form of pellets and this diet was dried until 12% of moisture at normal room temperature. Pig weights and feed disappearance were measured to determine ADG and ADFI. The ratio of feed to gain was calculated from ADG and ADFI.

Slaughtering and sampling

Pigs of 103±1 kg live weight were transported to a normal abattoir near the experimental station. The pigs were slaughtered after 12 h from the time of feed restriction. They were stunned electrically (300 V for 3 s) with a pair of stunning tongs, shackled by the right leg and exsanguinated while hanging. Carcasses were then placed in a dehairer at 62°C for 5 min and the hair that remained was removed after exit from the dehairer using a knife and flame. Carcasses were then eviscerated and split before being placed in a chiller set at 5°C for 12 h. For the determination of chemical composition and meat quality parameters, the LM (6th to 13th rib) was cut off and kept at 5°C, and then transported to the laboratory.

Chemical compositions

The content of moisture, crude protein, crude fat and crude ash in samples of LM were determined according to AOAC (1995) about 24 h after slaughter.

Meat quality parameters

For measurement of pH_{24}, a 5 g sample of LM was homogenized about 24 h postmortem in 10 volumes of distilled water using a polytron homogenizer (MSE, USA). pH_{24} was measured using a Hanna HI 9025 pH meter (Woonsocket, RI) with an Orion 8163 glass electrode (Berverly, MA). Water holding capacity (WHC) of LM was determined by centrifugal method as followed by Jauregui et al. (1981). Meat color of LM and back-fat were evaluated on a cut surface (3 cm thick slice) using a Minolta chromameter CR-300 (Minolta, Japan) (D65/10°) after placing for 20 min at room temperature. The average of five replicates were expressed as Hunter L*, a*, b*.

Sensory evaluation

Sensory evaluation was performed in duplicate at Meat

Table 2. Effect on growth performance and feed intake of Berkshire by addition of fermented persimmon shell diet

Items	Treatments (Feed, %)[2]			
	C	T1	T2	T3
Growth performance				
Initial body weight (kg)	61.93±0.98	61.21±0.98	61.13±1.13	61.88±1.37
Final body weight (kg)	107.52±1.29[b]	107.86±1.81[b]	109.90±1.14[a]	108.71±1.40[ab]
ADG (g/day)[1]	701.43±19.52[b]	718.57±35.32[b]	751.25±17.27[a]	721.67±36.56[ab]
Feed intake				
ADFI (kg/day)[1]	2.75±0.03[b]	2.72±0.03[b]	2.80±0.05[a]	2.52±0.01[c]
Feed conversion	3.93±0.12[a]	3.79±0.15[ab]	3.73±0.05[b]	3.50±0.17[c]

[a, b, c] Means with different superscripts in a row differ significantly (p<0.05).
[1] ADG, average daily gain; ADFI, average daily feed intake.
[2] C, 0% of FPSD; T1, 3% of FPSD; T2, 5% of FPSD; T3, 7% of FPSD.

Table 3. Effect of feed with fermented persimmon shell on chemical composition (%) of pig *longissimus dorsi* muscle

Items	Treatments (Feed, %)[1]			
	C	T1	T2	T3
Moisture	74.62±0.44[a]	74.73±0.70[a]	74.72±0.35[a]	72.39±0.42[b]
Crude protein	21.92±0.77	21.80±0.84	21.65±0.75	21.62±0.73
Crude fat	5.01±0.19[c]	5.20±0.18[b]	5.26±0.21[b]	5.93±0.19[a]
Crude ash	1.06±0.07	1.09±0.05	1.10±0.07	1.11±0.08
pH_{24}	5.87±0.20[a]	5.88±0.23[a]	5.74±0.11[b]	5.70±0.19[b]
WHC (%)	76.19±0.50[a]	76.51±0.80[a]	74.89±0.77[b]	73.69±0.68[c]

[a, b, c] Means with different superscripts in a row differ significantly (p<0.05).
[1] C, 0% of FPSD; T1, 3% of FPSD; T2, 5% of FPSD; T3, 7% of FPSD.

Science Laboratory, Jinju National University, Jinju, Korea. Samples were evaluated by 35 untrained panelists in one session. Panelists were provided with fresh meat and cooked meat samples. Fresh meat samples were sliced into 1.0 cm slices, and the crust of the sample was removed to keep all the samples uniform. Fresh meat samples were allowed to equilibrate to room temperature for 30 min before sensory evaluation was applied. Cooked meat samples were cooked to an internal temperature 70°C on a water bath. The internal temperature was monitored with thermocouple scanner (ETI, England). The panelists were asked to assess fresh meat samples for meat color, marbling and drip loss, and to assess cooked meat samples for tenderness, juiciness, flavor and overall acceptability using a 9-point hedonic scale (1 = dislike extremely, 9 = like extremely). Panelists were instructed to rinse their mouths with water before starting and between sample evaluations. Evaluations were made in individual sensory evaluation booths under fluorescent white light. The ratings of each sensory attribute were converted to numerical scores and the numerical scores were collected for statistical analyses.

Statistical analyses

Statistical analyses were performed by the Statistical Analysis Systems Institute software package (SAS, 1995) and using the general linear model procedure (GLM). The data of growth performance, chemical compositions, meat quality parameters and sensory evaluation scores of meat was obtained from pigs was subjected to analysis of least square means by completely randomized design. The results were given as means and standard deviation (SD).

RESULTS AND DISCUSSION

Effect on growth performance and feed intake of Berkshire by the addition of FPSD is shown in Table 2. Pigs were allotted 61±1 kg live weight, and the experimental diet of FPSD was given during 65 days. All groups had similar initial body weight (kg) during growth performance. Final body weight (kg) and ADG (g/day) significantly increased (p<0.05) in T2 than C and T1. ADFI (kg/day) was significantly higher (p<0.05) in T2 than other groups but it was similar (p>0.05) between C and T1. Feed conversion ratio was significantly lower (p<0.05) in T2 than other groups. Canibe and Jensen (2003) have reported that fermented liquid feed contained high level of lactic acid than non-fermented liquid feed. The addition of citric acid improved ADG for weaning pigs (Radcliffe et al., 1998). Other studies have also reported that organic acids improved growth performance of growing pigs and piglets (Roth and Kirchgessneer, 1998; Partanen et al., 2002). In our study, the addition of fermented persimmon shell diet improved growth performance and feed intake.

The results of chemical composition, pH_{24} and WHC of meat by addition of FPSD are shown in Table 3. Moisture was significantly lower (p<0.05) in T3 than other treatment. Crude protein resulted from 21.62 to 21.92% and was not significantly different by addition of FPSD on LM. For crude fat, T3 was highest at 5.93% but C was lowest at 5.01%. Crude fat was significantly increased (p<0.05) by

Table 4. Effect of feed with fermented persimmon shell on meat and backfat color of pig *longissimus dorsi* muscle

Items[1]	Treatments (Feed, %)[2]			
	C	T1	T2	T3
Meat color				
Hunter L*	40.86±0.96[b]	42.53±0.68[a]	42.62±0.66[a]	42.64±0.77[a]
Hunter a*	4.91±0.38[b]	5.61±0.35[a]	5.66±0.34[a]	5.67±0.35[a]
Hunter b*	2.41±0.13[b]	2.42±0.20[b]	2.42±0.17[b]	2.74±0.19[a]
Back-fat color				
Hunter L*	74.19±0.65[a]	72.64±0.74[b]	72.54±0.71[b]	72.52±0.85[b]
Hunter a*	2.22±0.35[c]	2.31±0.23[c]	2.60±0.26[b]	2.77±0.35[a]
Hunter b*	2.51±0.25[d]	2.74±0.26[c]	2.97±0.35[b]	3.54±0.32[a]

[a, b, c, d] means with different superscripts in a row differ significantly ($p<0.05$).

[1] Hunter L = Black (0) to white (100) scale, Hunter a* = red (+) to green (-) color scale, Hunter b* = yellow (+) to blue (-) color scale.

[2] C, 0% of FPSD; T1, 3% of FPSD; T2, 5% of FPSD; T3, 7% of FPSD.

Table 5. Effects of feed with fermented persimmon shell on sensory evaluation scores of pig *longissimus dorsi* muscle

Items	Treatments (Feed, %)[2]			
	C	T1	T2	T3
Fresh meat				
Meat color	5.83±0.19[b]	6.01±0.17[b]	7.74±0.20[a]	7.87±0.17[a]
Marbling	5.29±0.14[b]	6.19±0.15[a]	6.25±0.13[a]	6.28±0.11[a]
Drip loss	7.93±0.40[a]	6.75±0.32[b]	5.51±0.23[c]	5.26±0.09[c]
Cooked meat				
Tenderness	5.55±0.11[c]	5.62±0.18[c]	5.88±0.08[b]	6.22±0.10[a]
Juiciness	5.68±0.17[b]	6.29±0.21[a]	6.38±0.14[a]	6.37±0.23[a]
Flavor	5.98±0.14[c]	6.34±0.19[b]	6.74±0.12[a]	6.75±0.14[a]
Overall acceptability	5.97±0.17[c]	6.48±0.22[b]	6.74±0.20[a]	6.77±0.15[a]

[a, b, c] Means with different superscripts in a row differ significantly ($p<0.05$).

[1] C, 0% of FPSD; T1, 3% of FPSD; T2, 5% of FPSD; T3, 7% of FPSD.

addition of FPSD. Crude ash was ranged from 1.09 to 1.11% and was not significantly affected by addition of FPSD. pH_{24} was significantly decreased ($p<0.05$) in T2 and T3 than C and T1 by addition of FPSD. WHC significantly decreased ($p<0.05$) by addition of FPSD. Other studies reported that concentration of moisture correlated with fat in meat (Shuler et al., 1970; Shields et al., 1983; Ramsey et al., 1990). In our study, moisture concentration decreased but crude fat increased by addition of FPSD. Some study show that red clover silage decreased the concentration of crude fat in LM than assorted feed (Johansson et al., 2002). In our study, FPSD increased concentration of crude fat in LM. This could have influenced a result may be affected on increase in levels of total energy in FPSD by added to rice and barley bran. pH_{24} of LM was decreased by addition of FPSD. Other study reported that pH was affected by material diets on meat (Rosenvold et al., 2002). Accordingly, pH_{24} of LM may have changed by addition of FPSD. WHC of LM is an important factor on evaluation of meat quality parameter. WHC decreased with the addition of FPSD. Rosenvold et al. (2002) reported that material diets do not affect meat quality.

Table 4 shows the results of meat and back-fat color by addition of FPSD. In meat color, Hunter L value of lightness was significantly lower ($p<0.05$) in C than other treatments but was not significantly affected between treatments. Hunter a* value of Redness was significantly lower ($p<0.05$) in C than other treatments but was not different between treatments of FPDS. Hunter b* value for yellowness was significantly higher ($p<0.05$) in T3 than other treatments. The results of back-fat, Hunter L* value were significantly higher ($p<0.05$) in C than other treatments but were not different between treatments. Hunter a* value was not significantly different in C and T1 but significantly increased ($p<0.05$) in treatments by addition of FPDS. Hunter b* value significantly increased ($p<0.05$) by addition of FPDS. Addition of FPSD on meat color showed that Hunter L* and a* were higher ($p<0.05$) in T1, T2, and T3 than C. Also, our study has proved that meat is improved by addition of FPSD. Hunter b* was higher on T3 than other groups. Our study has shown that Hunter b* on LM was not affected until 5% FPSD but was affected at 7% of FPSD. On back-fat, hunter L* was higher in C than other treatments, hunter a* and b* increased in treatments than C. Change of meat color and back-fat color were affected by material diets (Dugan et al., 1999; Rosenvold et al., 2002; Moon et al., 2004).

The results of sensory evaluation scores on fresh and cooked meat by addition of FPSD are shown in Table 5. In results of fresh meat, the value of meat color was significantly higher ($p<0.05$) in T2 and T3 than C and T1. The value of marbling was significantly lower ($p<0.05$) in

C than other treatments by addition of FPSD but was not affected between treatments. The value of drip loss was significantly higher ($p<0.05$) in C than other treatments and was low ($p<0.05$) in T2 and T3 than other treatments. The results of cooked meat, the value of tenderness was not different in C and T1 but was significantly increased ($p<0.05$) in treatments by addition of FPSD. The value of juiciness was not affected in treatments by addition of FPSD but was significantly lower ($p<0.05$) in C than other treatments. The value of Flavor was significantly higher ($p<0.05$) in T2 and T3 than C and T1. The value of overall acceptability was significantly increased ($p<0.05$) by addition of FPSD but was not different in T2 and T3. Sensory evaluation is an important factor to judge meat quality parameter because it is important to the consumer. In fresh meat, meat color and marbling were higher but drip loss was lower in treatment groups than control groups. The results of sensory evaluation show that addition of FPSD, improved meat quality parameter on fresh meat. In cooked meat, addition of FPSD affected tenderness, juiciness, flavor and overall acceptability. Jonsall et al. (2000) reported that pork loins from pigs fed silage scored higher for flavor than the ones from pigs fed conventional feed.

According to results of our study, addition of FPSD affected growth performance and meat quality parameter. In particular, addition of FPSD improved crude fat, hunter L * and b*, and sensory evaluation on pork and also affected pH_{24} and WHC. FPSD can be used for improvement of meat quality parameters.

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