Soybean Checkoff-funded Research

Project Title: Effects of Feeding Dehulled Soybean Meal on Performance, Carcass Characteristics, Pork Quality and Blood Profile in Pig

Investigators: Kim, Chul-Wook (Principal Investigator), Young-Min Song, Sang-Keun Jin, Il-Suk Kim, Chung-Hee Kim, Ji-Hee Ha, Seoc-Mo Kang, Jung-Ha Lee and Young-Sik Park

Institution: Swine Science & Technology Center, Jinju National University

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1. Literature review:

Soybean meal has been extensively used in animal feeds for its plentiful protein content and excellent amino acid composition.

In recent days, as the need for high nutrient-density diets has been increasing to improve feed efficiency of pigs, awareness of necessity of dehulled soybean meal has also been accompanied.

The superior quality of US dehulled soybean meal has been demonstrated in many animal researches such as pigs, broilers, egg layers and fishes. Most of the research results validated the economic benefits of feeding US. dehulled soybean meal to replace non-dehulled soybean meals of different origins such as South America and India.

In Thailand, a feeding study was conducted at the swine farm using a total of 128 cross-bred weaning pigs aged 28 days until they reach to 58 days old. In this study, pigs fed the diets containing US. dehulled soybean meal improved final body weights by 7%, daily weight gain by 11.21% and feed efficiency by 8% compared to those groups fed the diets containing non-dehulled soybean meals. It was suggested that such improvements could be made due to lower fiber and higher protein and amino acids contents of dehulled soybean meal than non-dehulled soybean meal. A similar study was conducted with pigs, in which dehulled soybean meal was fed with cassava meal. The results showed improvements in final body weight, daily weight gain and daily feed intake when dehulled soybean meal was fed as a major protein source. In summary, feeding dehulled soybean meal to weaning pigs would result in some improvements in weight gain and feed conversion, leading to saving the costs to reach market weight of pigs(Uthai Kanto Asian Pork FEB MARCH 04 pp26-27).

Chung et. al., (1988) also reported that the weaning pigs fed US. dehulled soybean meal resulted in saving feed costs by 6.3% as their weight gain tended to be higher than the groups fed non-dehulled soybean meal.

Recently, a Chinese study also demonstrated that weight gain of pigs fed dehulled soybean meal improved significantly in the late phase of growth rather than the early phase of growth, as a result, reducing feed costs remarkably (Bushman, 1998).

Park (1998) reported that US. dehulled soybean meal-based swine diet increased feed intake by 3.8% and daily weight gain by 10%, and feed efficiency by 6.1% compared to those fed Brazilian soybean meal-based swine diet.

US. dehulled soybean meal was compared with Brazilian and Indian non-dehulled soybean meal in swine research conducted in Thailand (Swick and Shi, 1998). Three treatments based on different origins of non-dehulled soybean meal which were iso-caloric and iso-nitrogenous and the fourth treatment based on US. dehulled soybean meal that was higher in calorie were fed to a total of 96 pigs weighing 15 kg to 95 kg. Feed efficiency of US. dehulled soybean meal treatments was significantly better than that of Brazilian and Indian non-dehulled soybean meal treatments for the growth phase of 15 kg and 30 kg of body weight ($P<0.05$). Weight gain of US. dehulled soybean meal treatment with higher calory was significantly greater than other treatments for the growth phase of 30 kg and 60 kg of body weight ($P<0.05$). Also, daily weight gain of US. dehulled soybean meal treatment was significantly higher than other treatments for the growth phase between 60 kg to 95 kg of body weight ($P<0.05$).

2. Background of Research:

It has become common in Korea that pork should be differentiated based on breeds, feeds used and environmental conditions under which pigs are raised. One of such ways of differentiation is a brand pork which is produced from Berkshire varieties (black hogs) being marketed at premium price, 20~30% higher than normal pigs. These pigs are well known for their better meat quality characterized with high marbling score and low back fat thickness than other popular porks produced from Landrace, Large White and Duroc and their crossbreeds. Currently, it is general that Korean swine industry is seeking ways to develop various techniques for producing such value-added porks in more economical way. Therefore, it is required that Berkshire growers should develop an economical feeding program most suitable for their pigs to maintain meat quality while reducing the feed costs required to reach its market weight of 100 kg.

3. Purposes of Research:

The purpose of this research is to compare growth performances of Berkshire pigs raised on the diets containing dehulled soybean meal with those raised on the diets containing non-dehulled soybean meal during their growth stage of 25~80 kg, and secondly to evaluate the potential effects of feeding dehulled soybean meal on carcass characteristics and pork quality.

4. Materials & Methods:

This experiment has been carried out at Jiri Mountain Black Hog Cooperative's farm located Hamyang, Kyungsangnam-do province from March 25, 2005 to July 17, 2005.

A total of 360 Berkshire pigs aged 77 days post-farrowing and weighing about 25 kg on average was assigned to treatments as shown in Table 1. The experimental subjects were housed in each pen holding 30 heads without sex separation with 3 replications per treatment until they reach market weight (about 100 kg).

Table 1. Experimental design

Treatments	T1	T2	T3	T4
Number of heads per pen	30	30	30	30
Number of repetitions	3	3	3	3
Sum	90	90	90	90

T1: dehulled soybean meal for growth period+non-dehulled soybean meal for fattening of period, ME 3,265 kcal/kg
T2: dehulled soybean meal for growth period+non-dehulled soybean meal for fattening of period, ME 2,940 kcal/kg
T3: non-dehulled soybean meal for growth period+non-dehulled soybean meal for fattening of period, ME 3,265 kcal/kg
T4: non-dehulled soybean meal for growth period+non-dehulled soybean meal for fattening of period, ME 2,940 kcal/kg
* dehulled soybean meal(US., CP:48%), non-dehulled soybean meal(imported, CP:44%)

Experimental diets were manufactured at Daesang feed mill in Ansung, Kyunggi-do province based on the formula developed by Swine Science & Technology Center. Pigs were fed two types of experimental diets, one for grower stage from 25-80 kg (12 weeks) and the other for finisher stage from 80-100 kg (6 weeks) as appeared in Table 2.

Table 2. Feeding schedule

Treatment	Growing 25~80kg	Finishing 80~100kg
T1	US. dehulled soybean meal ME: 3,265 kcal/kg	non-dehulled soybean meal ME: 3,265 kcal/kg
T2	US. dehulled soybean meal ME: 3,265 kcal/kg	non-dehulled soybean meal ME: 2,940 kcal/kg
T3	non-dehulled soybean meal ME: 3,265 kcal/kg	non-dehulled soybean meal ME: 3,265 kcal/kg
T4	non-dehulled soybean meal ME: 3,265 kcal/kg	non-dehulled soybean meal, ME 2,940 kcal/kg

Table 3, 4 shows composition of experimental diets fed to growing and finishing pigs. Experimental diets fed to growing pigs of 25 to 80 kg were formulated to contain 3,265 kcal/kg and 16% protein on as-is basis while experimental diets fed to finishing pigs of 80 to 100 kg were formulated to contain 2,940 kcal/kg for low-energy diet and 3,265 kcal/kg for high-energy diet but to contain 16% protein regardless of energy level.

Table 3. Composition of experimental diets fed to growing pigs

Ingredients	A[1]	B[1]
Corn	55.955	56.158
Wheat	7.500	7.500
Lupin Kernel	6.500	6.500
Wheat Midding	3.000	2.000
Rice Bran	-	-
SBM(44%)	-	13.629
SBM(48%), USA	12.701	-
Rape Seed Meal	1.000	1.000
Palm Kernel Meal	3.000	3.000
Animal Fat(Korea)	3.000	3.167
Molasses	4.000	4.000
Limestone	0.424	0.157
TCP	1.437	1.482
Salt	0.360	0.360
Liquid-Lysine	0.737	0.677
Methionine	0.027	0.018
Choline(50%)	0.019	0.012
Vitamin Mix[2]	0.160	0.160
Mineral Mix[3]	0.190	0.190
Total	100.000	100.000
Chemical Composition[4]		
ME(kcal/kg)	3,265	3,265
Protein(%)	16.00	16.00
Lysine(%)	0.90	0.90
Methionine(%)	0.26	0.26
Calcium(%)	0.73	0.50
Phosphorus(%)	0.56	0.57

[1]A:Dehulled SBM, ME 3,265 kcal/kg; B:Non-dehulled SBM. ME 3,265 kcal/kg. [2]Provided per kg diet : Vitamin A, 4, 840IU; Vitamin D3, 1,100IU; Vitamin B2, 4.4mg; Nicotinic acid, 22mg; Vitamin B6, 1.65mg; Vitamin B12, 0.22mg; Biotin, 0.55mg; Folic acid, 0.33mg; Calcium pantothenic acid, 11mg. [3]Provided per kg diet : Cu, 43mg; Zn, 55mg; Mn, 50mg; Fe, 150mg; Co, 0.5mg; I, 0.5mg; Se, 0.2mg. [4]Calculated value.

Table 4. Composition of experimental diets fed to finishing pigs

Ingredients	B[1]	C[1]
Corn	56.158	33.478
Wheat	7.500	13.000
Lupin Kernel	6.500	6.500
Wheat Midding	2.000	23.000
Rice Bran	-	1.704
SBM(44%)	13.629	8.328
SBM(48%), USA	-	-
Rape Seed Meal	1.000	1.000
Palm Kernel Meal	3.000	3.000
Animal Fat(Korea)	3.167	1.500
Molasses	4.000	4.500
Limestone	0.157	1.013
TCP	1.482	1.140
Salt	0.360	0.500
Liquid-Lysine	0.677	0.947
Methionine	0.018	0.050
Choline(50%)	0.012	-
Vitamin Mix[2]	0.160	0.160
Mineral Mix[3]	0.190	0.190
Total	100.000	100.000
Chemical Composition[4]		
ME(kcal/kg)	3,265	2,940
Protein(%)	16.00	16.00
Lysine(%)	0.90	0.90
Methionine(%)	0.26	0.26
Calcium(%)	0.50	0.87
Phosphorus(%)	0.57	0.67

[1]B:Non-dehulled SBM, ME 3,265 kcal/kg; C:Non-dehulled SBM. ME 2,940 kcal/kg.
[2]Provided per kg diet : Vitamin A, 4, 840IU; Vitamin D3, 1,100IU; Vitamin B2, 4.4mg; Nicotinic acid, 22mg; Vitamin B6, 1.65mg; Vitamin B12, 0.22mg; Biotin, 0.55mg; Folic acid, 0.33mg; Calcium pantothenic acid, 11mg. [3]Provided per kg diet : Cu, 43mg; Zn, 55mg; Mn, 50mg; Fe, 150mg; Co, 0.5mg; I, 0.5mg; Se, 0.2mg. [4]Calculated value.

The four experimental diets for grower stage were formulated to contain 3,265 kcal/kg of metabolizable energy (ME) and either dehulled soybean meal or non-dehulled soybean meal was included as a major protein source. The experimental diets for finisher stage were formulated to contain two different levels of ME (3,265 kcal/kg vs. 2,940 kcal/kg) to evaluate the effect of dietary energy level on carcass characteristics and pork quality.

Pen size, feeds and water supply system of each treatment were consistent throughout the whole experimental period. The pig house was typical of open style with a pen of 5m in length and 2.5m in width. Experimental diets and water were provided ad-libitum through feeder and nipple. All other feeding management followed the routine practices adopted by the farm.

Body weights were measured three times throughout the entire experiment, one at 10 weeks post-farrowing, the second on the first day of feeding the diets for finisher stage and the last on the day to market pigs around 26 weeks of age. Body weight gain was calculated by subtracting initial body weight from market weight and daily weight gain was obtained from dividing total weight gain by total days of feeding.

Feed intake was measured by weighing the feed residues and daily feed intake was calculated by dividing total feed intake excluding the feed residues by days of feeding. Feed conversion was obtained by dividing feed intake by weight gain while feed efficiency was obtained by dividing weight gain by feed intake.

For blood sampling, five pigs from each treatment were randomly selected 3 hours after starvation and 5㎖ of blood was collected via jugular vein. Out of the blood collected, 2㎖ was put into heparinized -vacutainer and shacked carefully in "S" shaped movement and then transferred to laboratory for blood count. The remaining 3㎖ was stored in test tube to measure blood constituents.

For blood count test, leucocytes, erythrocytes, hemoglobin, hematocrit and MCV-mean corpuscular volume, MCH-mean corpuscular hemoglobin, MCHC- mean corpuscular hemoglobin concentration and platelet were analyzed using a blood counter (VETabc, France, 2002).

3㎖ of blood in the test tube was centrifuged at 3,000rpm for 15 min. to collect the supernatant. Using the blood constituent analyzer (Express Plus, Bayer US, 2002), BUN, creatine kinase, LDH, HDL, LDL and triglycerides were determined.

All experimental pigs reached at 182 days of age at the time of marketing were weighed out before transferring to slaughter house.

Carcass percentage was obtained by dividing carcass weight by live weight and multiplying by 100%. Backfat thickness was measured at the 11th and 12th rib of the left half of the carcass. Carcass grades (A, B, C, D) were evaluated based on the standard pork grade evaluation rules adopted by the National Livestock Product Grade Agency. Appearance of carcass and meat quality variables were also evaluated to obtain finalized carcass grade.

Slaughtered pigs were frozen for 24 hours and cut the left *longisimus dorsi* muscle from the carcass for analysis of chemical composition of meat. General compositions (moisture, crude protein, crude fat, crude ash and NFE) were analyzed according to the method described in the AOAC (2000). Muscle pH was measured using a pH meter from the homogenized sample after centrifuging 3g of the chopped loin meat, obtained after removing fat and muscle membrane, with 27㎖ of distilled water at 14,000rpm for 1 minute.

Water holding capacity and shear force of meat cut from the loin muscle were measured according to the methods practiced by the meat processing laboratory of the Jinju National University.

Meat color was measured with a Chroma meter (CR-310, Japan) using a cross section of loin meat 30 minutes after placing it at room temperature.

All the data obtained and collected from the experiment were analyzed using the General Linear Model developed by the SAS (1999).

5. Results and Discussions:

Table 5 shows weight gains, feed intakes and feed conversions of pigs fed the experimental diets containing either dehulled soybean meal or non-dehulled soybean meal from 25 kg to 80 kg.

Though there were no significant differences in body weight gain, daily weight gain, daily feed intake, feed conversion and feed efficiency among the two treatments containing dehulled soybean meal and non-dehulled soybean meal as a major protein source for growing pigs, general tendency in those responses appear to be better in groups fed the diets containing dehulled soybean meal than those fed the diets containing non-dehulled soybean meal in this trial.

Weight gain of pigs fed T1 and T2 diets containing US. dehulled soybean meal averaged 55.49 kg, which was 2.5% higher than those pigs fed T3 and T4 diets containing non-dehulled soybean meal (54.12 kg). Consequently, average daily weight gain of T1 and T2 groups was 0.730 kg and that of T3 and T4 represented 0.712 kg.

Average daily feed intake of T1 and T2 groups was 2.205 kg, which was 1.25% lower than that of T3 and T4 groups representing 2.233 kg. As a result, feed conversion of T1 and T2 groups was 3.036, which was 2.8% lower than that of T3 and T4 groups showing 3.123. On the while, feed efficiency of T1 and T2 averaged 0.330 and that of T3 and T4 was 0.321. On average, feed conversion was improved by 2.7% in pigs fed US. dehulled soybean meal compared to those fed South American non-dehulled soybean meal.

Based on the data obtained for the growing phase of 25 kg to 80 kg, growth rate, feed conversion and feed efficiency appeared to be improved in pigs fed the diets containing US. dehulled soybean meal compared with those of pigs fed the diets containing non-dehulled soybean meal of South American origin under the same dietary energy and protein levels. This implies that the diets containing dehulled soybean meal would reduce feed costs required for the growing period of pig.

Table 5. Body weight gain, weight gain, feed intake, feed conversion and feed efficiency of 25-80 kg pigs fed the diets containing dehulled soybean meal and non-dehulled soybean meal

Item	T1, T2(A diet[1])		T3, T4(B diet[2])	
	average		average	
Initial body weight(kg)	25.24	25.50	25.30	25.42
	25.37		25.36	
21weeks body weight(kg)	81.66	80.05	80.34	78.62
	80.86		79.48	
Body weight gain(kg)	56.42	54.55	55.04	53.20
	55.49		54.12	
Daily weight gain(kg/day)	0.742	0.718	0.724	0.700
	0.730		0.712	
Daily feed intake(kg/day)	2.200	2.230	2.210	2.235
	2.215		2.223	
Feed conversion(feed/gain)	2.965	3.106	3.052	3.193
	3.036		3.123	
Feed efficiency(gain/feed)	0.337	0.322	0.328	0.313
	0.330		0.321	

[1]:A diet-T1, T2: dehulled soybean meal ME: 3,265 kcal/kg
[2]:B diet-T3, T4: non-dehulled soybean meal ME: 3,265 kcal/kg
It was indicated that average body weight of pigs (T1 and T2) fed diets containing US. dehulled soybean meal averaged 81.00 kg, which was 2.1 % higher than average body weight of 79.33 kg of the groups fed diets (T3 and T4) containing non-dehulled soybean meal.

Table 6 shows body weight gain, daily weight gain, daily feed intake, feed conversion and feed efficiency of pigs fed the diets containing high ME (3,265kcal/kg) and low ME (2,940kcal/kg) for the finishing phase of 80kg to 100 kg.

There were no significant differences in body weight gain, daily weight gain, daily feed intake, feed conversion and feed efficiency among the two treatment groups fed high-energy density diets (3,265 kcal/kg) and low-energy density diets (2,940 kcal/kg).

Though there was 305 kcal/kg difference in ME between the two diets, no significant differences were found in such responses, which were unlikely to be expected. This might suggest that black hogs have a limited ability to utilize energy effectively, unlike normal white-variety pigs for fattening period.

Table 6. body weight gain, daily weight gain, daily feed intake, feed conversion and feed efficiency of pigs fed the diets containing dehulled soybean meal and non-dehulled soybean meal for the finishing phase from 80 kg to 100 kg.

Item	T1, T3(B diet[1])		T2, T4(C diet[2])	
	average		average	
Initial body weight(kg)	81.66	80.34	80.05	78.62
	80.86		79.48	
26weeks body weight(kg)	98.67	96.50	97.33	95.33
	97.09		96.33	
Body weight gain(kg)	17.01	16.16	17.28	16.71
	16.59		17.00	
Daily weight gain(kg/day)	0.610	0.590	0.620	0.600
	0.600		0.610	
Daily feed intake(kg/day)	1.950	1.890	1.910	1.880
	1.920		1.900	
Feed conversion(feed/gain)	3.197	3.203	3.081	3.133
	3.200		3.107	
Feed efficiency(gain/feed)	0.313	0.312	0.325	0.319
	0.312		0.322	

[1]:B diet-T1, T3: non-dehulled soybean meal ME: 3,265 kcal/kg
[2]:C diet-T2, T4: non-dehulled soybean meal ME: 2,940 kcal/kg

Table 7 shows body weight gain, daily weight gain, daily feed intake, feed conversion and feed efficiency of pigs fed the diets containing dehulled soybean meal and non-dehulled soybean meal for the growing period (25-80 kg) and the diets containing high ME (3,265 kcal/kg) and low ME (2,900 kcal/kg) for the finishing period (80-100 kg).

Table 7. Body weight gain, daily weight gain, daily feed intake, feed conversion and feed efficiency of pigs fed the diets containing dehulled soybean meal vs. non-dehulled soybean meal for the growing phase (25-80 kg) and the subsequent diets containing high-energy vs. low-energy (3,265 kcal/kg vs. 2,940 kcal/kg)

Item	Treatment[1)]			
	T1 (A→B)	T2 (A→C)	T3 (B→B)	T4 (B→C)
Initial body weight(kg)	25.24±0.15	25.50±0.17	25.30±0.14	25.42±0.18
Finals body weight(kg)	98.67±0.45 a	97.33±0.44 ab	95.50±0.41 b	95.33±0.38 b
Body weight gain(kg)	73.43±0.36 a	71.83±0.28 b	71.20±0.34 b	69.91±0.18 b
Daily weight gain(kg/day)	0.700±0.007	0.680±0.012	0.680±0.009	0.670±0.011
Daily feed intake(kg/day)	2.130±0.012	2.140±0.013	2.130±0.014	2.140±0.012
Feed conversion(feed/gain)	3.040±0.007	3.150±0.005	3.130±0.008	3.190±0.006
Feed efficiency(gain/feed)	0.329±0.004	0.318±0.006	0.319±0.010	0.313±0.011

[1)]T1: dehulled soybean meal(ME 3,265 kcal/kg) for growth period + non-dehulled soybean meal(ME 3,265 kcal/kg) for fattening period.
T2: dehulled soybean meal(ME 3,265 kcal/kg) for growth period + non-dehulled soybean meal(ME 2,940 kcal/kg) for fattening period.
T3: non-dehulled soybean meal(ME 3,265 kcal/kg) for growth period + non-dehulled soybean meal(ME 3,265 kcal/kg) for fattening period.
T4: non-dehulled soybean meal(ME 3,265 kcal/kg) for growth period + non-dehulled soybean meal(ME 2,940 kcal/kg) for fattening period.
[2)] Means±S.D.
[a~b] Means in the same row with different superscripts differ significantly($P<0.05$).

Final body weight, body weight gain and daily weight gain were significantly different among the four treatments throughout the entire experimental period from 25 kg to 100 kg, while daily feed intake, feed conversion and feed efficiency were similar among the treatments without significant differences.

Pigs on the T1 feeding program consisting of the diets containing dehulled soybean meal for the growing phase and the high ME diets for the finishing phase showed higher final body weight, body weight gain and daily weight gain than the other treatment groups, T2 (dehulled soybean meal-based diet + low ME diet), T3 (non-dehulled soybean meal-based diet + high ME diet) and T4 (non-dehulled soybean meal-based diet + low ME diet).

Meanwhile, pigs on the T2 feeding program consisting of the diets containing dehulled soybean meal for the growing phase and the subsequent diets with low ME tended to be higher in final body weight, body weight gain and daily weight gain response than the T3 and T4 treatment groups without significant differences.

Based upon the results obtained from this trial, it came to conclusion that black hogs should grow faster on the diets containing dehulled soybean meal as a major energy source than those on the diets containing non-dehulled soybean meal for the growing phase of 25-80 kg. Also, it was found that the finishing-phase diets, either containing high ME or low ME, did not affect growth performances of black hogs raised on the diets containing dehulled soybean meal for the growing phase. This might imply that black hogs would be lack of metabolic ability to convert dietary energy or fat into body fat reserve, especially, for the finishing phase.

Table 8 represents the effects of feeding the diets with different ME levels on the blood count of finishing pigs.

There were no significant differences in blood count profile among the treatments as shown in Table 7. This implies that blood count profile of pigs was not influenced by the difference in dietary energy concentration for the fattening period.

Table 8. Blood count of finishing pigs fed the diets with different ME levels

Item	Unit	Treatment			
		T1	T2	T3	T4
Leukocyte	$10^3/㎣$	18.95±0.68	18.56±0.32	18.10±0.48	18.52±0.43
Erythrocyte	$10^6/㎣$	7.23±0.66	7.29±0.45	7.13±0.43	7.42±0.68
Hemoglobin	g/dℓ	12.90±0.39	13.00±0.41	13.05±0.34	12.76±0.43
Hematocrit	%	37.77±0.77	37.56±0.64	37.23±0.43	37.06±0.69
MCV[2)]	μm^3	52.33±0.62	51.40±0.69	52.25±0.50	51.80±0.64
MCH[3)]	pg	17.90±0.69	17.86±0.78	18.35±0.48	18.16±0.71
MCHC[4)]	g/dℓ	34.18±0.67	34.62±0.59	35.05±0.58	35.74±0.61
Thrombocyte	$10^3/㎣$	303.83±1.70	302.80±1.34	308.75±1.90	305.60±1.43

[2)] MCV : (mean corpuscular volum).
[3)] MCH : (mean corpuscular hemoglobin).
[4)] MCHC : (mean corpuscular hemoglobin concentration).
[5)] Means±S.D.
[a~b] Means in the same row with different superscripts differ significantly($P<0.05$).

Table 9. Concentrations of blood constituents of finishing pigs fed the diets different in ME levels

Item	Unit	Treatment			
		T1	T2	T3	T4
Total cholesterol	㎎/㎗	141.00±0.71[a]	131.50±0.71[b]	140.25±0.96[a]	137.40±0.55[a]
HDL-cholesterol[2)]	㎎/㎗	96.60±0.89	106.75±0.15	91.13±0.15	101.66±0.61
LDL-cholesterol[3)]	㎎/㎗	57.98±0.61	58.85±0.35	57.90±0.57	59.72±0.42
LDH	g/㎗	536.80±0.84	539.50±0.42	537.50±0.58	527.00±0.56
Creatine Kinase	㎎/㎗	6.00±0.71	5.50±0.71	5.25±0.50	5.46±0.72
Creatinine	㎎/㎗	1.42±0.29	1.48±0.04	1.40±0.18	1.56±0.09
Triglycerides	㎎/㎗	98.00±0.71[a]	91.50±0.71[b]	97.00±0.82[a]	93.73±0.79[b]
BUN[4)]	㎎/㎗	24.70±0.54[b]	24.70±0.57[b]	34.58±0.65[a]	28.34±0.65[b]

[a~b] Means in the same row with different superscripts differ significantly($P<0.05$).

Total cholesterol concentration was lower in T2 groups fed the diets with low ME level for fattening phase and the diets containing dehulled soybean meal for growing phase than the other treatment groups, T1 (diets with high ME level for fattening period + dehulled soybean meal-based diets for growing period), T3 (diets with high ME level for fattening period + non-dehulled soybean meal-based diets for growing period) and T4 (diets with low ME level for fattening period + non-dehulled soybean meal-based diets for growing period).

Triglyceride concentrations were also lower in T2 and T4 groups fed the diets with low ME for fattening period than those T1 and T3 groups fed the diets with high ME for the same period.

These findings suggested that blood metabolites of pigs on the fattening phase would be influenced by dietary energy change. But it was not investigated in this study that these changes might influence concentrations of the same constituents in meat.

Table 10 shows carcass percentage, backfat thickness and carcass grade of pigs fed the finisher diets high in ME and low in ME from 80 kg to 100 kg after feeding the grower diets containing dehulled soybean meal and non-dehulled soybean meal from 25 kg to 80 kg.

Table 10. Carcass percentage, backfat thickness and carcass grade of pigs fed finisher diets high or low in ME

Item	Treatment[1)]			
	T1	T2	T3	T4
Carcass percentage (%)	74.80±0.12[b]	76.42±0.31[a]	75.49±0.24[ab]	74.51±0.34[b]
Backfat thickness (㎜)	22.33±0.82[a]	19.17±0.41[b]	23.83±0.41[a]	21.17±0.75[ab]
Carcass grade (B:C:D, %)	30:50:20	38:50:12	32:51:17	33:50:17

[a~b] Means in the same row with different superscripts differ significantly($P<0.05$).

Carcass percentage was higher in T2 groups fed the diets low in ME for fattening period after feeding the diets containing dehulled soybean meal for grower period than other T1(dehulled soybean meal-based diet for grower phase + high ME diet for fattening phase), T3 (non-dehulled soybean meal-based diet for grower phase + high ME diet for fattening phase) and T4 groups(non-dehulled soybean meal-based diet + low ME diet for fattening phase).

Backfat thickness was lower in T2 groups than other T1, T3 and T4 groups, which means that feeding high-energy diet for fattening phase would result in an increase in backfat thickness of black hogs well known to be a breed having low backfat. But it was inferred that backfat of black hog was not affected by the grower diet containing dehulled soybean meal, which has generally higher ME value than non-dehulled soybean meal.

As for carcass grade, B grade appearance seems to be higher in T2 groups than other T1, T3 and T4 groups without significant difference.

Table 11 shows general composition of pork from pigs fed finisher diets high or low in ME from 80 kg to 100 kg.

Table 11. General composition of pork from pigs fed finisher diets from 80 kg to 100 kg(%)

Item	Treatment[1)]			
	T1	T2	T3	T4
Moisture	72.98±0.21	73.82±0.26	73.50±0.22	72.98±0.25
Crude protein	22.72±0.21	21.80±0.13	21.84±0.13	21.96±0.11
Crude fat	2.90±0.11	2.71±0.09	2.71±0.10	2.82±0.07
Crude ash	1.15±0.03	1.12±0.03	1.13±0.03	1.11±0.04

There were no significant differences in moisture, crude protein, crude fat and crude ash of pork among all treatments. This means that feeding dehulled soybean meal for grower phase had no effect on pork quality although dietary ME level of finisher diet maintains high at 3,265 kcal/kg in this study.

Table 12. pH, water-holding capacity and shear force of pork from pigs fed finisher diets high or low in ME

Item	Treatment[1)]			
	T1	T2	T3	T4
pH	5.72±0.04	5.61±0.03	5.70±0.05	5.66±0.03
Water-holding capacity(%)	81.17±0.24	81.24±0.21	81.16±0.25	82.88±0.22
Shear force (kg/cm^2)	12.47±0.35	12.28±0.27	11.92±0.15	11.07±0.60

There were no significant differences in pH, water-holding capacity and shear force of pork from pigs fed the diets high or low in ME for finisher phase after feeding grower diets containing dehulled soybean meal from 25 kg to 80 kg.

Table 13. Meat color indexes of pork from pigs fed finisher diets high or low in ME

Item	Treatment[1)]			
	T1	T2	T3	T4
L^*(lightness)	48.38±0.18	51.34±0.17	49.60±0.36	48.94±0.14
a^*(redness)	6.91±0.38	7.08±0.26	6.76±0.18	6.48±0.37
b^*(yellowness)	2.18±0.27	2.59±0.29	2.26±0.20	2.25±0.26

No significant differences were found in meat color indexes of pork among treatments. Dehulled soybean meal inclusion in grower diet to replace non-dehulled soybean meal and dietary ME change in finisher diet did not affect meat color of pork from black hogs.

Table 14. Fat color indexes of pork from pigs fed finisher diets high or low in ME

Item	Treatment[1)]			
	T1	T2	T3	T4
L^*(lightness)	78.27±0.54	77.79±0.49	77.60±0.36	77.28±0.45
a^*(redness)	2.02±0.26	2.25±0.20	2.16±0.14	2.51±0.29
b^*(yellowness)	2.61±0.16	2.82±0.27	2.42±0.24	2.59±0.28

There were no significant differences in fat color indexes of pork from pigs fed finisher diets high or low in ME after offering grower diets containing dehulled soybean meal or non-dehulled soybean meal from 25 kg to 80 kg. This also suggests that fat color of black hogs is not influenced by dietary energy change during finisher phase although they are fed the diets containing dehulled soybean meal for grower phase.

6. Summary:

A total of 360 black hogs weighing 25 kg were fed experimental diets containing either dehulled soybean meal or non-dehulled soybean as a major protein source until they reach 80 kg. The pigs were then fed the finisher diets either high or low in ME to evaluate the effects of dietary energy level for finisher phase on the performances, blood profile, pork characteristics and quality.

The results indicated that pigs fed the grower diet containing dehulled soybean meal and the finisher diet high in ME showed highest weight gain among treatments, while pigs fed the grower diet containing non-dehulled soybean meal and the finisher diet low in ME showed lowest weight gain among treatments.

Feed conversion was highest in groups fed the grower diet containing non-dehulled soybean meal and the finisher diet low in ME, on the while, feed conversion was lowest in groups fed the grower diet containing dehulled soybean meal and the finisher diet high in ME.

Blood count variables were not significantly different among treatments regardless of dehulled or non-dehulled status of soybean meals and dietary energy level.

Among blood constituents, total cholesterol and triglycerides were lowest in groups fed the diets containing dehulled soybean meal for grower phase and the diets low in ME for finisher phase, and BUN was lowest in two treatments, one fed the grower diet containing dehulled soybean meal and finisher diet high in ME and the other fed the grower diet containing dehulled soybean meal and finisher diet low in ME.

Carcass percentage was higher in groups fed the grower diet containing dehulled soybean meal and the finisher diet low in ME, backfat thickness was lower in the same groups, and B grade appearance was higher in the same groups than other treatments. Pork quality such as meat and fat color indexes were not significantly different among treatments.

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