Comparative Feeding Values of Soybean Hulls and Wheat Bran for Growing and Finishing Swine

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ABSTRACT : Feeding values of soybean hulls (SH) were compared to those of wheat bran (WB) for swine diets by chemical compositions, a digestion trial, a preference test by self-selection, and two feeding trials. The SH and the WB appeared to have, on air-dry basis, 11.1 vs. 15.4% CP, 32.5 vs. 8.7% crude fiber (CF), 36.8 vs. 10.7% ADF, 0.6 vs. 0.1% Ca, and 492 vs. 92 ppm Fe, respectively. Lysine and total sulfur-containing amino acids in the SH were 0.66 vs. 0.37%, respectively. Apparent digestibility values of the SH were 71% for dry matter, 50% for CP, and 74% for CF. Apparent digestible energy and MEn values of the SH were 2,420 and 2,370 kcal kg^{-1}, respectively, which were comparable to those of the WB, 2,420 and 2,275 kcal kg^{-1} (NRC, 1998), respectively. The first feeding trial was conducted with 72 crossbred growing pigs with an average weight of 29.6 kg. The pigs when fed the diets containing 0, 6 and 10% SH by replacing the WB on a weight basis for 42 days did not show significant differences in body weight gain and feed/gain ratio among the treatments. The same trends were observed in the second trial with 60 crossbred finishing pigs with an average weight of 64.5 kg when fed the diets containing 12% SH or WB for 41 days. Back-fat thickness and adjusted loin eye muscle area of the finisher pigs were also not significantly different between the two groups. When allowed to self-select from two different feed troughs containing 10% SH or WB for two weeks, two groups of 80 pigs with 10 pigs per pen consumed the two diets exactly in equal proportion. In conclusion, the soybean hulls can be included up to 10 and 12% for growing or finishing pig diets, respectively, replacing the wheat bran on a weight basis without any adverse effects on palatability of diets and animal performances. ***(Asian-Aust. J. Anim. Sci. 2005. Vol 18, No. 6 : 861-867)***

Key Words : Comparative Feeding Values, Soybean Hulls, Wheat Bran, Digestible Energy, Swine

INTRODUCTION

Soybean hulls, a by-product of soybean processing, are usually blended back into meal to produce 44% crude protein (CP) soybean meal in Korea. The hulls are reported to contain about 10-12% CP, 43% crude fiber (CF), 1-2% ether extract (EE), and 4-5% crude ash (Kornegay, 1978; Mitaru et al., 1984). The hulls' amino acid patterns as percentage of total CP were similar to those of soybean meal (Kornegay, 1981b; NRC, 1998). Digestible energy contents of the hulls, 2,070 kcal kg^{-1}, were lower than those of wheat bran, 2,420 kcal kg^{-1} (NRC, 1998). Soybean hulls, due to their high fiber contents, are known to be poorly digested by non-ruminant animals, but normally well digested by ruminants.

Recent studies, however, suggest that the hulls have potential as an alternative feed ingredient for swine. Growing and finishing pigs fed the diets containing 6-8% soybean hulls showed better daily gain or equal feed/gain ratio compared to control groups. However, when the pigs were fed the diet containing 24% hulls, their performances were depressed (Kornegay, 1981a, b).

We thought it might be interesting to find out if soybean hulls could successfully replace wheat bran on a weight basis in swine diet in nutritional and palatability points of view. If then, soybean hulls could be an alternative ingredient to wheat bran depending on their market prices. Wheat bran, a traditional ingredient for swine diet (Bhar et al., 2000), is known to have higher energy, CP and lower CF contents than the hulls (NRC, 1998).

The purposes of this study were to investigate the nutritional values of local soybean hulls and to evaluate a possible use of the hulls as a replacement for the local wheat bran in growing and finishing pigs.

MATERIALS AND METHODS

Analyses of the soybean hulls and wheat bran

Soybean hulls used for this study were obtained from a local commercial soybean processor (CJ, Seoul). Wheat bran was also obtained from a local feed mill. Analyses of dry matter, CP, EE, CF and minerals (Ca, P, Mg, Fe, Cu, Zn) of the soybean hulls and the wheat bran were performed according to the procedures in the Association of Official Analytical Chemists (AOAC, 1990). ADF and NDF were analyzed as described by Goering and Van Soest (1970).

Amino acid concentrations of the soybean hulls and

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wheat bran were measured using an automatic amino acid analyzer (Carlo Erba, 3A 30) following 22 h hydrolysis in 6 N HCl at 110°C except cystine and methionine. The sulfur containing amino acids were oxidized with performic acid overnight according to the AOAC (1990). Urease activity was measured by a titration method with phenol red as an indicator (AOCS, 1976).

Digestion trial for soybean hulls

Digestibility, apparent digestible- and metabolizable energy contents of the soybean hulls were measured by a method (by difference) as described by Scott et al. (1982) and Pond et al. (1995). Seven castrated male, crossbred (Landrace×Yorkshire×Duroc) pigs with an average of 56 kg body weight were individually allotted into metabolic crates. While adapting to the crates, all the pigs were fed a basal diet based on corn-tapioca-soybean meal. Four of them were switched to an experimental diet for a three-day preliminary and a three-day collection. Meanwhile the other three pigs were allowed to continue on the basal diet for six days. The experimental diet was prepared by mixing the basal diet and soybean hulls at 1:1 ratio on a weight basis. All diets were mixed with 0.2% chromic oxide as an indicator to allow a partial sampling of the fecal materials.

Daily feed intake and urine output of each pig were recorded during the last three days. Total feces and urine over the collection period from individual pigs were collected for sampling. A portion of daily fecal or urine output from every pig was saved and stored frozen. Fecal samples were dried in an oven at 60°C, and urine samples were lyophilized. The feces and urine were analyzed for gross energy contents with an adiabatic bomb calorimeter (Parr Instrument Co.), and nitrogen (AOAC, 1990). Chromic oxide contents of the diets and the feces were analyzed with an atomic absorption spectrophotometry (Baird, Alpha 4) after digestion with bromo-phosphoric acid solution (Williams et al., 1962).

The energy content and digestibility of the wheat bran were not measured in this study. Instead, the digestible energy and apparent metabolizable energy values of the wheat bran were cited from the NRC (1998).

Feeding trials of soybean hulls with pigs

Chemical composition and energy data of the soybean hulls analyzed at the beginning of the study were used in formulating the experimental diets (Table 3). Although wheat bran contained higher concentrations of CP and P than the soybean hulls, the differences in chemical compositions of the experimental diets appeared not significant except the higher CF content in the soybean hulls diet. No attempt, however, was made to adjust nutrient levels of all the experimental diets.

Two feeding trials with growing or finishing pigs were conducted to compare the effects of the soybean hulls and the wheat bran on their performance.

Trial with growing pigs : Seventy two crossbred (L×Y×D) growing pigs, 29.6 kg average body weight, were fed the experimental diets *ad libitum* for 42 days. Animals were divided into three groups of four pens with six pigs each. Three castrated males and three females were allotted to each pen.

The hulls were added to a basal diet by replacing wheat bran at levels of 0, 6 and 10% on a weight basis (Table 3). The diets were isocaloric (3,390 kcal DE kg^{-1}) and isonitrogenous (14.5-15.0%). Total lysine and methionine +cystine levels were in the ranges of 0.74-0.75 and 0.58-0.59%, respectively.

Trial with finishing pigs : Sixty crossbred (L×Y×D) finishing pigs with an average body weight of 64.5 kg were divided into two dietary groups. Each group consisted of three pens each with ten pigs, five females and five castrated males. One group consumed a diet containing 12% wheat bran while the other group consumed a diet containing 12% soybean hulls for a period of 41 days up to around 88 kg body weight. Both diets were isocaloric (3,410 kcal DE kg^{-1}) and isonitrogenous (15.4-15.8%). However, CF content of the soybean hulls diet was higher by 7.1% vs. 4.0% compared to that of the wheat bran diet. Total lysine and methionine+cystine levels were in the ranges of 0.70-0.71 and 0.63-0.64%, respectively (Table 3).

At the end of the feeding trial, six female pigs of average body weight were selected from each dietary group and sacrificed to measure carcass quality. Back fat thickness was measured with a probe at three points: the first rib, the last rib, and the last lumbar vertebra. Cross section areas of longissimus muscle were also estimated (NRC, 1998). The areas were compared after being adjusted to 104.5 kg live weight according to the following equation (Drewry, 1977).

$$\text{Adjusted loin eye area (cm}^2\text{)} = \text{actual loin eye (cm}^2\text{)} + 0.033\ (104.5\text{-actual weight, kg})$$

Preference test between soybean hulls and wheat bran

Two feeding tests each with different groups of eighty, three-way crossbred (L×Y×D) female pigs, were conducted for two weeks to compare preference of the diets containing 10% soybean hulls or wheat bran (Table 6). All experimental procedures including the dietary formulations were the same for the two tests except the mean body weight of pigs, 55 and 60 kg for tests 1 and 2, respectively. They were allotted to eight pens with ten pigs each and allowed to self-select from two different feed troughs containing the different diets. Proportions of all ingredients of the diets were kept identical except soybean hulls and wheat bran. Despite the supplementation of soybean hulls

Table 1. Nutrient compositions of soybean hulls and wheat bran

Nutrient composition	Soybean hulls	Wheat bran
	% Air dry matter[1]	
Energy values (kcal kg^{-1})		
Digestible energy	2,420±139[2]	2,420[3]
AMEn[4]	2,370±112	2,275[3]
Digestibility (%)		
Dry matter	71.1±1.9[2]	-
Crude protein	50.3±9.2	-
Crude fiber	73.8±6.6	-
Proximate (%)		
Crude protein	11.1	15.4
Crude fat	1.5	3.6
Crude fiber	32.5	8.7
Crude ash	4.9	5.1
Van soest (%)		
ADF	36.8	10.7
NDF	52.9	41.0
Minerals		
Ca (%)	0.6	0.1
P total (%)	0.2	1.0
Mg (%)	0.3	0.5
Fe (ppm)	492	92
Cu (ppm)	8.0	8.4
Zn (ppm)	45	54
Urease activity change in pH	0.1±0.02	-

[1] Based on 90% dry matter. [2] Means of seven pigs±STD.
[3] NRC (1998). [4] N-corrected apparent metabolizable energy.

or wheat bran, the two diets appeared isocaloric (3,350 kcal DE kg^{-1}) and isonitrogenous (16.2-16.8%) with the only difference in CF content (6.5 vs.4.2%) as shown in Table 6.

The position of each feed trough was rotated every day during the period as an attempt to eliminate any possible effects from feeder location. Feed intake, corrected for spillage, was recorded every day.

Statistical analysis

One-way analysis of variance (ANOVA) was carried out on all the data using the General Linear Models (GLM) procedure of Statistical Analysis System (SAS, 1998). Significance between means was tested by Tukey's (Steel and Torrie, 1980). Differences were considered significant at $p<0.05$. Pooled standard error of the mean (SEM) were provided whenever applicable.

RESULTS

Chemical composition of soybean hulls and wheat bran

Proximate analyses, minerals, and amino acid compositions of the soybean hulls and the wheat bran were as shown in Table 1. CP level of the soybean hulls was slightly lower than that of wheat bran by 11.1% vs. 15.4%. However, the soybean hulls contained higher levels of CF (32.5% vs. 8.7%), ADF (36.8% vs. 10.7%), and NDF (52.9% vs. 41.0%) compared to the wheat bran. Ca (0.6% vs. 0.1%) and Fe (492 vs. 92 ppm) levels in the hulls appeared five to six times higher than those in the bran, which, however, had total P five times higher than the hulls (1.0% vs. 0.2%). The Fe in the hulls could be an excellent source of the mineral if it has adequate biological availability in pigs as shown by Huh et al. (1999) in rats.

Table 2. Amino acid compositions of soybean hulls and wheat bran

Amino acids	% Air dry matter		% Crude protein	
	Soybean hulls	Wheat bran	Soybean hulls	Soybean meal[2]
Arginine	0.75	0.92	6.76	7.37
Lysine	0.66	0.54	5.95	6.46
Histidine	0.26	0.61	2.34	2.67
Phenylalanine	0.17	0.51	1.53	4.98
Leucine	0.50	0.81	4.50	7.81
Isoleucine	0.29	0.44	2.61	4.54
Valine	0.45	0.66	4.05	4.70
Methionine	0.18	0.20	1.62	1.39
TSAA[1]	0.37	0.46	3.33	2.99
Threonine	0.39	0.40	3.51	3.95
Tyrosine	0.20	0.45	1.80	3.86

[1] Methionine+cystine. [2] NRC (1998).

Amino acid contents of the soybean hulls and wheat bran were as shown in Table 2. Lysine was the only essential amino acid for the soybean hulls to have more than in wheat bran by 0.66% to 0.54%. Contents of total sulfur-containing amino acids (TSAA) of the hulls and the bran were 0.37 and 0.46%, respectively. When expressed as % of CP, profiles of indispensable amino acids of the soybean hulls appeared fairly similar to those of the soybean meal (Table 2) except phenylalanine, leucine, and isoleucine. Lysine and TSAA levels, the first and second limiting amino acids in swine diets, were 5.95% and 3.33% in the soybean hulls and 6.46% and 2.99%, as % of CP, in the soybean meal, respectively. This similarity in the amino acid profiles between the soybean hulls and soybean meal was also noticed by Kornegay (1978).

Urease activity of the soybean hulls appeared around 0.1 unit of pH change. The urease activity as an indirect way of measuring trypsin inhibitor was within an acceptable range of 0.05-0.2 unit (Leeson and Summers, 2001).

Digestibility and energy contents of soybean hulls

Soybean hulls contained 2,420 kcal digestible energy (DE) and 2,370 kcal nitrogen-corrected apparent metabolizable energy (AMEn) per kg diet as shown in Table 1. Digestibility of the dry matter, CP, and CF of the hulls were 71.1%, 50.3% and 73.8%, respectively. The energy values and digestibility of the wheat bran were not measured in this study. According to the NRC (1998), DE and AMEn contents of the wheat bran are 2,420 and 2,275 kcal kg^{-1}, respectively, as referred in Table 1.

Table 3. Composition and nutrients contents of the diets for feeding trials of growing- and finishing pigs

Ingredients	Growing pigs			Finishing pigs	
	Soybean hulls	SBH+WB	Wheat bran	Soybean hulls	Wheat bran
	------------ % ------------				
Soybean hulls	10.00	6.00	0	12.00	0
Wheat bran	0	4.00	10.00	0	12.00
Corn, yellow	55.57	55.57	55.57	23.88	23.88
Wheat	-	-	-	26.00	26.00
SBM (45%)	15.00	15.00	5.00	11.50	11.50
Others[1]	Up to 100.0				
Calculated nutrient composition					
DE (kcal g^{-1})	3.39	3.39	3.39	3.41	3.41
C. protein (%)	14.5	14.7	15.0	15.4	15.8
C. fiber (%)	5.9	4.9	3.5	7.1	4.0
Calcium (%)	0.72	0.70	0.67	0.65	0.60
P available (%)	0.28	0.29	0.30	0.27	0.29
Lysine (%)	0.75	0.74	0.74	0.71	0.70
TSAA[2] (%)	0.58	0.58	0.59	0.63	0.64

[1] Grower diets contained tapioca 9.0; rapeseed meal 3.0; yellow grease 3.07; molasses 2.0; tri-calcium phosphate 0.98, limestone 0.64, salt 0.27; vitamin and mineral premix 0.30; choline-HCl(25%) 0.08; lysine-HCl 0.07 and antibiotics 0.01. Finisher diets contained milo 14.0; rapeseed meal 4.0; lupin 2.8; tallow 3.5; tri-calcium phosphate 0.8; limestone 0.7; salt 0.3; lysine-HCl 0.2 and premix 0.7.
[2] Methionine+cystine.

Table 4. Performances of growing pigs fed the diets containing soybean hulls or wheat bran[1]

Dietary groups	1-3 week	4-6 week	1-6 week
Body weight gains (kg pig^{-1})			
10% soybean hulls	16.5	18.5	35.0
6% SH+4% WB	17.7	17.7	35.4
10% wheat bran	16.3	18.2	34.5
SEM	0.07	0.43	0.72
Feed intake (kg pig^{-1})			
10% soybean hulls	40.2	49.6	89.8
6% SH+4% WB	40.9	51.0	91.9
10% wheat bran	39.7	50.1	89.8
SEM	1.2	4.6	2.4
Feed intake/body weight gain ratio			
10% soybean hulls	2.43	2.68	2.56
6% SH + 4% WB	2.31	2.88	2.60
10% wheat bran	2.44	2.75	2.60
SEM	0.47	0.18	0.91

[1] Means of 24 pigs. No significant differences among dietary groups ($p<0.05$).
Average initial body weight was 29.6 kg.

Table 5. Performances, back fat thickness and loin eye areas of the finishing pigs fed the diets containing soybean hulls or wheat bran at 12% level

Measurements	Dietary treatments		
	Soybean hulls	Wheat bran	SEM
Body weight gain[1] (kg pig^{-1})	23.9	23.6	0.6
Feed intake (kg pig^{-1})	76.4	75.8	1.6
Feed intake/body weight gain	3.20	3.21	0.09
Back fat thickness[2] (cm)	2.2	2.3	0.25
Loin eye area [2] (cm^2)			
Actual	24. 7	26.3	1.9
Adjusted [3]	25.0	26.6	1.8

[1] Initial body weight was 64.3±0.2 (STD) kg per pig.
[2] Data are means of 6 pigs and three points readings. No significant differences among the treatments ($p<0.05$).
[3] Adjusted to areas of 104.5 kg live body weight according to Drewry's equation (1977).

Feeding trials with the soybean hulls diet

Growing pigs : Performances of growing pigs fed the diets containing different levels of soybean hulls are shown in Table 4. During the first three wk period, average body weight gain (16.3-17.2 kg), feed intake (39.7-40.9 kg) and feed/gain ratios (2.31-2.44) of the pigs were not significantly different among the dietary groups. The same trends were observed in the pigs from 4 to 6-wk periods and during the overall period. Overall average body weight gain per pig was 35.0 kg, and feed intake and feed/gain ratio were 90.5 kg and 2.59, respectively.

Finishing pigs : Performances of the finishing pigs fed the experimental diets are as shown in Table 5. The data for average body weight gain, feed intake, feed/gain ratio, back fat thickness and loin eye area appeared almost identical between the two dietary groups. The average body weight gains of the two groups were in the range of 23.6-23.9 kg, and the ranges for feed intake and feed/gain ratio were 75.7-76.4 kg and 3.20-3.21, respectively.

Back fat thickness was in the range of 2.2-2.3 cm, and the ranges of loin eye muscle area were 24.7-26.3 cm^2 for actual measurement and 25.0-26.6 cm^2 for 104.5 kg-adjusted live weight. The mean values for loin eye area of the pigs fed the diet containing the soybean hulls appeared lower by about 6% than those of the pigs fed the wheat bran diet, although no significant differences were observed ($p<0.05$).

Table 6. Composition and nutrients contents of the diets for preference test

Ingredients	Dietary groups	
	Soybean hulls	Wheat bran
	--------------------- % --------------------	
Soybean hulls	10.0	0
Wheat bran	0	10.0
Corn, yellow	23.5	23.5
Soybean meal	11.5	11.5
Others[1]	Up to 100.0	
Calculated nutrients contents		
DE (kcal kg^{-1})	3,350	3,350
Crude protein (%)	16.2	16.8
Crude fiber (%)	6.5	4.2
Calcium (%)	0.68	0.64
P avail (%)	0.27	0.29
Lysine (%)	0.80	0.79
TSAA[2] (%)	0.63	0.64

[1] Others included (%) 28.0 wheat; 14.0 milo; 2.6 lupin; 4.0 rapeseed meal; 3.5 tallow; 0.8 limestone; 0.8 tricalcium phosphate; 0.4 salt; 0.2 lysine-HCl and 0.7 micro-ingredients.

[2] Methionine+cystine.

Preference tests of soybean hulls in growing pigs

Table 7 shows the results of the preference tests 1 and 2. Data presented are the mean weight of each diet consumed by a group of 10 pigs each and the % of each diet out of total intake per day.

In test 1, the average intakes of the soybean hulls diet and the wheat bran diet were of the same range, 0.92 vs. 0.93 kg per day, respectively. The same trend was also observed in test 2, in which the average body weight was similar to that in test 1. However, the pigs in test 2 consumed more diets, on the average 2.5 kg per day, compared to 1.9 kg for pigs in test 1. Proportional intakes from the soybean hulls and the wheat bran diets in test 2 were 49.8 and 50.2%, respectively. Numbers of pens in which pigs consumed the soybean hulls diet over 50% were four and five out of eight pens in tests 1 and 2, respectively. Pigs in test 2 showed a wide range (38.5-56%) of preferences for the diet containing the soybean hulls to the wheat bran diet.

DISCUSSION

The protein contents of the soybean hulls used to vary depending on the processors. Recently, Cole et al. (1999) observed a range of 9.2-18.7% CP for soybean hulls from nine different sources across the U.S. The protein level of the soybean hulls in this study was similar to those reported by Kornegay (1978) and Mitaru et al. (1984). However, the levels of the CF, ADF, and NDF in Table 1 appeared lower than those reported by Kornegay (1978), which were 43.4, 45.3 and 65%, respectively.

The DE and the AME values of the hulls from this study were 17 and 20% higher than the values, 2,070 and 1,870 kcal kg^{-1}, respectively, reported by Kornegay (1978). The higher energy values of the hulls could be associated with the digestibility differences of the soybean hulls between

Table 7. Intake of the diets containing soybean hulls or wheat bran at 10% level by pigs allowed to self-select in preference test[1]

Pen No.	Dietary groups				Total intake (kg pig^{-1})
	Soybean hulls		Wheat bran		
	kg pig^{-1} d^{-1}	%	kg pig^{-1} d^{-1}	%	
Test 1					
1	0.96	53.0	0.85	47.0	1.81
2	0.85	49.4	0.87	50.6	1.72
3	0.87	50.3	0.86	49.7	1.73
4	0.95	47.5	1.05	52.5	2.00
5	1.05	48.6	1.11	51.4	2.16
6	0.85	48.3	0.91	51.7	1.76
7	0.91	51.4	0.86	48.6	1.77
8	0.95	51.6	0.89	48.4	1.84
Mean±STD	0.92±0.06	50.0±1.8	0.93±0.09	50.0±1.7	1.85±0.14
Test 2					
1	1.30	54.2	1.10	45.8	2.40
2	1.30	52.0	1.20	48.0	2.50
3	1.10	44.0	1.40	56.0	2.50
4	1.00	38.5	1.60	61.5	2.60
5	1.10	45.8	1.30	54.2	2.40
6	1.40	56.0	1.10	44.0	2.50
7	1.30	52.0	1.20	48.0	2.50
8	1.40	56.0	1.10	44.0	2.50
Mean±STD	1.24±0.14	49.8±5.9	1.25±0.17	50.2±6.0	2.49±0.06

[1] Two groups of 80 pigs each with average body weight of 55 and 60 kg for tests 1 and 2, respectively, were allowed to self-select between the two diets containing 10% level of soybean hulls or wheat bran for two weeks.

No significant differences were observed among the treatments ($p<0.05$).

the two studies. Data for digestible dry matter, CP and CF of the soybean hulls reported by Kornegay (1978) were rather lower (49.7, 32.0 and 44.2%, respectively) than those obtained in this study (Table 1). The differenence in digestibility could be related to the different chemical compositions (particularly fiber content) of the soybean hulls between the two studies. The methodology (by difference method) used to measure the digestibility of the hulls was basically the same for the two studies. Apparent digestion coefficients for dry matter, CP, CF, and the energy values of the soybean hulls were measured based on the assumption that digestibility of the basal components does not change even when soybean hulls are added (Schneider and Flatt, 1975).

Levels of dietary limiting amino acid (lysine and TSAA) in this study were not affected significantly when the basal diet was supplemented with the soybean hulls compared to those in the wheat bran. Overall contribution of the two feed ingredients to the limiting amino acid contents in the diets appeared less than 10% of their requirements. Lysine and TSAA levels of the diets (Table 3) were always within the ranges satisfying their requirements (NRC, 1998).

The higher AMEn value for the soybean hulls in this study than the published value for the wheat bran (NRC, 1998) was not expected when considering the great differences in CF, ADF and NDF levels between the two ingredients (Table 1). However, some reports suggest that the fiber types in the soybean hulls could be easier to be digested than those in wheat bran. Chabeauti et al. (1991) showed that digestibility coefficients of NDF, ADF and non-starch polysaccharide in the soybean hulls were 0.68, 0.62 and 0.79, while those in wheat bran were 0.40, 0.19 and 0.46, respectively, in growing pigs. Another report also showed high levels of digestibility coefficients (0.8-0.9) for high water soluble dietary fibers from soybean hulls or sugar beet pulp. The dietary fibers with high digestibility could make a positive contribution to energy supply in adult sows (Noblet and Goff, 2001).

According to Shriver et al. (2003), fiber addition (10% soybean hulls) to a low protein diet had little effect on overall nitrogen balance or growth performances, but increased volatile fatty acid concentrations in barrows. They also observed that supplementing soybean hulls to a low protein diet had minor effect on carcass traits. However, the average back fat decreased, and the10th-rib fat depth was numerically reduced by adding the hulls.

The fact that the growth performances in growing or finishing pigs and the carcass traits of finishing pigs were identical between the two dietary groups (Tables 4 and 5) indicates that soybean hulls can successfully replace wheat bran in swine diets up to 10 or 12%. The similar feed intakes between the dietary groups also suggest that the energy levels of the diets supplemented with the soybean hulls or the wheat bran were fairly close as shown in Table 1.

Levels of dietary limiting amino acids (lysine and TSAA) in this study were not affected at all when the basal diet was supplemented with soybean hulls or wheat bran. Overall contribution of the two feed ingredients to the limiting amino acid contents in the diets appeared less than 10% of their requirements. Lysine and TSAA levels of the diets (Table 3) were always within the ranges satisfying their requirements (NRC, 1998).

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The data in Table 7 show that any differences between the two diets containing the soybean hulls or the wheat bran at 10% level did not affect the choice of diets when the pigs were allowed to self select. This implies that those two diets were palatable or acceptable to the same extent to the pigs. The different feed intakes between the two tests with the pigs of similar body weight were likely due to the different environmental temperature. Test 2 was conducted one month later than test 1 in late autumn.

The above observations suggest that soybean hulls from local processors can be supplemented up to 10 or 12% for growing and finishing pig diets, respectively, by replacing wheat bran on a weight basis without any nutritional or palatability problems.

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