Effects of Feeding Dried Food Waste on Growth and Nutrient Digestibility in Growing-Finishing Pigs

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ABSTRACT : A total of thirty-six gilts (24.78±1.39 kg) were employed for 38 days (Exp. 1), and twenty-four gilts (46.50±1.90 kg) for 43 days (Exp. 2) to determine growth performance and carcass characteristics in pigs fed dried food waste (DFW). Pigs were allocated by dietary treatments: 0%, 20% and 40% DFW. For nutrient digestibility, twelve female pigs (50.20±0.52 kg) were used in individual pens to collect feces. Food wastes were collected from restaurants and apartment complex areas and dried in a drum-type dryer at 115±2℃. Experimental diets for feeding trials were formulated to contain 3,400 kcal DE/kg and 17% crude protein. The tested DFW contained 2,858 kcal DE/kg, 25.0% crude protein, 17.3% crude fat, 1.37% Ca, 1.28% P, and 3.28% NaCl. As compared to crude protein content, the limiting amino acids (i.e., 0.90% lysine and 0.52% methionine) were low. The digestibilities of energy, ash, calcium and phosphorus in the DFW were generally lower than those in the grower diets, but the digestibilities of crude protein and crude fat were higher in DFW than the grower diet. Feeding DFW in pigs had a linear ($p<0.01$) effect on ADG and feed/gain as the inclusion levels of DFW were increased (Exp. 1). The ADG of pigs fed 40% DFW was also poorer ($p<0.05$) than that fed the control diet (Exp. 2). Carcass characteristics in terms of backfat and dressing percentage were not affected by dietary treatments. In conclusion, it seems that the optimal dietary inclusion level of the DFW is about 20% in the diet for growing-finishing pigs. (*Asian-Aus. J. Anim. Sci. 2000. Vol. 13, No. 9 : 1304-1308*)

Key Words : Dried Food Waste, Nutrient Digestibility, Growth, Pig

INTRODUCTION

There has been growing interest in using food wastes as a feed resource during the last decade due to the increased cost of disposal and environmental contamination (Westendorf et al., 1996; Bryhni et al., 1999).

Using food wastes as pig diet is not a new idea. Feeding of kitchen waste to pigs has been a common practice in most countries (Boda, 1990); in the United States, food wastes for feeding must be cooked to prevent health and safety problems (Westendorf et al., 1996).

Food wastes are generally high in fat and salt contents, and moderately high in protein and ash (Kornegay et al., 1970; Myer et al., 1999). However, one of the problems with feeding food waste is the variation in sources, resulting in variation in nutrient composition (Kornegay et al., 1965; Soliman et al., 1978; Lipstein, 1984; Pond and Maner, 1984; Myer et al., 1999; Yang, 1999).

The digestibility of nutrients in food waste is generally not poor. Westendorf and Dong (1997) reported that protein digestibility was higher in the food waste diet than in a corn-soybean meal diet (88.2% vs 84.3%), although rates of nitrogen retention were not different between the two diets. Myer et al. (1999) also reported that pepsin digestibility and available lysine in the dried food wastes were found to be moderately higher but lower than values for soybean meal.

Food wastes may be used dried or in liquid form. Myer et al. (1999) blended wet food waste with a dry feedstock (soyhulls and wheat flour) and dried. They found that the ADG, gain:feed, carcass characteristics of the finishing pigs were not affected by the inclusion of the dried food waste product at 40% of the diet (25% dried food waste in the product) or 85% of the diet (50% dried food waste in the product). Yang (1999) also reported that feeding dried food waste had no adverse effect on ADG in growing pigs when it was 30% of the diet. For liquid feeding, Bryhni et al. (1999) made a food waste product containing 32.4% food leftover and other food wastes from factories in order to balance nutrient variation in food waste. Increasing dietary levels of the food waste reduced (linear) daily feed intake, and they concluded that the optimal dietary inclusion level of the food waste product was in the range of 20-50% in the diet.

Data are still limited in feeding dried food waste for pigs. In this experiment, wet food wastes were dried and growth performance and nutrient digestibility were determined with growing-finishing pigs.

MATERIALS AND METHODS

Animals and feeding

Two feeding trials were separately conducted to

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evaluate the feeding values of dried food wastes (DFW) in growing-finishing pigs. An attempt was also made to determine the nutrient digestibility of DFW in growing pigs. Food wastes were collected from restaurants and apartment complex areas and dried in a drum-type dryer (MI Engineering Co., Korea) at 115 ±2℃. Before drying, materials unsuitable for feed use were separated manually and mechanically from the wet food wastes, and the wet food wastes were ground (MI Engineering Co., Korea) through 5 mm screen.

For feeding trials, thirty-six gilts (24.78±1.39 kg) were employed for 38 days (Exp. 1), and twenty-four gilts (46.50±1.90 kg) for 43 days (Exp. 2) to determine growth performance and nutrient digestibility in pigs fed DFW. For nutrient digestibility, twelve female pigs (50.20±0.52 kg) were employed in individual pens to collect feces. All pigs were three-way crossed breeds (Landrace×Yorkshire× Duroc).

Experimental diets for feeding trials were formulated to contain 3,400 kcal DE/kg and 17% crude protein (table 1). Salt (NaCl) was not added in the experimental diets except for the control diets. The pigs were housed in a building partically constructed with glass windows and solid concrete floors. Feed and water were offered for *ad libitum* consumption. In exp. 2, twelve gilts (91.33±0.93 kg), three/treatment, were sacrificed to evaluate carcass characteristics (backfat depth and dressing percentage).

In a digestibility trial, three DFW samples from different batches were collected. Vitamin and trace mineral premixes used in the feeding trials were added (0.2%) in the DFW samples to exceed their requirements suggested by NRC (1998), and 0.3% chromic oxide was also included as an indigestible marker. Pigs had *ad libitum* access to water and feeds were offered twice (09:00 and 17:00) per day. Feces were collected for two days after a four-day adjustment period. Feces were mixed and dried in an air forced drying oven at 60℃ for 72 hours for chemical analysis.

Chemical and statistical analyses

Proximate nutrients of the feeds and feces were analyzed according to the methods of AOAC (1990)

Table 1. Formula and chemical composition of diets (Exp. 1 & 2)

	Exp. 1 (DFW, %)			Exp. 2 (DFW, %)		
	0	20	40	0	20	40
Dried food waste	-	20.00	40.00	-	20.00	40.00
Corn	67.30	53.60	41.10	65.30	57.24	36.83
SBM (44%)	19.00	14.40	5.60	18.40	10.00	8.00
Fish meal	3.00	1.80	3.00	2.00	0.40	1.00
Wheat bran	5.00	5.10	5.10	5.00	5.00	5.00
Canola meal	3.00	3.00	3.00	3.00	3.00	3.00
Corn oil	0.60	1.00	1.00	2.00	1.00	2.00
Molasses	-	-	-	2.00	2.00	2.00
Limestone	1.00	-	-	1.70	0.50	1.90
TCP	0.80	1.00	1.00	0.10	0.50	0.10
L-lysine · HCl	-	-	-	0.10	0.10	-
Vit.-min. mix.[1]	0.10	0.10	0.10	0.10	0.10	0.10
Methionine (50%)	-	-	-	0.10	0.16	0.07
Salt	0.20	-	-	0.20	-	-
Total	100	100	100	100	100	100
Chemical composition[2] (%)						
DE (kcal/kg)	3,400	3,403	3,402	3,403	3,403	3,403
Crude protein	17.00	17.00	17.00	17.00	17.00	17.00
Lysine	0.96	0.89	0.92	1.06	1.06	1.06
Met+Cys	0.65	0.66	0.67	0.66	0.66	0.66
Calcium	0.96	0.76	0.70	1.90	1.90	1.90
Av. phosphorus	0.25	0.25	0.26	0.22	0.22	0.22

[1] Supplied per kilogram of diet: 8,000 IU vitamin A, 1,500 IU vitamin D_3, 40 IU vitamin E, 1.5 mg vitamin K (as menadione), 1 mg thiamine, 4 mg ribofilavin, 2 mg pyridoxine, 12 mg pantothenic acid (as d-calcium pantothenate), 20 mg niacin, 0.1 mg biotin, 0.6 mg folic acid, 550 mg choline, 0.02 mg vitamin B_{12}, 25 mg Mn, 60 mg Fe, 60 mg Zn, 15 mg Cu, 0.2 mg I, and 0.25 mg Se.

[2] Calculated value.

and gross energy was measured with an adiabetic bomb calorimeter (Model 1261, Parr Instrument Co., Molin, IL). Chromium was measured with a spectrophotometer (Kontron 942, Italy). Minerals were analyzed with an atomic absorption spectrophotometer (Model Spectr AA. arian). Following acid hydrolysis in 6N HCl at 105℃ for 24 hours, amino acid concentrations were determined, using an HPLC (Waters, 486). Data were analyzed using the General Linear Model (GLM) Procedure of SAS (1985). The statistical model was that appropriate for a randomized complete block design.

RESULTS AND DISCUSSION

Chemical composition and nutrient digestibility in DFW

The chemical compositions of DFW are presented in tables 2 and 3. Collected wet food wastes contained 60-80% of moisture as reported by Myer et al. (1999), who demonstrated that restaurant food wastes typically contain 60-75% moisture. After drying (dry matter basis), it was regarded as a moderately high energy (2,858 kcal DE/kg) and high crude protein (25%) feedstuff. Ether extract, crude ash and sodium chloride were very high (17.3, 18.07 and 3.28%, respectively). As compared to crude protein content, the limiting amino acids (i.e., lysine and methionine) were extremely low.

The nutrient levels in DFW are not in agreement with the report of Myer et al. (1999) who observed 18-20% crude protein, 24-26% crude fat, 5-6% ash, 0.5-0.8% Ca and 0.3-0.8% P, but salt content was also high (2.0-2.5%) in their study. The differences in nutrient contents might be attributed to different diet patterns between the two countries.

The nutrient contents of DFW were compared to those of corn-soybean mix (ratio of 6:4) on the same level of crude protein (25% as DM basis) in table 2. DE and most essential amino acid contents were much lower in DFW than in the corn-soybean meal mix., but calcium, phosphorus and NaCl were higher in DFW.

The DFWs collected in Chunchon area in Korea showed a great variation in chemical compositions (table 3). In case of crude protein, the range was 11.58-26.46% (50.18% CV). Great variation in chemical composition and nutritive values in food wastes were reported by several researchers (Kornegay et al., 1965; Soliman et al., 1978; Lipstein, 1984). Pond and Maner (1984) stated that the variation in nutrient contents is one of the problems with feeding food wastes.

The digestibilities of energy, ash, calcium and phosphorus in DFW were generally lower than those in the grower diet. The digestibilities of crude protein and crude fat were higher in DFW than the grower diet (table 4). This agrees with the report of Westendorf and Dong (1997), who reported that the protein digestibility was higher in the food waste diet than the corn-soybean meal diet (88.2 vs 84.3%). Like chemical composition, there were significant (p<0.05) differences in digestibilities of energy and ether extract among the DFW.

Table 2. Comparative chemical composition of dried food waste and corn-soybean meal mix (DM basis)

Nutrient	Corn-soybean meal[1]	DFW (n=3)
Digestible energy (kcal/kg)	3,944	2,858±7.96[2]
Crude protein (%)	25.00	25.00±0.21
Crude fat (%)	3.30	17.30±2.89
Crude ash (%)	3.51	18.07±0.23
Amino acid (%)		
Arginine	1.70	1.27±0.25
Cystine	0.44	0.46±0.14
Histidine	0.68	1.06±0.36
Isoleucine	1.08	0.56±0.11
Leucine	2.20	1.00±0.26
Lysine	1.45	0.90±0.23
Methionine	0.39	0.29±0.10
Phenylalanine	1.24	0.52±0.04
Threonine	0.97	0.68±0.13
Valine	1.17	0.87±0.18
Minerals		
Ca (%)	0.16	1.37±0.26
P (%)	0.48	1.28±0.15
NaCl (%)	0.02	3.28±0.11
K (%)	0.65	0.54±0.21
Mg (%)	0.20	0.20±0.09
Fe (mg/kg)	110.34	315±0.42
Zn (mg/kg)	34.61	66.30±0.93
Cu (mg/kg)	17.75	15.80±0.14

[1] Data (NRC, 1998) are calculated with the mixture of corn and soybean meal (60%:40%) to make the isoprotein level with dried food waste.

[2] Calculated by the equation of Noblet and Perez (1993).

Growth performance

In Exp. 1, feeding DFW to growing pigs had a linear (p<0.01) effect on ADG and feed/gain (table 5), with significantly (p<0.01) decreased ADG and feed/gain when DFW was added up to 40% in the diet. There was no difference in daily feed intake among treatments. In Exp. 2, the ADG and feed intake were significantly (p<0.01) lower in 40% DFW group than in control group. The ADG of pigs fed 40% DFW was also lower than those fed 20% DFW.

These data are similar to the report of Yang (1999), who reported that feeding DFW had no

Table 3. Variations in chemical compositions of dried food wastes by month (as fed basis after drying)[1]

Item	Month (1999)					CV (%)
	May	June	July	August	September	
Moisture (%)	6.41	7.32	9.39	6.73	7.12	15.82
Gross energy (kcal/kg)	4,624	4,570	4,581	4,616	4,628	0.58
Crude protein (%)	26.46	13.32	11.58	11.32	21.13	50.18
Crude fat (%)	12.32	11.27	10.93	8.92	10.32	11.67
Crude fiber (%)	5.53	6.27	7.82	8.93	6.12	20.20
Crude ash (%)	18.73	17.56	19.34	17.12	8.32	27.76
NFE (%)	30.55	44.28	46.94	46.98	46.99	16.54

[1] Samples were collected from batches collected at apartment complexes.

Table 4. Nutrient digestibility of dried food wastes in growing pigs

Item	Grower diet[1]	Dried food waste[2]			
		A	B	C	Mean
Dry matter (%)	64.80	57.99[a]	58.71[a]	54.31[b]	57.00± 2.33
Gross energy (%)	65.85	59.65[ab]	61.89[a]	55.87[b]	59.14± 4.17
Crude protein (%)	67.64	71.62	71.78	68.74	70.71± 3.54
Crude fat (%)	67.40	79.11[a]	67.52[b]	80.69[b]	75.77± 7.47
Crude ash (%)	51.30	39.20	34.19	28.71	34.03±14.94
Ca (%)	63.33	65.07	60.25	54.35	59.89±25.65
P (%)	61.72	40.39	41.78	34.71	38.96±12.04

[1] The experimental diet used in Exp. 2.

[2] A, B and C are samples obtained from different batches during drying.

[a,b] Means with the same letter are not significantly different ($p<0.05$).

Table 5. Effects of feeding dried food waste on growth and carcass characteristics in growing-finishing pigs

	Dried food waste (%)			SE
	0	20	40	
Exp. 1				
Growth performance				
ADG (g/d)[1]	775[a]	759[a]	606[b]	93.35
ADFI (g/d)	2,269	2,298	2,491	195.97
F/G[1]	2.93[b]	3.04[b]	4.18[a]	0.91
Exp. 2				
Growth performance				
ADG (g/d)	789[a]	781[ab]	600[b]	108.12
ADFI (g/d)	3,149[a]	2.931[ab]	2,827[b]	0.15
F/G	3.99	3.75	4.71	0.58
Carcass characteristics				
Backfat thickness (last rib, cm)	2.63	3.13	3.15	0.46
Dressing percentage	72.80	69.71	70.51	2.87

[1] Linear effect ($p<0.01$).

[a,b] Means with the same letter are not significantly different ($p<0.01$).

adverse effect on ADG in growing pigs, but feed/gain was affected when 30% or more of the diet. In the present study, the optimal inclusion level of DFW seems to be less than 20% in the growing-finishing pigs in terms of growth performance. This is a little lower level than that suggested by Bryhni et al. (1999), who concluded that the optimal dietary inclusion level of food waste product was in the range of 20-50% in the diet. Myer et al. (1999) also reported that the ADG and gain:feed of the finishing pigs were not affected by the inclusion of the DFW product at 25-50% dried food waste. It seems that the optimal inclusion level of food waste in pig diets depends on its quality, processing and feeding methods.

Carcass characteristics in terms of backfat and dressing percentage were not affected by dietary treatments. This is agreement with Bryhni et al. (1999) and Myer et al. (1999). However, it is reported that dietary food waste gave a reduction in carcass fat firmness due to a high level of polyunsaturated fatty acids in the fat of food wastes (Bryhni et al., 1999; Myer et al., 1999). So, attention should be given to the addition level of food wastes in order to produce quality pork.

IMPLICATIONS

Dried food waste has a potential value as a feed ingredient for growing-finishing pigs. In terms of growth performance, the optimal dietary addition level of dried food waste was less than 20% in the diet.

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