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Effects of Dietary Energy Intake Levels on Growth Performance and Body Composition of Finishing Barrows and Gilts

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ABSTRACT : This study was conducted to investigate the effects of different energy intake on physical and chemical composition in body fractions, growth performance and meat characteristics of finishing barrows and gilts. A total of twenty six crossbred (Landrace× Yorkshire) consisting of 16 barrows and 13 gilts were used in this study. The animals were allocated by sex to two treatments to form a 2×2 factorial arrangement. The respective factors were sex (barrow and gilt) and dietary energy intake (1.8 and 3.0 times energy for maintenance). Pigs were kept in individual pens and had *ad libitum* access to feed and water from the start of the experiment at 52.4±1.9 kg until they reached 109.9±4.4 kg live weight. The growth performance, physical composition and meat characteristics of finishing pigs were not greatly affected by the sex. However, higher fat tissue weight in the carcass was observed in barrows compared with gilts ($p<0.05$). Higher proportions of water and protein ($p<0.05$), and lower lipid proportion ($p<0.01$) in the empty body and carcass were observed in gilts compared with barrows, while protein proportion in lean tissue was not affected by the sex. In fat tissue, only protein proportion was higher in gilts compared with barrows ($p<0.05$). Although, growth performance, physical and chemical compositions in body fractions were greatly affected, final body or carcass weight was partly affected by the energy intake In addition, loin characteristics such as shear force and loin eye area were partly influenced by energy intake levels. Therefore, the present results showed that growth performance and meat characteristics were not influenced but chemical body composition was greatly influenced by the sex. Growth performance, physical and chemical compositions in body fractions were greatly affected, whereas meat characteristics were partly affected by the energy intake levels. (**Key Words :** Energy Intake, Growth Performance, Body Composition, Finishing Barrows and Gilts)

INTRODUCTION

Numerous factors may affect body composition and growth potential. The relationship between energy intake and body composition is influenced by various factors, including pig genotype (Gu et al., 1992; Quiniou et al., 1995), sex (Bereskin and Davey, 1978), nutrition (Davey and Bereskin, 1978; Bikker, 1994), and environment (Stahly et al., 1979; Black et al., 1995). The growth potential of pigs is mainly controlled by genotype and sex among the factors (Quiniou et al., 1999). As result of the sex and growth rate in relation to carcass leanness and fat deposition, fast growing pigs had thicker fat on the shoulder compared to slow growing ones and gilts had thinner fat cover over the ham than barrows (Correa et al., 2006). In addition, increase of energy intake would result in increase of lean gain in barrows and gilts, whereas the increase of fat gain would be higher in barrows (Davis et al., 1980). Accretion of carcass lean and fat tissue is of primary interest because the quantity and ratio of these two components determine the economic value of the animal (Akridge et al., 1992).

Therefore, the objective of this study was to investigate the effects of different energy intake levels on physical and chemical composition in body fractions, growth performance, and meat characteristics in finishing barrows and gilts.

MATERIALS AND METHODS

Animals and treatments

A total of twenty six crossbred (Landrace×Yorkshire) consisting of 16 barrows and 16 gilts in this study. Pigs were housed in a pen size of 3×2 m, and kept in environmentally controlled rooms (minimum 22°C). Pigs were allocated with sex to two treatments to form a 2×2

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Table 1. Ingredients and chemical composition of the diet

Item	Basal diet
Ingredient (%)	
Corn	79.99
Soybean meal, 44%	16.67
L-lysine	0.25
Biotin	0.10
Limestone	0.96
Calcium phosphate	0.80
Soy oil	0.63
Vitamin-mineral mixture[1]	0.25
NaCl	0.25
Antibiotics	0.10
Chemical composition (%)	
Dry matter	87.15
Crude protein	13.41
Ether extract	3.86
Crude ash	3.69
Lysine	0.77
Methionine	0.22
Calcium	0.69
Phosphorus	0.44

[1] Provided the following per kilogram of diet: vitamin A 5,500 IU, vitamin D_3 550 IU, vitamin E 27 IU, menadione sodium bisulfate 2.5 mg, pantothenic acid 27 mg, niacin 33 mg, riboflavin 5.5 mg, vitamin B_{12} 0.04 mg, thiamin 5 mg, pyridoxine 3 mg, biotin 0.24 mg, folic acid 1.5 mg, choline chloride 700 mg, selenium 0.15 mg, manganese 0.03 g, zinc 0.1 g, iron 0.1 g, iodine 0.5 mg, magnesium 0.1 g.

factorial arrangement. The respective factors were sex (barrow and gilt) and dietary energy intake (1.8 and 3.0 times energy for maintenance).

Pigs were kept in individual pens and had *ad libitum* access to feed and water from the start of the experiment at 52.4±1.9 kg until they reached 111.1±4.4 kg live weight. One experimental diet (Table 1) was used for all treatment groups. Live weight and feed intake were determined twice a week.

Management at slaughter and analysis

The pigs were killed by electrical stunning and exsanguinations at a live weight of 111.1±4.37 kg. Body components were collected and stored as described by Bikker et al. (1995). The bodies were dissected into eviscerated carcass and organs. The organ fraction comprised the blood and all organs, including mesenteric fat. Empty body excluded gastrointestinal tract contents, and carcass excluded head, feet, tail, gastrointestinal tracts, blood, skin and all organs. Carcass was dissected into trimmed major joints (referred to as lean fraction) and other carcass parts (referred to as fat fraction). The lean fraction comprised the ham, shoulder and loin, all without subcutaneous fat, and meat scraps. The lean fraction was expressed as proportion in the carcass. The fat fraction comprised all other carcass parts and consisted mainly of backfat, belly fat, other fat depots, head, feet, and tail (Bikker et al., 1995). Meat quality was measured by the described method of Hwang et al. (2004). Water, nitrogen, lipid, and ash contents in samples were determined by the method of AOAC (1990). All data were analyzed by ANOVA using the GLM procedure of SAS (1999) to identify sex, energy intake and their interaction effects.

RESULTS AND DISCUSSION

Growth performance

As shown in Table 2, growth performance such as initial and final body weight, feed intake and daily body weight gain were not significantly different between gilts and barrows. However, Piao et al. (2004) reported that barrows grew faster and had higher feed intake than gilts. The difference between the present study and the previous study may be due to the differential factor of slaughter weight of the experimental pigs (approximately, 111 kg vs. 87 kg).

While, 3.0 times energy for maintenance (3.0 M) treatment had significantly higher feed intake, daily body weight gain and feed:gain ratio (p<0.001) compared with 1.8 times energy for maintenance (1.8 M) treatment which in agreement with observation of Bikker et al. (1995 and 1996). The better growth of 3.0 M treatment compared with 1.8 M treatment was due to the greater feed intake, whereas poorer feed efficiency was due to their higher fat amount in their body. There was no sex and energy intake interaction effect on growth performance.

Physical composition

Final and empty body weight, carcass weight, and weights of bone and lean tissue in carcass were not significantly different between gilts and barrows (Table 3). However, weight of fat tissue in carcass was significantly

Table 2. Effects of dietary energy intake and sex on growth performance of finishing pigs

	Gilt		Barrow		SEM	Significance[1]		
	1.8 M	3.0 M	1.8 M	3.0 M		S	E	S×E
Initial body wt (kg)	50.6	52.0	53.9	53.0	1.87	NS	NS	NS
Final body wt (kg)	110.9	111.2	110.6	111.5	4.37	NS	NS	NS
Feed intake (kg/d)	1.38	2.43	1.40	2.48	0.06	NS	***	NS
Body wt gain (kg/d)	0.26	0.71	0.22	0.70	0.03	NS	***	NS
Feed:gain	0.18	0.29	0.15	0.28	0.08	NS	***	NS

[1] In this and all other tables S = Sex effect, E = Energy effect, S×E = Interaction effect between sex and energy intake, and NS, *, ** and *** refer to significance levels p>0.05, p<0.05, p<0.01 and p<0.001, respectively.

Table 3. Effects of dietary energy intake and sex on physical body composition in body fractions of finishing pigs

Item (kg)	Gilt		Barrow		SEM	Significance		
	1.8 M	3.0 M	1.8 M	3.0 M		S	E	S×E
Final body (wt)	110.9	111.2	110.6	111.5	4.37	NS	NS	NS
Body fraction								
Empty body (wt)	96.4	101.9	94.3	102.2	4.18	NS	NS	NS
Carcass (wt)	75.3	80.6	72.8	81.5	3.12	NS	*	NS
Carcass composition								
Bone (wt)	12.3	10.1	12.8	10.4	0.66	NS	**	NS
Lean tissue (wt)	52.5	54.2	48.8	49.0	2.38	NS	NS	NS
Fat tissue (wt)	10.5	16.3	11.3	22.2	1.13	*	***	NS

higher in barrows compared with gilts ($p<0.05$) which agrees with Friesen et al. (1994).

Similar to results of Cho et al. (2006), carcass weight was decreased as energy intake decrease ($p<0.05$). While, energy intake did not affect final and empty body weight, and weight of lean tissue in carcass between 1.8 M and 3.0 M treatments. Unlike to the previous results, the efficiency of lean tissue gain decreased with increasing energy intake (Kanis, 1988; Bikker et al., 1995). This could be explained by Ellis et al. (1983), who reported an increase in gain:feed ratio with increasing feed intake, whereas lean tissue proportion and efficiency was constant or tended to decrease. The weight of bone in carcass was lower in 3.0 M treatment, but that of fat tissue in carcass was higher in 3.0 M treatment compared with 1.8 M treatment ($p<0.01$ and $p<0.001$, respectively). There was no sex and energy intake interaction effect on final body weight, body fraction and physical carcass composition.

Quiniou et al. (1996) suggested that composition of body weight gain, especially its high fat content, induces an increased body fatness when energy supply increase. Therefore, energy intake could be considered to be the main factor developing adipose fat tissue and conditioning whole body lipogenesis. Also, the present results indicating that the increased gain was largely the result of an increase in gut, bone and fat contents is consistent with findings by others (de Greef, 1992; Bikker, 1994; Quiniou et al., 1995; Correa et al., 2006).

Chemical composition

The proportions of water and protein in empty body and carcass were higher ($p<0.05$), but lipid proportion and energy deposition were lower ($p<0.05$ and $p<0.01$, respectively) in gilts compared with barrows (Table 4).

Table 4. Effects of dietary energy intake and sex on final body fraction and muscle chemical composition of pigs

	Gilt		Barrow		SEM	Significance		
	1.8 M	3.0 M	1.8 M	3.0 M		S	E	S×E
Empty body (%)								
Water	67.8	59.2	65.5	55.6	1.26	*	***	NS
Protein	16.8	17.9	14.9	16.0	0.73	*	NS	NS
Lipid	8.6	20.1	10.6	25.9	1.09	**	***	NS
Ash	3.3	2.9	3.2	2.6	0.23	NS	NS	NS
Energy (kcal)	1,717	2,892	1,802	3,353	115.0	*	***	NS
Carcass (%)								
Water	67.2	56.3	64.5	51.5	1.34	*	***	NS
Protein	16.8	18.2	14.9	16.9	0.64	*	*	NS
Lipid	8.9	22.9	10.7	29.3	1.05	**	***	NS
Ash	2.4	2.7	2.2	2.3	0.22	NS	NS	NS
Energy (kcal)	1,737	3,092	1,787	3,540	129.7	NS	***	NS
Lean tissue (%)								
Water	74.0	66.8	71.9	65.0	0.65	*	***	NS
Protein	22.0	19.7	20.2	18.5	0.84	NS	*	NS
Lipid	5.7	12.5	7.8	15.5	0.74	**	***	NS
Ash	1.2	1.0	1.0	1.0	0.04	NS	NS	NS
Energy (kcal)	1,740	2,235	1,803	2,471	86.60	NS	***	NS
Fat tissue (%)								
Water	47.8	18.2	42.3	16.8	3.60	NS	***	NS
Protein	19.7	12.4	13.3	10.1	1.58	*	*	NS
Lipid	34.2	69.1	43.2	72.8	5.15	NS	***	NS
Ash	0.4	0.3	0.4	0.3	0.03	NS	*	NS
Energy (kcal)	4,359	7,847	5,390	8,113	409.0	NS	***	NS

Table 5. Effects of dietary energy intake and sex on loin characteristics in finishing pigs

	Gilt		Barrow		SEM	Significance		
	1.8 M	3.0 M	1.8 M	3.0 M		S	E	S×E
Meat color[1]								
CIE L*	52.47	52.02	51.35	51.36	1.21	NS	NS	NS
CIE a*	9.66	8.22	8.30	8.28	0.38	NS	NS	NS
CIE b*	4.80	4.22	4.95	4.42	0.71	NS	NS	NS
Shear force (kg)	4.15	3.15	3.72	3.10	0.15	NS	***	NS
Cooking loss (%)	32.60	32.56	32.02	33.10	0.78	NS	NS	NS
Water holing capacity (%)	55.29	54.88	56.47	55.21	0.93	NS	NS	NS
pH	5.58	5.54	5.58	5.52	0.03	NS	NS	NS
Loin eye area (cm^2)	57.23	49.70	49.05	39.70	3.03	*	*	NS

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

While ash proportion in empty body and carcass was not significantly different between gilts and barrows. In lean tissue, water proportion was higher (p<0.05), but that of lipid was lower (p<0.01) in gilts compared with barrows. Similarly, intramuscular fat amount was higher in barrows than in gilts (Ellis et al., 1996; Correa et al., 2006). The proportions of protein and ash in lean tissue were not significantly different between gilts and barrows. Energy deposition in carcass and lean tissue was not significantly different between gilts and barrows, but it is higher (p<0.05) in barrows compared with gilts. The proportions of water, lipid and ash, and energy deposition in fat tissue were not significantly different between gilts and barrows. However, protein proportion in fat tissue was higher (p<0.05) in gilts compared with barrows. No sex and energy intake interaction effect on chemical composition and energy deposition in empty body, carcass and lean tissue was founded.

In empty body, water proportion was lower (p<0.001), but lipid proportion and energy deposition were higher (p<0.001) in 3.0 M treatment compared with 1.8 M treatment. Protein and ash proportions in empty body were not significantly different between the two treatments. While the proportions of protein and lipid was higher (p<0.05 and p<0.001, respectively), but that of water in carcass was lower (p<0.001) in 3.0 M treatment compared with 1.8 M treatment. In lean tissue, the proportions of lipid was higher (p<0.001), but those of water and protein was lower (p<0.001 and p<0.05, respectively) in 3.0 M treatment in comparison to 1.8 M treatment. Bikker et al. (1996) explained the proportion protein in the lean tissue decreased with increasing energy intake imply that maximization of protein deposition is accompanied by d deterioration in body composition. The ash proportion in carcass and lean tissue was not significantly different between the two treatments. As expected, energy deposition in empty body, carcass and lean tissue was significantly higher (p<0.001) in 3.0 M treatment compared with 1.8M treatment. In fat tissue, the proportion of lipid and energy deposition were higher (p<0.001), but those of water, protein and ash were lower (p<0.001, p<0.05 and p<0.05, respectively) in 3.0 M treatment compared with 1.8 M treatment. There was no sex and energy intake interaction effect on chemical composition and energy deposition in empty body, carcass, lean and fat tissue. The present results showing protein and lipid deposition in empty body and carcass increased with increasing energy intake which agrees with the results of Bikker et al. (1995 and 1996).

Meat characteristics

Sex did not affect meat color, shear value, cooking loss, water holding capacity and pH (Table 5). Similarly, previous studies also reported that shear force, cooking loss and pH are not affected by sex (Cisneros et al., 1996; Weatherup et al., 1998; Hamilton et al., 2000). In addition, Lee et al. (2005) reported color and pH of longissimus dorsi muscle were not affected by the sex. While loin eye area is higher in gilts compared with barrows (p<0.05), which similarly agrees with Leach et al. (1996) and Unruh et al. (1996).

Meat color, cooking loss, water holding capacity, and pH were not affected by energy intake levels. However, shear force was lower in 3.0 M treatment compared with 1.8 M treatment (p<0.001) reflecting that 1.8 M treatment had higher loin eye area was compared with 3.0 M treatment (p<0.05). The present results may indicate that higher fat is preferentially deposited in the carcass through higher energy intake. There was no sex and energy intake interaction effect on meat characteristics.

CONCLUSION

The present results showing that growth performance, physical body composition and meat characteristics of finishing pigs were not greatly affected by the sex. While chemical body composition was partially affected by the sex. Also, meat quality was not largely influenced by the sex. Although, growth performance, physical and chemical compositions in body fractions were greatly affected, final body or carcass weight was partly affected by the energy intake levels, and the feed efficiency is beneficially low in 1.8M treatment. In addition, meat characteristics were partly affected, such as loin eye area, by the different energy intake levels between 1.8 and 3.0 times energy for maintenance. Therefore, it may suggest that energy intake level for barrow or gilts could be economically reduced from 3.0 to 1.8 times energy for maintenance based on the present results.

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