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UNSATURATED TO SATURATED FATTY ACIDS RATIO ADJUSTMENTIN DIETS ON DIGESTIBILITY AND PERFORMANCE OF GROWING PIGS

SUMMARY

Fat and oils are the most concentrated energy source for pigs. Various fat sources differ considerably in their physical-chemical characteristics and fatty acid profile. Therefore, the current study aimed to evaluate the effect of diets containing 3% fat with different ratios of unsaturated to saturated fatty acids (U:S) on the nutrient digestibility, energy utilization and growth performance of growing pigs. In experiment 1, a total of 6 crossbred, castrated male pigs (Duroc × Large White × Landrace) were used to determine the nutrient digestibility and energy utilization according to a repeated 3 × 3 Latin square design. Each of the two pigs was fed with one of the three diets containing 3% fat with a U:S ratio of 3, 4 or 5, respectively. No differences ($P>0.05$) in the nutrient digestibility were observed among groups, but the highest digestible and metabolizable energy ($P<0.05$) appeared in pigs receiving the dietary U:S ratio of 4. In experiment 2, a total of 30 pigs (with an equal number of entire males and females) were allotted into 3 groups in a randomized complete block design. Pigs were fed a diet without fat (T1), or the diets containing 3% fat with U:S ratio of 4 (T2) or 5 (T3), respectively.

Although there were no significant difference in any growth criteria, average daily gain and feed conversion ratio was slightly improved ($P>0.05$) in the T2 group. In conclusion, the present results suggest that diets containing 3% fat with a U:S ratio of 4 is optimal for improving energy utilization in growing pigs and results in a slight enhancement of performance.

Keywords: *Digestibility, Energy utilization, Fatty acids profile, Growing pigs, Growth performance*

INTRODUCTION

Fats and oils are the most concentrated energy source for livestock animals, and their inclusion in the diet is a common practice in modern animal production to increase energy density. Park et al. (2012) noted that dietary fat plays a considerable role in the development of growing-finishing pigs because

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of its high energy content. Moreover, it is recommended for use in growing-finishing pigs being reared under environmental heat stress due to a lower heat increment than other feedstuff (Spencer et al., 2005). Jung et al. (2003) found that the replacement of animal fat with vegetable oil rich in unsaturated fatty acids, such as soybean oil or corn oil, resulted in an improved growth performance in weaning pigs. Results from the poultry model reported that an optimal combination of vegetable oil and animal fat sources in broiler diets enhanced growth performance and carcass traits (Poorghasemi et al., 2013).

On the other hand, some reports described that vegetable oil (expressed as unsaturated fatty acids) or animal fat (representing extremes of saturated fatty acids) did not affect the fat digestibility of pigs (Jørgensen and Fernández, 2000; Kil et al., 2011). Recently, Tartrakoon et al. (2016) published that a different dietary U:S ratio greatly affect the performance and meat quality of finishing pigs. Gatlin et al. (2005) also reported that the apparent digestibility of dietary fat in finishing swine was improved with increasing values of the U:S ratio. This seems to suggest that unsaturated lipids may be more easily digested than saturated lipids (Scheeder et al., 2003). To our knowledge, there is limited data contributing to an understanding of the most optimal dietary U:S ratio for use in swine nutrition and production.

Therefore, the present trial was conducted to evaluate the effect of diets containing 3% fat with different U:S ratios on the nutrient digestibility, energy utilization and growth performance of growing pigs. These different U:S ratios in diets were adjusted by a combination of poultry fat and soybean oil.

MATERIALS AND METHODS

In experiment 1, a total of 6 crossbred, castrated male pigs (Duroc × Large White × Landrace) was used to determine nutrient digestibility and energy utilization according to a repeated 3 × 3 Latin square design. Each of two pigs was fed with one of the three diets containing 3% fat with U:S ratio of 3 (T1), 4 (T2) or 5 (T3), respectively (Table1).

Additionally, all diets contained 0.5% titanium dioxide as an indigestible marker to calculate the apparent total tract digestibility of nutrients and energy value. Feed was limitedly provided for 2.5 times the metabolizable energy (ME) requirements for maintenance (Kraler et al., 2014). Feces were collected daily, weighed and stored immediately in a -20°C freezer to prevent microbial activity until further processing. All samples of experimental diets and feces were prepared for analyses by drying in a hot air oven at 60 ºC for 72 h.

Feed and fecal samples were finely ground through a 1-mm mesh screen using an electric blender. Titanium dioxide was analyzed in the diet and feces according to Myers et al. (2004) with a minor modification. Dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE) and ash in the feces and diet samples were analyzed according to the standard methods of AOAC (2000). The gross energy of the diets and feces was determined through bomb-calorimeter.

Table 1. Ingredients and chemical composition of the experimental diets

	Experiment 1			Experiment 2		
Item	T1	T2	T3	T1	T2	T3
Ingredients (g/kg as fed basis)						
Corn	480	480	480	626	480	480
Rice bran	180	180	180	50	180	180
Soybean meal	285	285	285	299	285	285
Poultry fat	23	9	0	0	9	0
Soybean oil	7	21	30	0	21	30
Di-calcium phosphate	14	14	14	14	14	14
$CaCO_3$	5	5	5	5	5	5
$NaCl_2$	3.5	3.5	3.5	3.5	3.5	3.5
Vitamin and mineral premix[1]	2.5	2.5	2.5	2.5	2.5	2.5
Analytical composition (g/kg DM basis)						
Gross energy (kcal/kg) 3823		4004	3786	3760	3848	3851
Crude protein	185.6	185.8	185.9	180.5	185.8	185.9
Ether extract	33.8	34.1	33.7	5.3	34.1	33.7
Calculated composition (g/kg DM basis)						
Metabolizableenergy(kcal/kg)	3307	3310	3312	3234	3310	3312
Lysine	10.3	10.3	10.3	10.4	10.3	10.3
Methionine+cystine	6.4	6.4	6.4	6.4	6.4	6.4
Tryptophan	4.9	4.9	4.9	5.6	4.9	4.9
Threonine	7.2	7.2	7.2	7.2	7.2	7.2
Total unsaturated fatty acids (U)	35.7	37.9	39.4	14.7	37.9	39.4
Total saturated fatty acids (S)	11.6	9.4	7.9	3.6	9.4	7.9
U:S ratios	3.08	4.03	4.99	4.08	4.03	4.99

[1]Vitamin and mineral premix provided per kilogram of diet: 450 mg Fe; 400 mg Cu; 250 mg Zn; 150 mg Mn; 0.5 mg I; 0.25 mg Se; 8,000 IU vitamin A; 2,000 vitamin D_3; 37.5 mg vitamin E; 0.925 mg vitamin K-3; 8.43 mg vitamin B_2; 0.04 mg vitamin $B_{12;}$ 34.5 mg nicotinic acid; 26 mg pantothenic acid.

The apparent total tract digestibility of DM, CP, CF, EE, ash, and DE contents were calculated according to Chen et al. (2013). ME was calculated using the equation according to NRC (1998) as shown in following: ME = DE × [1.012-(0.0019 × %CP)]. In experiment 2, a total of 30 pigs (with an equal number of entire males and females) were allotted into 3 groups in a randomized complete block design. Pigs were fed a diet without fat (T1), or diets containing 3% fat with a U:S ratio of 4 (T2) or 5 (T3), respectively. All pigs used in the current experiment were selected based on BW (initial 20 kg) during the pre-experimental period. They were housed in individual pens (1.0 m × 0.75 m) and provided feed and water ad libitum; the room had negative pressure ventilation with an evaporative cooling system. Animal management and care was performed by trained researchers under Naresuan University's Animal Care and Use Committee (NUACUC). Statistically, all data were subjected to statistical

analysis by one-way analysis of variance (ANOVA) followed by Duncan's least-significance multiple range test. Differences between means were considered to be significant at P<0.05.

RESULTS AND DISCUSSION

Data on the apparent total tract digestibility of the nutrient and energy values of growing pigs fed diets containing 3% fat with different U:S ratios is presented in Table 2.

Table 2. Apparent total tract digestibility of nutrient and energy value of growing pig fed diets containing 3% fat with different U:S ratios

Item	Apparent total tract digestibility (%)					Energy value	
	DM	CP	CF	EE	Ash	DE[2]	ME[3]
Treatment[1]							
T1	89.50	92.72	70.46	90.21	79.4	3,365[b]	3,352[b]
T2	89.62	92.69	68.73	90.30	79.54	3,604[a]	3,587[a]
T3	89.64	92.39	69.03	88.19	79.20	3,332[b]	3,318[c]
SEM[4]	0.37	0.25	1.11	0.74	0.41	36.07	32.33
P-value	0.99	0.86	0.81	0 .45	0.89	0.01	0.01

Growing pigs were fed with the diets containing 3% fat with a U:S ratio of 3 (T1), 4 (T2) or 5 (T3), respectively. [2]Digestible Energy (kcal/kg); [3]Metabolizable Energy(kcal/kg); [4]Standard error of the means;[a-c] Means within a column having dissimilar superscripts are significantly different (P<0.05).

No differences (P>0.05) in the apparent total tract digestibility of DM, CP,CF, EE and ash were observed among groups, but the highest DE and ME (P<0.05) appeared in pigs receiving the dietary fat at a U:S ratio of 4. Increasing the level of tallow from 3 to 6% decreased the apparent total tract digestibility of GE in pigs (Kellner et al., 2014). This finding seems to suggest that the lower digestibility might be due to the higher saturated fatty acids in the tallow, suggesting that an optimal U:S ratio in dietary fat could be an important consideration. Similarly, Powles et al. (1993) reported that DE content improved exponentially as a function of the U:S ratio. Gatlin et al. (2005) also reported that the apparent digestibility of dietary fat in finishing swine improved with increasing values of the U:S ratio. This seems to suggest that unsaturated lipid may be easier to digest than saturated lipids (Scheeder et al., 2003). Conversely, previous papers described that vegetable oil (expressed as unsaturated fatty acids) or animal fat (representing extremes of saturated fatty acids) did not affect the fat digestibility in pigs (Jørgensen and Fernández, 2000; Kil et al., 2011). The results on the growth performance of growing pigs fed a diet without fat or a diet containing 3% fat with different U:S ratios are shown in Table 3.

All experimental animals remained in good health throughout the study, with no mortalities. No correlations (P>0.05) between the diets and the sexes in regard to growth performance of the growing pigs was found.

Table 3.Growth performance of growing pigs fed a diet without fat or a diet containing 3% fat with different U:S ratios

Item	Experimental group[1]				Sex		
	T1	T2	T3	SEM[2]	Barrows	Gilts	SEM[2]
Period of trial, d	50.50	47.20	49.30	0.67	48.21	49.57	0.67
Average daily feed intake, kg/d	1.49	1.48	1.46	0.02	1.51	1.44	0.02
Average daily gain, kg/d	0.60	0.63	0.62	0.01	0.63	0.61	0.01
Feed conversion ratio	2.49	2.35	2.38	0.04	2.43	2.37	0.04
Feed cost/kg of weight gain, Baht	32.70	31.77	32.96	0.48	32.82	32.10	0.48

[1]Growing pigs were fed a diet without a fat source (T1), or the diets containing 3% fat with a U:S ratio of 4 (T2) or 5 (T3), respectively.
[2]Standard error of the means.

Although there were no significant differences in any growth criteria, average daily gain and feed conversion ratio slightly improved ($P>0.05$) in the T2 group. However, Jung et al. (2003) noted that the replacement of animal fat with vegetable oil, such as soybean oil or corn oil (with an increased value of the U:S ratio), resulted in an improved growth performance in weaning pigs. Tartrakoon et al. (2016) also reported that a dietary U:S ratio of 5.0 has the potential to improve the body weight gain and feed conversion ratio of finishing pigs, resulting in a higher quality of pork. According to the current results, improved performance with the highest DE and ME contents ($P<0.05$) occurred in pigs receiving the diet containing 3% fat with a U:S ratio of 4.

CONCLUSIONS

The present results suggest that diets containing 3% fat with a U:S ratio of 4 is optimal for improving the DE and ME contents in growing pigs, resulting in a slight enhancement of growth performance such as average daily gain and feed conversion ratio.

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