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Effect of Replacement of Maize by Animal Fat on Energy Utilization in Pigs

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Abstract—*The experiment was conducted to assess the effect of replacement of maize by different levels of animal fat on energy utilization in Large White Yorkshire (LWY) pigs. Thirty weaned piglets were randomly divided into three groups and were allotted to the three dietary treatments, T1 (control ration as per NRC, 1998), T2 (50 per cent of maize of control ration replaced by animal fat) and T3 (100 per cent of maize of control ration replaced by animal fat). Digestibility trial was conducted following total collection method and gross energy was estimated using bomb calorimeter. Gross energy of feed and faeces were 4144.68, 4173.92, 4249.99 and 4102.04, 3834.24, 3453.09 kcal/kg, respectively for T1, T2 and T3 treatments. The gross energy converted as digestible energy was 85.85, 74.37 and 66.78 per cent and the calculated digestible energy of feed was 3558.12, 3104.22 and 2837.90 kcal/kg, respectively for three treatments. The result of this experiment revealed that as the level of replacement of maize by animal fat increases, the efficiency of energy utilization was reduced in pigs fed isocaloric and isonitrogenous diet.*

Keywords*: Maize, Animal fat, Pigs, Energy.*

1. INTRODUCTION

Maize forms the major source of energy in the swine feed. Even though, India produces more than 20 million MT of maize per year, it could meet only 60 per cent of the requirement in the country. The lower availability coupled with increasing price of maize, necessitates an alternative energy source for incorporation in the swine feed. Animal fat is a byproduct of meat industry and can be included as a source of energy in swine ration. India produces 0.14 million MT of tallow and 0.02 million MT of lard per year (FAO, 2010). The use of fat as an energy source for pigs has been shown to increase digestibility of nutrients, improve growth rate and also reduces dustiness of feeds and, increases palatability.

Improved dry matter and nitrogen digestibility and nitrogen and energy retention were found in pigs fed diet with tallow at 0.33 and 0.75 per cent of body weight (Galloway and Ewan, 1989), with white choice grease at 10 per cent (Li *et al.*, 1990) and with lard at six per cent of the diet (Lawrence *et al.*, 1994). Overland *et al.* (1994) reported that the apparent ileal and overall digestibility of crude fat and total fatty acids, apparent digestibility of dry matter, nitrogen and calcium and retention of nitrogen and energy were increased in pigs fed diets with six per cent of rendered fat. Reis *et al.* (2000) observed increased apparent digestibility of ether extract and energy in pigs fed diet with eight per cent of tallow compared to that with four per cent tallow. However, studies on the effect of replacing maize by animal fat on energy utilization was not studied much in India, hence this work was carried out in growing Large White Yorkshire piglets.

2. MATERIALS AND METHODS

The experiment was conducted to assess the effect of replacement of maize by different levels of animal fat on energy utilization in growing piglets. Thirty weaned female Large White Yorkshire piglets were randomly divided into three groups with five replicates in each group. Each replicates were allotted with two piglets and housed in a single pen. All piglets were housed in the same shed and were maintained under identical management conditions throughout the experimental period of 70 days. Animals were allowed to consume as much as they could, within a period of one hour and the balance feed was collected and weighed after each feeding. Clean drinking water was provided *ad libitum* in all the pens throughout the experimental period.

The animals were fed with standard grower ration containing 18 per cent of CP and 3265 kcal of ME/kg of feed up to 50 kg body weight and finisher ration with 16 per cent CP and 3265 kcal of ME /kg of feed from 50 kg body weight as per NRC (1998). The three groups of piglets were randomly allotted to the three dietary treatments, T1 (control ration as per NRC, 1998), T2 (50 per cent of maize of control ration replaced by animal fat) and T3 (100 per cent of maize of control ration replaced by animal fat). Ingredient and chemical composition of pig grower and finisher ration were given in the Table 1 and 2. The ration used in this study had similar nutrients as per NRC (1998; 2012) recommendations. The animal fat is a mixture of mainly beef fat (tallow), pig fat (lard) and little of poultry fat, obtained from rendering plant of Meat Technology

Unit, College of Veterinary and Animal Sciences, Mannuthy, freshly as and when the feed was prepared. Digestibility trial was conducted at the end of the experiment following total collection method.

Energy utilization

Gross energy of feed and faeces were estimated using bomb calorimeter (plain jacket calorimeter, model: 1341, Parr instruments co., USA) to determine the energy utilization of pigs fed three experimental rations.

Statistical analysis

Data collected on various parameters were statistically analyzed by Completely Randomized Design (CRD) method and m means were compared by Duncan Multiple Range Test (DMRT) using Statistical Package for Social Studies (SPSS. 17.0.1v) software.

3. RESULTS AND DISCUSSION

Data on energy utilization of pigs under the three experimental rations T1, T2 and T3 are presented in Table 3. Gross energy of feed and faeces were 4144.68, 4173.92, 4249.99 and 4102.04, 3834.24, 3453.09 kcal/kg, respectively for T1, T2 and T3 treatments. The gross energy converted as digestible energy was 85.85, 74.37 and 66.78 per cent and the calculated digestible energy of feed was 3558.12, 3104.22 and 2837.90 kcal/kg, respectively for three treatments.

The control group (T1) had higher ($P<0.01$) DE than T2 and T3 and the lowest DE was recorded in T3. Reddy (2009) opined that an increase in dietary fibre level by one per cent (beyond maximum level) will depress the digestibility of gross energy by about 3.5 per cent. T1 ration had no animal fat whereas T2 and T3 had 7 and 14 per cent animal fat respectively, could be the main reason for lower energy utilization in growing pigs. Also when maize was replaced by different level of animal fat, wheat bran was added to adjust the ration to make isocalorious and isonitrogenous.

The level of wheat bran in T1, T2 and T3 ration were 3.6, 34.7 and 64.9 per cent respectively which could increase crude fibre and acid insoluble ash level from 3.73 and 1.04 per cent (T1 ration-control group) to 6.54 and 4.29 per cent (T2 ration-50 **per cent maize replacement**) and 9.40 and 6.52 per cent (T3 ration-**100 per cent maize replacement**). The increased level of crude fibre and acid insoluble ash in the T2 and T3 ration might **have contributed to the lowered digestibility of energy. Everts *et al*. (1986) observed a reduced digestibility of dry matter, organic matter and crude protein with increased level of crude fibre (11.26 per cent) in the diet of pigs.** Bhar *et al*. (2000) also observed decreased digestibility of dry matter, organic matter, crude fibre, total carbohydrate, nitrogen free extract and energy with increased level of wheat bran (0, 50 and 100 per cent maize replacement) in the diet of crossbred pigs. The digestive tract enlarges to accommodate a larger volume of feed rich in crude fibre and the rate of passage of ingesta increases, resulting in reduction in digestibility of nutrients (Ewan, 2000; Lentle and Janssen, 2008). Blair (2007) stated that in pigs higher the crude fibre level in the diet lower will be the digestibility of protein and energy. Sheikh (2011) observed a significant reduction in digestibility of dry matter, ether extract, crude fibre, NFE and energy in crossbred pigs fed diet containing paddy grain instead of maize.

Lawrence and Maxwell (1983) found that efficiency of use of digestible energy tended to decrease with added choice white grease (0 to 12 per cent). Significant improvement in digestibility of energy as a result of fat supplementation in the diet of pigs was also reported by Li *et al.* (1990) (white choice grease supplemented at 10 per cent), Overland *et al.* (1994) (six per cent of rendered fat) and Reis *et al.* (2000) (eight per cent tallow). However no significant difference in the energy digestibility in pigs by supplementation of tallow at five per cent in the diet was observed by Garry *et al.* (2007) and Huang *et al.* (2010).

4. CONCLUSION

The result of this experiment could be concluded that as the level of replacement of maize by animal fat increases, the efficiency of energy utilization was reduced in pigs fed isocaloric and isonitrogenous diet.

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Table 1: Ingredient composition of pig grower and finisher rations, %

	Grower rations1			Finisher rations1		
Ingredients	T1	T2	T3	T1	T2	T3
Yellow maize	70	35	0	74	37	0
Wheat bran	1.5	31	59.8	3.6	34.7	64.9
Soyabean meal	26.25	25.5	25.0	20.5	19.7	19.2
Animal fat	0	6.5	13	0	7	14
Salt	0.5	0.5	0.5	0.5	0.5	0.5
Dicalcium phosphate	0.9	0.4	0	0.65	0.10	0
Calcite	0.85	1.1	1.7	0.75	1.0	1.4
Total	100	100	100	100	100	100
Nicomix AB2D3K 1, g	25	25	25	25	25	25
Nicomix BE 2, g	25	25	25	25	25	25
Zinc Oxide3, g	45	13	0	30	0	0
Oxylock antioxidant 4, g	10	10	10	10	10	10

[1]Nicomix A, B_2, D_3, K (Nicholas Piramal India Ltd, Mumbai) containing Vitamin A- 82,500 IU, Vitamin B_2-50 mg, Vitamin D_3-12,000 IU and Vitamin K-10 mg per gram.

[2]Nicomix BE (Nicholas Piramal India Ltd, Mumbai) containing Vitamin B_1-4 mg, Vitamin B_6-8 mg, Vitamin B_{12}-40 mg, Niacin-60 mg, Calcium pantothenate- 40 mg and Vitamin E-40 mg per gram.

[3]Zinc oxide (Nice Chemicals Pvt. Ltd., kochi) containing 81.38% of Zn.

[4]Oxylock antioxidant (Vetline Ltd., Indore) contains Ethoxyquin, Butylated HydroxyToluene (BHT), Chelators and Surfactantant.

Table 2: Chemical composition*of pig grower and finisher rations

Parameters	Grower rations1			Finisher rations1		
	T1	T1	T2	T1	T2	T3
Dry matter, %	89.20±0.12	90.56±0.11	91.41±0.13	89.11±0.12	90.41±0.17	91.50±0.18
Crude protein, %	18.25±0.11	18.18±0.17	18.03±0.13	16.39±0.10	16.28±0.06	16.06±0.18
Ether extract, %	3.10±0.05	8.53±0.09	13.69±0.10	3.28±0.06	9.04±0.11	14.11±0.07
Crude fibre, %	3.72±0.11	6.58±0.13	9.42±0.10	3.73±0.07	6.54±0.10	9.40±0.03
Total ash, %	5.64±0.17	9.50±0.20	12.40±0.18	5.54±0.15	9.54±0.12	12.47±0.14
Nitrogen free extract, %	69.29±0.16	57.21±0.21	46.46±0.21	71.06±0.20	58.60±0.30	47.96±0.05
Acid insoluble ash, %	1.10±0.02	4.51±0.09	6.63±0.12	1.04±0.06	4.29±0.13	6.52±0.16
GE, kcal/kg	4132.18 ± 22.92	4134.95 ±14.98	4212.87 ±9.21	4165.18 ±22.24	4203.07 ±17.05	4448.30 ±36.74
Calcium, %	0.59±0.01	0.62±0.006	0.78±0.01	0.62±0.02	0.65±0.01	0.77±0.02
Phosphorus, %	0.58±0.01	0.71±0.01	0.85±0.01	0.55±0.02	0.72±0.02	0.83±0.01
Magnesium, %	0.14±0.006	0.24±0.009	0.40±0.007	0.13±0.008	0.25±0.01	0.37±0.02

Manganese, ppm	16.78±0.38	39.14±1.76	69.99±1.18	16.59±0.45	38.76±0.96	69.85±1.31
Copper, ppm	6.35±0.08	9.34±0.06	12.62±0.19	6.15±0.15	9.17±0.08	12.39±0.15
Zinc, ppm	71.52±1.29	67.19±2.23	88.52±1.15	71.39±1.36	64.95±1.47	88.50±1.62

* On DM basis; [1] Mean of four values with SE

Table 3: Energy utilization of LWY pigs maintained on the four experimental rations

Parameter	Three experimental rations1		
	T1	T2	T3
Average dry matter intake, kg	2.3208±0.07ab	2.4330±0.08b	2.2871±0.04ab
Gross energy of feed, kcal/kg	4144.68	4173.92	4249.99
Gross energy intake, kcal	9618.84±310	10155.02±647	9720.01±179
Dry matter voided, kg	0.3304±0.007a	0.6718±.02b	0.9343±0.03c
Gross energy of faeces, kcal/kg	4102.04±132b	3834.24±94ab	3453.09±69a
Gross energy voided, kcal	1357.35±65a	2580.87±122b	3221.65±102c
Gross energy-digested, kcal	8216.48±304b	7574.15±431ab	6498.36±244a
Per cent gross energy as digestible energy	85.85±0.76c	74.37±1.83b	66.78±1.45a
Digestible energy of feed, kcal/kg	3558.12±31.47c	3104.22±76.15b	2837.96±61.48a

[1]Mean of 5 observations

a, b - Means of different superscripts within the same row differ significantly

Significant ($P<0.05$)