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Effect of Replacement of Maize by Animal Fat on Growth and Nutrient Utilization of Growing Large White Yorkshire Pigs

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ABSTRACT

In order to study the effect of replacement of maize by animal fat on growth and nutrient utilization, thirty weaned female Large White Yorkshire piglets were divided in to three groups with five replicates in each group and were maintained under identical management conditions for the period of 70 days. The piglets were randomly allocated to one of the three treatments namely T_1 (control ration), T_2 (50 per cent of maize of control ration replaced by animal fat) and T_3 (100 per cent of maize of control ration replaced by animal fat). The average daily gain and feed conversion efficiency were 813.00, 769.86, 678.43 g, and 2.80, 2.88, 3.08, respectively for three dietary treatments. The pigs of T_1 had higher ($P<0.05$) average body weight gain than that of other treatments. The crude fibre digestibility was higher ($P<0.05$) for T_1 and T_2 rations than that of T_3. The digestibility of dry matter, organic matter, crude protein and NFE was higher for T_1 ration as compared to other groups. Availability of calcium, magnesium and manganese was lowered ($P<0.01$) in T_3 group. It can be concluded that partial (50 per cent) replacement of the maize in the feed for pigs by animal fat did not affect the weight gain, feed intake, feed conversion efficiency and nutrient utilization.

Key words: Animal fat, Growth, Nutrient digestibility, Pig, Replacement of maize

INTRODUCTION

Cereal grain 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 of the country. The lower availability and increasing price of maize, necessitate 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 (Best, 2012). 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 (Apple *et al.,* 2007). However, studies on the effects of adding animal fat to swine diets have yielded variable results. Hence, the present was undertaken to study the effect of replacement of maize by animal fat on growth and nutrient utilization of growing Large White Yorkshire pigs.

MATERIALS AND METHODS

Thirty weaned female Large White Yorkshire piglets were randomly divided into three groups of five replicates in each group. Each replicates were allotted with two piglets and housed in a single pen. All piglets were maintained under identical management conditions throughout the experimental period of 70 days. Restricted feeding was followed and daily feed intake was recorded. The animals were fed with standard grower ration containing 18 per cent of crude protein (CP) and 3265 kcal of metabolizable energy (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 (2012). Ingredient composition and proximate composition of the grower and finisher ration is given in the table 1 and 2. Piglets were randomly distributed into three dietary treatment groups; namely T_1 (control ration), T_2 (50 per cent of maize of control ration replaced by animal fat) and T_3 (100 per cent of maize of control ration replaced by

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Table 1. Ingredient composition (%) of pig grower and finisher rations

Ingredients	Grower rations[1]			Finisher rations[1]		
	T_1	T_2	T_3	T_1	T_2	T_3
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 Oxide[3], 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 surfactant.

animal fat). The pigs were weighed at the beginning of the experiment and subsequently at fortnight intervals. Digestibility trial was conducted at the end of the experiment following total collection method. The samples of feed and faeces were analyzed for proximate principles (AOAC, 2010) and minerals such as calcium, magnesium, zinc, copper and manganese; were analyzed using Atomic Absorption Spectrophoto-

Table 2. Chemical composition of pig grower and finisher rations

Parameters	Grower rations[1]			Finisher rations[1]		
	T_1	T_2	T_3	T_1	T_2	T_3
DM, %	89.20±0.12	90.56±0.11	91.41±0.13	89.11±0.12	90.41±0.17	91.50±0.18
			on DM basis			
CP, %	18.25±0.11	18.18±0.17	18.03±0.13	16.39±0.10	16.28±0.06	16.06±0.18
EE, %	3.10±0.05	8.53±0.09	13.69±0.10	3.28±0.06	9.04±0.11	14.11±0.07
CF, %	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
NFE, %	69.29±0.16	57.21±0.21	46.46±0.21	71.06±0.20	58.60±0.30	47.96±0.05
AIA, %	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±22.9	4134.9±14.9	4213 ±9.21	4165±22.2	4203±17.1	4448±36.7
Ca, %	0.59±0.01	0.62±0.006	0.78±0.01	0.62±0.02	0.65±0.01	0.77±0.02
P, %	0.58±0.01	0.71±0.01	0.85±0.01	0.55±0.02	0.72±0.02	0.83±0.01
Mg %	0.14±0.006	0.24±0.009	0.40±0.007	0.13±0.008	0.25±0.01	0.37±0.02
Mn, 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
Cu, 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
Zn, 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

DM, dry matter; OM, organic matter, CP, crude protein; EE, ether extract, CF, crude fibre; NFE, nitrogen free extract; AIA, acid insoluble ash; GE, gross energy; [1]Mean of four values with SE

meter (Perkin Elmer 3110, USA). Phosphorus contents of both feed and faecal samples were analyzed according to AOAC (2010). Data collected were statistically analyzed using Statistical Package for Social Studies (SPSS. 17.0.1V, 2008) software.

RESULTS AND DISCUSSION

The data on the body weight, feed intake, daily gain and feed conversion efficiency of pigs fed the experimental rations are presented in Table 3. The average initial and final body weight of piglets belonging to three groups were 23.94, 23.96 and 24.01 kg, and 80.85, 77.85 and 71.50 kg, respectively. Replacement of maize at 50 per cent by animal fat had no significant effect on body weight of pigs. However, pigs reared on T_1 had higher ($P<0.01$) final body weight than that of T_3 treatment. In agreement to the results obtained in the present study non-significant growth performance in pigs fed different levels of supplemental fat were reported by Reis *et al.* (2000), Guo *et al.* (2006) and Realini *et al.* (2010) (animal fat at five per cent).

In this present study pigs maintained on T_3 treatment recorded significantly lower growth rate as compared to T_1 group. This may be due to the higher level of wheat bran (64.9 per cent) in T_3 ration which resulted in high crude fibre (9.40 per cent) and acid insoluble ash (6.52 per cent) content in the ration. The total feed intake recorded for three treatments were 159.28, 154.98 and 145.98 kg, respectively. There was no significant difference in total feed intake among three treatments. This is in agreement with Bhar *et al.* (2000) who observed similar feed intake in crossbred pigs fed diet with 0, 50 and 100 per cent replacement of maize by wheat bran.

The average daily gain was 813.00, 769.86 and 678.43 g, respectively for three treatments. Statistical analysis revealed no difference in average daily gain between T_1 and T_2 treatments, whereas T_1 treatment had higher ($P<0.05$) gain than that of T_3 treatment. The feed conversion efficiency for three treatment groups was 2.80, 2.88 and 3.08, respectively. There was no difference in feed efficiency between T_1 and T_2; but both had better ($P<0.05$) feed efficiency than that of T_3. In the present study T_3 treatment recorded significantly lower average daily gain and feed efficiency compared to other groups. This may be due to high crude fibre (9.40 per cent) and acid insoluble ash (6.52 per cent) content in the ration which might have affected the digestion and utilization of the nutrients. Growth rate and feed efficiency of pigs were depressed as fiber level in the diet increased (Lewis and Southern, 2000). Sheikh *et al.* (2011) observed significant deterioration in feed conversion efficiency in crossbred pigs fed diet containing paddy grain (rice) instead of maize. No significant difference was observed on growth performance and cost of production in LWY pigs fed diet containing 0 and 50 per cent replacement of maize by wheat bran whereas at 100 per cent replacement of maize by wheat bran showed significantly lower growth rate and higher production cost (Elanchezhian and Ally, 2016).

Data on apparent digestibility of nutrients and availability of minerals is presented in Table 4. Ether

Table 3. Weight gain, feed intake, average daily gain and feed conversion efficiency of pigs maintained on the three experimental rations

Parameters	Treatments		
	T_1	T_2	T_3
Initial body weight, kg	23.94±1.30	23.96±1.55	24.01±1.19
*Final body weight, kg	80.85^{b}±2.76	77.85^{ab}±2.35	71.50^{a}±2.00
**Total weight gain, kg	56.91^{b}±1.48	53.89^{b}±0.85	47.49^{a}±1.26
**Average daily gain, g	813.00^{b}±21.20	769.86^{b}±12.16	678.43^{a}±18.06
Total feed intake, kg	159.28±6.54	154.98±4.42	145.98±3.30
**Feed conversion efficiency	2.80^{a}±0.05	2.88^{a}±0.05b	3.08^{b}±0.06

^{a,b}Means with different superscripts within the same row differ significantly; *($P<0.05$); **($P<0.01$)

Table 4. Apparent digestibility of nutrients and availability of minerals of the three experimental rations

Parameters	Treatments		
	T_1	T_2	T_3
Dry matter, %	85.73^{c}±0.36	72.18^{b}±1.57	59.07^{a}±1.77
Organic matter, %	87.95^{c}±0.40	76.14^{b}±1.28	64.00^{a}±1.48
Crude protein, %	84.48^{c}±0.68	77.59^{b}±1.03	67.94^{a}±2.39
Ether extract, %	67.60±2.07	62.83±3.47	58.62±4.15
Crude fibre, %	55.36^{b}±1.49	49.63^{b}±1.70	38.84^{a}±3.05
Nitrogen free extract, %	91.49^{c}±0.54	80.48^{b}±1.23	69.21^{a}±1.75
DE, kcal/kg	3558.12^{c}±3.47^{c}	3104.22^{b}±76.15	2837.96^{a}±61.48
Calcium, %	60.34^{b}±1.77	55.28^{ab}±2.11	47.53^{a}±2.27
Phosphorus, %	54.53±2.74	51.38±3.23	46.22±2.36
Magnesium, %	66.29^{b}±2.29	58.82^{ab}±2.53	52.95^{a}±2.40
Manganese, %	71.38^{b}±1.38	64.13^{b}±2.06	54.92^{a}±2.23
Copper, %	62.02±1.74	57.41±3.70	53.08±2.22
Zinc, %	63.40±1.94	61.48±2.80	56.65±2.76

^{a,b,c}Means with different superscripts within the same row differ significantly, (P<0.01)

extract digestibility was similar in all the three treatments. The digestibility of all other nutrients in the control group was higher than the other groups. Pigs fed ration with 50 per cent of maize replaced with animal fat had higher (P<0.05) digestibility of nutrients than T_3. The crude fibre digestibility was higher (P<0.05) in T_1 and T_2 as compared to T_3, in which it was the lowest. In T_3 (100 per cent maize replacement) group the level of wheat bran was 64.9 per cent, compared to 34.7 per cent in T_2. The level of crude fibre and acid insoluble ash in the three rations were 3.73 and 1.04; 6.54 and 4.29 and 9.4 and 6.52, respectively for T_1, T_2 and T_3. The higher levels of crude fibre and acid insoluble ash might have contributed to the lowered digestibility of all nutrients except ether extract. 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 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 (Lentle and Janssen, 2008). Sikka *et al.* (1987) found that replacement of maize and rice bran with paddy in growing and finishing pigs led to a significant decrease in the digestibility of organic matter and crude fibre. Sheikh (2011) observed a significant reduction in digestibility of dry matter, ether extract, crude fibre and NFE in crossbred pigs fed diet containing paddy grain instead of maize. The digestible energy values of the three experimental rations were 3558, 3104 and 2837 kcal/kg, respectively. The control group (T_1) had higher (P<0.01) DE than T_2 and T_3 and the lowest DE was recorded in T_3.

Significant improvement in digestibility of energy as a result of fat supplementation in the diet of pigs was reported by 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). As the level of replacement of maize by animal fat increased, the efficiency of energy utilization was reduced in pigs (Elanchezhian *et al.,* 2014; Elanchezhian and Ally, 2020).

From the present study, it was observed that there was no difference in the availability of phosphorus, copper and zinc between the three rations, whereas the availability of calcium, magnesium and manganese were lowered (P<0.01) in T_3 group. The comparatively higher levels of phosphorus (0.83 per cent) in T_3 might have caused an imbalance between calcium and phosphorus resulting in lowered absorption of calcium. The high level of wheat bran (64.7 per cent) in 100 per cent maize replacement (T_3) group might have led to a

decrease in availability of minerals like magnesium and manganese. Fibrous feedstuffs such as peanut hulls, oat hulls, wheat bran, and soyabean hulls have been shown to decrease mineral absorption in pigs (Kornegay and Moore, 1986).

CONCLUSION

Results obtained in the experiment indicates that 50% replacement of the maize by animal fat in the diet of pigs did not affect the weight gain, feed intake, feed conversion efficiency and nutrient utilization. However, 100% replacement of maize with animal fat showed adverse impact on weight gain, feed conversion efficiency and nutrient utilization. Thus, 50% of maize can be replaced be replaced with animal fat in the diets of pigs without any adverse impact.

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REFERENCES

AOAC. 2010. *Official Methods of Analysis*.18th rev. ed. Association of Official Analytical Chemists, Arlington, Washington DC, USA.

Apple, J. K., Maxwell, C.V., Sawyer, J.T., Kutz, B.R., Rakes, L.K., Davis, M.E., Johnson, Z.B., Carr, S.N. and Armstrong, T.A. 2007. Interactive effect of ractopamine and dietary fat source on quality characteristics of fresh pork bellies. *J. Anim. Sci*. 85: 2682-2690.

Best, P. 2012, July-August, 2012. Global pig production: Trends shaping the pork industry. *Pig International-Bimonthly*, 42(4): pp. 8-11. Available: www.WATTAg Net.com.

Bhar, R., Pathak, N.N. and Paul, S. 2000. Performance of crossbred (Landrace × local Indian) finisher barrows fed maize or wheat bran based diets: Short note. *Asian-Australas. J. Anim. Sci.* 13: 1429-1432.

Lewis, A.J. and Southern, L.L. (eds.), 2000. *Swine Nutrition* (2nd Ed.). CRC press, Florida, USA.

Elanchezhian, N., Ally, K., Mercy, A.D., Gangadevi, P., Kuttinarayanan, P. and Usha, A.P. 2014. Effect of supplementation of animal fat on plasma and muscle lipid profile of Large White Yorkshire pigs. *Indian J. Anim. Nutr.* 30: 423-427.

Elanchezhian, N. and Ally, K. 2016. Influence of replacement of maize by wheat bran on cost of production in pigs. *Indian J. Anim. Nutr.* 33: 236-240.

Elanchezhian, N. and Ally, K. 2020. Effect of replacement of maize by animal fat on energy utilization in pigs. *Indian J. Anim. Nutr.* 37: 57-61.

Garry, B.P., Pierce, K.M. and O'Doherty, J.V. 2007. The effect of phase-feeding on the growth performance, carcass characteristics and nitrogen balance of growing and finishing pigs. *Irish J. Agric. Food Res.* 46: 93-104.

Guo, Q., Richert, B.T., Burgess, J.R., Webel, D.M., Orr, D.E., Blair, M., Grant, A.L. and Gerrard, D.E. 2006. Effect of dietary vitamin E supplementation and feeding Period on pork quality. *J. Anim. Sci.* 84: 3071-3078.

Huang, Y., Yoo, J.S., Kim, H.J., Wang, Y., Chen, Y.J., Cho, J.H. and Kim, I.H. 2010. The Effects of different copper (inorganic and organic) and energy (tallow and glycerol) sources on growth performance, nutrient digestibility, and fecal excretion profiles in growing pigs. *Asian-Australas. J. Anim. Sci.* 23: 573-579.

Kornegay, E. T. and Moore, R.J. 1986. Dietary fiber sources may affect mineral use in swine. *Feedstuffs.* 58: 36.

Lentle, R.G. and Janssen, P.W.M. 2008. Physical characteristics of digesta and their influence on flow and mixing in the mammalian intestine: A review. *J. Comp. Physiol.* 178: 673-690.

NRC. 2012. *Nutrient Requirements of Swine* (11th Ed.). National Academy of Sciences, Washington, D. C., 210p.

Realini, C.E., Duran-montage, P., Lizardo, R., Gisperta, M., Oliver, M.A. and Esteve-Garcia, E. 2010. Effect of source of dietary fat on pig performance, carcass characteristics and carcass content, distribution and fatty acid composition. *Meat Sci.* 85: 606-612.

Reis de souza, T.C., Aumaitre, A., Mourot, J. and Peiniau, J. 2000. Effect of graded levels of tallow in the diet on performance, digestibility of fat, lipogenesis and body lipid deposition of the weaned piglet. *Asian-Australas. J. Anim. Sci.* 13: 497-505.

Sheikh, G.G., Ganie, A.A., Baghel, R.P.S. and Nayak, S. 2011. Effect of paddy grain as maize replacer on the growth performance and nutrient utilization in growing and finishing pigs. *Indian J. Anim. Nutr.* 28: 437-440.

Sikka, S.S., Chawla, J.S. and Ichhponani, J.S. 1987. Effect of protein levels on the performance of growing pigs during different season. *Indian J. Anim. Sci.* 57: 164-167.

SPSS. 2008. 17.0.1 V. Windows user's guide 2008 by Statistical Package for the Social Sciences Inc. USA.

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