EFFECT OF PHYTASE SUPPLEMENTATION ON GROWTH AND NUTRIENT DIGESTIBILITY IN SWINE*

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Abstract

A feeding trial for a period of 114 days was carried out using thirty six weaned Large White Yorkshire x Desi piglets (18 males and 18 females) to assess the effect of phytase supplementation on growth and nutrient digestibility. The animals were divided into three groups and were fed with the three experimental rations, T1- Control ration containing 0.6 per cent calcium and 0.3 per cent phosphorus, T2 - Control ration without any mineral supplements and with 750 units of phytase/kg feed and T3-Control ration without phytase and mineral supplementation. Blood samples were collected before the start of the experiment and on 85th day of the experiment. Digestibility trial was conducted towards the end of the experiment. The average final body weight was 67.79, 69.54, and 64.75kg and the average daily gain (ADG) was 0.51, 0.53 and 0.48 kg for animals of T1, T2 and T3 respectively. The feed conversion efficiency of the animals of the three treatment groups was 5.65, 5.52 and 5.79, respectively. There was no difference (P>0.05) with regard to body weight between pigs of treatments T1, T2 and T3 in fortnights 0, 1, 2, 3 and 5 whereas, body weight of pigs belonging to T2 was higher (P<0.05) than that of T3 in fortnights 4, 6, 7, 8 and 9. There was no difference in body weight of animals belonging to T1 and T2 in all the fortnights. There was no difference in feed efficiency among pigs reared under the three dietary treatments. The percentage digestibility of nutrients in the three rations T1, T2 and T3 were 86.11, 87.92 and 87.95 for DM, 83.63, 85.31 and 84.97 for CP, 52.81, 53.89 and 53.89 for EE, 55.49, 57.41 and 55.94 for CF and 92.22, 93.55 and 93.56 for NFE, respectively. There was no difference in digestibility of nutrients and plasma biochemical parameters among pigs reared under the three dietary treatments. Cost of feed per kg body weight gain of pigs maintained on the three dietary treatments was Rs. 65.73, 59.90 and 62.44 respectively, the difference was significant (P< 0.01) on statistical analysis. Feed cost /kg gain of T1 pigs was higher than that of T2 (P< 0.01) and T3 (P< 0.05). But the difference in the cost of production between T2 and T3 was non significant (P>0.05). It can be concluded that phytase supplementation decreased feed cost / kg gain.

Keywords: *Effect of phytase, growth, swine*

Though the Indian Council of Medical Research recommends 10.8 kg meat / year / individual, the per capita availability is only 5.5 kg/ annum. Swine rearing has become an enterprising livelihood of farm sector of Kerala to fill up the large gap between the availability and requirement of meat owing to the fast growth, high feed conversion and prolificacy of pigs. More than 75 per cent of cost of production is for feed. Swine are mainly fed with cereals and oil cakes and over 60 per cent of total phosphorus (P) found in them are in their storage form as phytates and its availability is low compared to inorganic mineral supplements or other supplements of animal origin. Ruminants are able to utilize

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phytate P due to the presence of microbial phytase. Pigs do not have this microbial phytase enzyme for the hydrolysis of phytate P. Hence an experiment was carried out to study the effect of phytase supplementation on growth and nutrient digestibility in cross bred pigs.

Materials and Methods

Thirty six Large White Yorkshire x Desi weaned piglets (18 males and 18 females) were divided into three groups. Piglets of each group were allotted randomly into six pens with two piglets in each pen. Male piglets were castrated and all animals were dewormed before the start of the experiment. They were randomly allotted to the three experimental treatments. Each replicate was housed in separate pens in the same shed with facilities for feeding and watering. All the animals were maintained under identical management conditions. Restricted feeding was followed throughout the experimental period. Balance of feed was collected and weighed before the next feeding. Clean drinking water was provided in all the pens for twenty four hours throughout the experimental period.

The animals were fed with standard grower ration (18 percent CP and 3200 kcal of ME /kg of feed) up to 50 kg body weight and finisher ration (16 per cent CP and 3200 kcal of ME / kg of feed) from 50 to 70 kg body weight formulated as per NRC (1998). The three experimental rations were T1-Control ration containing 0.6 per cent calcium and

Table 1. Ingredient composition of experimental starter and finisher rations

Ingredients	Starter rations			Finisher rations		
	T1	T2	T3	T1	T2	T3
Yellow maize, kg	70	70	70	76	76	76
Soya bean meal, kg	29.4	29.4	29.4	23.5	23.5	23.5
Salt, kg	0.5	0.5	0.5	0.5	0.5	0.5
Lysine, kg	0.1	0.1	0.1	-	-	-
Total	100	100	100	100	100	100
To 100 kg of the above mixture added						
Dicalcium phosphate, kg	1.7	-	-	1.7	-	-
Shell grit, kg	0.6	-	-	0.6	-	-
Zinc oxide, g	75	-	-	75	-	-
Indomix AB_2D_3, g [1]	25	25	25	25	25	25
Rovi BE, g [2]	25	25	25	25	25	25
Phytase, g [3]	-	30	-	-	30	-

[1] *Indomix A, B2, D3, K (Nicholas Piramal India Ltd, Mumbai) containing Vitamin A- 40,000 IU, Vitamin B2-20mg, Vitamin D3-5000 IU and Vitamin K-50mg, per gram*

[2] *Rovi BE (Nicholas Piramal India Ltd, Mumbai) containing Vitamin B1-4mg, Vitamin B6-8mg, Vitamin B12-40mg, Niacin-60mg, Calcium pantothenate-40mg, Vitamin E- 40mg, per gram.*

[3] *Maxiphos (Polchem Hygiene laboratories PVT.Ltd, Pune) containing 2500 units of phytase per gram*

0.3 per cent phosphorus, T2- Control ration without any mineral supplements and with 750 units of phytase/kg feed and T3- Control ration without phytase and mineral supplementation. The ingredient and chemical composition of the starter and finisher rations are furnished in Tables 1 and 2.

The pigs were weighed at the beginning of the experiment and at fortnightly intervals thereafter. Daily feed intake was recorded. Blood samples were collected at the beginning and on 85th day and blood plasma was analyzed for Ca, Mg, Mn, Cu and Zn by Atomic Absorption Spectrophotometer (Perkin Elmer 3110) and phosphorus by Phospho molybdate method, using the kit supplied by Agappe diagnostics, Shailesh Industrial Complex, Thane. The alkaline phosphatase enzyme activity in plasma samples was estimated using the kit supplied by Agappe diagnostics, Shailesh Industrial Complex, Thane.

A digestibility trial was conducted at the end of the experiment to determine the

Table 2. Chemical composition[1] of grower and finisher rations , %

Parameter	Grower Rations Treatments			Finisher rations Treatments		
	T1	T2	T3	T1	T2	T3
Dry matter, %	92.80	92.30	92.24	88.85	88.53	87.83
Crude protein, %	18.43	18.48	18.37	16.15	16.32	16.63
Ether extract, %	2.8	2.54	2.58	2.58	2.79	2.64
Crude fibre, %	3.57	3.23	3.14	3.49	3.48	3.32
Total ash, %	6.35	5.19	4.82	5.7	3.42	3.30
Nitrogen free extract, %	68.85	70.56	71.09	71.68	73.99	74.11
Acid insoluble ash, %	1.74	1.22	0.97	0.76	0.66	0.57
Calcium, %	0.75	0.2	0.19	0.75	0.20	0.20
Phosphorus, %	0.57	0.25	0.24	0.56	0.26	0.25
Magnesium, %	0.33	0.24	0.24	0.34	0.24	0.25
Zinc, ppm	262.03	36.39	37.81	336.47	44.18	42.90
Copper, ppm	9.59	9.52	9.03	9.40	9.05	9.80
Manganese, ppm	13.79	13.44	12.98	13.16	13.58	12.44

[1] *On DM basis*

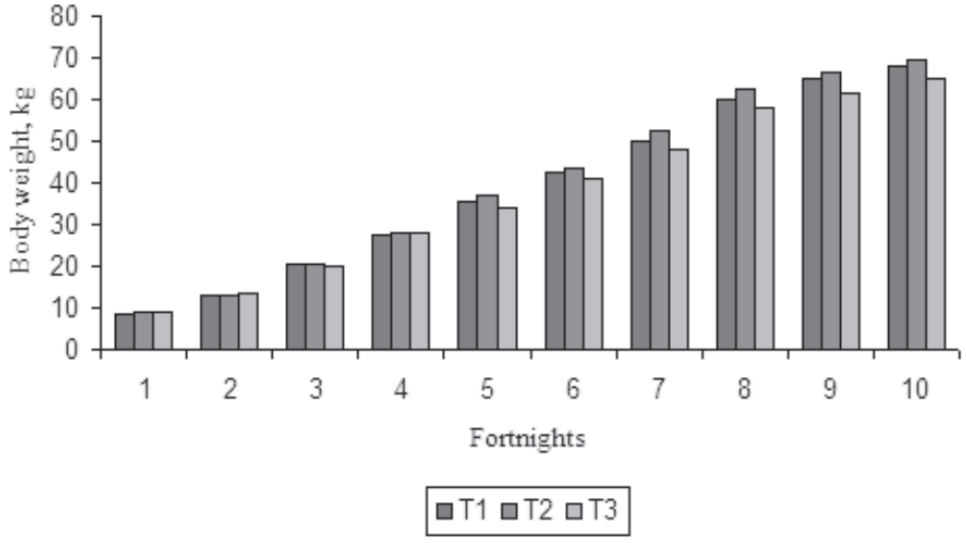

Fig.1. Fortnightly body weight of pigs maintained on three experimental rations

digestibility of nutrients of the experimental diets. Before the commencement of the actual collection period, animals were subjected to a preliminary period of three days when they were fed the same quantity of the feed. Total quantities of the faeces voided were collected as and when they were voided, uncontaminated with feed, dirt or urine during the collection period of three days. Samples collected daily from each animal were weighed and representative samples were taken after thorough mixing. The representative samples of feed offered during the collection period were also taken each day and were pooled and sub samples were taken for the analysis. The feed and faecal samples were analyzed for proximate principles (AOAC, 1990). Data collected on various parameters were statistically analyzed by Completely Randomized Design (CRD) method as described by Snedecor and Cochran (1994). Means were compared by Least Significant Difference (LSD) test.

Results and Discussion

Body Weight

The body weight of pigs under the three dietary treatments T1, T2 and T3 recorded at fortnightly intervals are represented in Fig.1. Average final body weight of pigs of the three dietary treatments were 67.79, 69.54, 64.75 kg, respectively. Average total body weight gain of animals belonging to groups T1, T2 and T3 were 59.12, 60.58, 55.66 kg respectively. There was no difference (P>0.05) with regard to body weight of pigs of treatments T1, T2 and T3 in 1st, 2nd, 3rd and 5th fortnight. Further, body weight of pigs belonging to T2 was higher (P<0.05) than that of T3 in fortnights 4, 6, 7, 8 and 9. There was no difference between body weights of T1 and T2 in fortnights 4, 6, 7, 8 and 9. The results of the present study revealed that phytase supplementation significantly increased the total weight gain of the animals fed with a ration without any mineral supplementation and the weight gain of these animals reached up to the level of those fed the control ration supplemented with adequate levels of Ca and Phosphorus.

The results of the present study are in agreement with Cromwell *et al.* (1993) and Biehl *et al.* (1996) who obtained increased body weight as a result of phytase supplementation. Similarly Murry *et al.* (1997) and O'Quinn *et al.* (1997) observed linear increase in growth performance in pigs when graded levels of phytase were supplemented to low P diets.

Average Daily Gain

Data on average daily gain (ADG) of pigs under the three dietary treatments T1, T2 and T2 are presented in Table 3. For the three dietary treatments T1, T2 and T3, the values for cumulative ADG were 0.51, 0.52 and 0.48 kg respectively.The ADG of pigs under T2 was high (P< 0.05) than that of T3 while there was

Table 3. Average daily gain[1] and feed efficiency of experimental animals maintained on three experimental rations

Treatment	Average initial weight (kg)	Average final weight (kg)	Total weight gain (kg)	Average daily gain (kg)	Average dry matter intake (kg)	Feed efficiency
T1	8.71	67.79	59.08	0.51 ^{ab}	334.04	5.65
T2	9.02	69.54	60.52	0.53 ^{a}	334.09	5.52
T3	9.09	64.75	55.66	0.48 ^{b}	322.27	5.79
Pooled SE	0.13	0.87	0.85	0.01	3.92	0.06

[1]Mean of six values

a, b Means with different superscripts within the column differ (P<0.05)

no difference between treatments T1 and T2. The result of the present study revealed that phytase supplementation increased ADG of animals fed with a ration containing no mineral supplements.

Increased ADG as a result of phytase supplementation in pigs was reported by Omogbenigun *et al*. (2004), Jendza *et al.* (2005), Brana *et al.* (2006). Veum *et al.* (2006) and Guy *et al.* (2008) where as no significant difference in ADG was reported by Cervantes *et al.* (2004).

Feed Conversion Efficiency

The total drymatter (DM) intake and the feed conversion efficiency of pigs maintained on dietary treatments T1, T2 and T3 are presented in Fig.2 and Table 3 respectively. Animals belonging to treatments T1, T2 and T3 registered a feed conversion efficiency of 5.66, 5.52 and 5.79, respectively which was similar (P>0.05) statistically.

Han *et al.* (1997) obtained similar feed efficiency in pigs when supplemented with microbial phytase, cereal phytase or

Table 4. Digestibility of nutrients[1]of three experimental rations (%)

Treatments	Nutrients				
	Dry matter	Crude protein	Ether extract	Crude fibre	Nitrogen free extract
T1	86.11	83.63	52.81	55.49	92.22
T2	87.92	85.31	53.89	57.41	93.55
T3	87.95	84.97	53.89	55.94	93.56
Pooled SE	0.66	0.42	0.69	1.17	0.27

[1] Mean of six values

Table 5. Cost of feed per kg body weight gain of pigs maintained on three dietary treatments

Item	Treatments		
	T1	T2	T3
Total body weight gain, kg	59.12	60.58	55.66
Total feed intake, kg	334.04	334.09	322.27
Cost /kg of starter ration, Rs.	11.71	10.97	10.89
Cost of finisher ration, Rs.	11.29	10.56	10.48
Total cost of feed, Rs.	3876.20	3630.62	3475.68
Cost of feed per kg body weight gain, Rs.	65.73	59.90	62.44

inorganic P (iP) indicating that supplementation of phytase can completely replace iP in the diet of pigs. No effect of phytase supplementation on feed conversion was reported in growing pigs by Cervantes *et al.* (2004) and Martinez *et al.* (2004) in concurrence with the present study. However Williams *et al.* (2005) and Brana *et al.* (2006) observed improved gain:feed ratio with phytase supplementation in pigs.

Digestibility of Nutrients

Dry Matter

Data on per cent digestibility of nutrients are presented in Table 4. The percentage DM digestibility of the three rations T1, T2 and T3 were 86.11, 87.92 and 87.95. On statistical analysis it was seen that the DM digestibility of rations T2 and T3 was higher (P<0.05) than that of T1.

Cowieson and Adeola (2005) and Jendza *et al.* (2005) noticed that apparent digestibility of DM was not affected by phytase supplementation in swine. On contrary, Mroz *et al.* (1994), Sands *et al.* (2001), Kies *et al.* (2006) and Viswanathan *et al*. (2007) observed that phytase addition resulted in higher DM digestibility in pigs. But Kemme *et al.* (1997) observed that addition of phytase to the diet significantly reduced the digestibility of DM in piglets but not in growing-finishing pigs and sows fed corn-soyabean meal based diets.

Crude Protein

The per cent CP digestibilities of rations T1, T2 and T3 were 83.63, 85.31 and 84.97 respectively (Table 4) and the values were similar (P>0.05). It could be concluded that phytase supplementation to rations with or without added minerals had no effect on CP digestibility.

O'Quinn *et al.* (1997), Traylor *et al.* (2001) and Cervantes *et al*. (2004) also did not observe any effect of phytase supplementation on the apparent ileal digestibility of CP and amino acids in pigs fed sorghum-soyabean meal diet. On the other hand, Omogbenigun *et al*. (2004) and Kies *et al.* (2005) noted that adding phytase increased CP digestibility in weaned pigs.

Ether Extract

The digestibility percentage of (ether extract) EE in animals fed the three treatment rations were 52.81, 53.89 and 53.89 respectively. There was no significant difference (P>0.05) evident between the three treatment groups on statistical analysis. It could be concluded that phytase supplementation to rations without any mineral supplementation had no effect on EE digestibility.

In contrast with the present observation Kies *et al.* (2005) observed that 1500 PU of phytase/kg feed increased apparent digestibility of fat by 1.2 per cent. Viswanathan *et al*. (2007) also observed that the digestibility coefficient of EE was significantly higher for citric acid plus phytase supplemented groups than that of the control without phytase in Large White Yorkshire pigs.

Crude Fibre

The per cent digestibility of crude fibre (CF) of the three treatments T1, T2 and T3 were 55.49, 57.41 and 55.94, respectively and were similar statistically (P>0.05).

Viswanathan *et al*. (2007) observed that the digestibility coefficient of crude fibre was significantly higher for citric acid plus phytase supplemented groups than that of control. In the present trial also phytase supplemented animals registered higher crude fibre digestibility though was not statistically significant.

Nitrogen Free Extract

The results of the present study registered per cent digestibility of 92.22, 93.55 and 93.56 respectively in T1, T2 and T3 for NFE and it was noted that there was no significant difference (P>0.05) between the treatments and it could be concluded that phytase supplementation to rations without any added minerals did not have any effect on digestibility of NFE.

Economics of Gain

Data on cost of feed per kg body weight gain of pigs maintained on the three dietary treatments are presented in Table 5. Phytase was supplied by Polchem Hygiene Laboratories PVT. Ltd, Pune at the rate of Rs.350 /kg. Cost of feed per kg body weight gain of pigs maintained on the three dietary treatments were Rs. 65.73, 59.90 and 62.44 respectively. Feed cost /kg gain of T1 pigs was higher than that of T2 (P< 0.01) and T3 (P< 0.05). But the difference in cost of production between T2 and T3 were nonsignificant (P>0.05). It can be concluded that phytase supplementation of rations resulted in decreased feed cost / kg gain.

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