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Growth performance, nutrient digestibility and production economics of fattener pigs supplemented with graded level of indigenously developed pig specific mineral mixture

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ABSTRACT

Present study was conducted to evaluate the effects of supplementation of pig specific mineral mixture on growth performance, nutrient digestibility and production economics. Fattening pigs (12) of 4 month-old, with an average body weight of 47.12±0.13 kg were subjected to 3 different isocaloric and isonitrogenous rations having pig specific mineral mixture at the rate of 0, 1.5 and 2.0%, respectively. Growth performance and digestibility coefficient of nutrients were assessed at 45 days and 90 days of experiment. Results showed that during the entire experimental periods pig specific mineral mixture supplementation @ 1.5% significantly improved body weight gain, FCR of pigs over control but further no significant improvement was observed with 2% supplementation rate. However, in comparison to control, only at 90th days of experiment digestibility coefficient of DM, CP and EE was significantly higher in pigs supplemented with 1.5% mineral mixture with no significant difference with 2% supplemented group. Moreover, calcium retention at both 45th and 90th day and phosphorus retention only at 90th days of experiment was significantly better in pigs supplemented with 1.5% mineral mixture with no further improvement with 2% supplementation. Margin of receipts per pig over feeding cost in 1.5% supplemented group was highest and was Rs. 833.60 higher than control. It was concluded that dietary inclusion of pig specific mineral mixture @ 1.5% is sufficient to improve the growth performance and nutrient digestibility with highest economic return from fattener pigs.

Keywords: Economics, Growth performance, Mineral mixture, Nutrient digestibility, Pigs

Minerals, including trace-minerals, are essential nutrients for pigs which are incorporated in the feed; because commonly available feedstuffs are deficient to meet the high requirement of minerals of modern exotic breeds of pigs with high growth performance potential. The mineral concentration of feed stuffs is highly variable and greatly influenced by a number of agronomic factors like crop variety, soil quality, agronomic practices and climate (Sauerbeck and Helal 1990, Fageria 2001). Further, variable bioavailability of minerals from plant origin feed ingredient (Adeola 1995, Weremko *et al*. 1997) also supports need of supplementation of dietary allowance. Incorporation rates of added minerals represent less than 3% of the feed. Up to now, commercially, pig specific mineral mixture containing all macrominerals, trace minerals and vitamins, satisfying the pig requirements is not available in India and rather vitamins and trace minerals are usually mixed together into the feed representing 0.10, 0.15 and 0.30% of the growing-fattening, sow and piglet feeds, respectively. While macro minerals are incorporated separately as di-calcium phosphate and limestone powder in pig ration. Keeping in view the demand and plight of pig farmers for pig specific mineral mixture, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana indigenously prepared a specific mineral mixture for various categories of pigs.

Contrary to actual of requirement of minerals as per the species, age and physiological status, as a thumb rule, most of the mineral mixtures are incorporated @ 2.0% in feed of all species including swine. So, present study was conducted to standardize the supplementation rate of indigenously developed pig specific mineral mixture for improving growth performance of grower fattener pigs and better economic returns to pig farmers.

MATERIALS AND METHODS

Selection and feeding of experimental pigs: The present investigation was carried out to study the effect of pig specific mineral mixture supplementation on growth performance and nutrient digestibility in growing fattener pigs. The experiment was conducted at the Pig Farm, Department of Livestock Production Management and laboratory analysis of feed and fecal samples was done in the Department of Animal Nutrition, GADVASU, Ludhiana, Punjab. A total of 12 growing pigs of around 4 months of age with average body weight of 47.12±0.13 kg were selected and randomly subjected to 3 different iso-caloric

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and iso-nitrogenous diets (Table 1) containing 0, 1.5 and 2% of pig specific mineral mixture. Each treatment had total 4 pigs (2 male and 2 female) wherein each animal represented individual replicate. The treatment details are as follows, $T_{1:}$ feed without mineral mixture whereas T_2: feed with 1.5% pig specific mineral mixture and $T_{3:}$ feed with 2% pig specific mineral mixture. Pigs were housed in 3 different experimental pens with concrete flooring with adequate space, feeding and watering facilities. The water was available *ad lib.* round the clock in open watering tank. However, in order to ensure round the clock availability of feed in the feeder of experimental pigs, feed was offered daily @ 2.5% body weight in two split doses in evening and morning hours. The daily feed allowance was adjusted as per fortnightly body weight of experimental pigs.

Recording of growth performance: The feed intake was recorded daily and fortnightly for each treatment for assessment of growth performance after 45 and 90 days of experiments.

Conduction of digestion trial: A digestion trial was conducted at 45 days and 90 day of the experiment. All the fecal collection method was adopted for digestion trials. The measured quantity of feed for 5 consecutive days was offered to each treatment both in the morning and evening. The residual feed left, if any was weighed to record the actual consumption of feed for each treatment. The faeces voided by each treatment were collected daily in the morning and weighed. After collection 25 ml of 10% sulphuric acid was mixed in the faeces to avoid nitrogen loss and dried separately at 80ºC in hot air oven. Faeces collected over 5 consecutive days for each treatment were mixed properly. Five days total collection method was used for faeces. The sample of faeces were grounded and analyzed for various proximate parameters (AOAC 2005).

Production economics: The production economics of supplementation of different levels of pig specific mineral mixture was calculated as income due to sale of live pig over feeding expenditure per pig. Total feeding cost per pig (Rs) was calculated by multiplying the total feed consumed with cost of per kg experimental diet. Income from sale per pig was calculated by multiplying the total weight of pig and prevailing price of live weight of pig. Margin of receipt over feed cost per pig and difference in margin of receipt over control was calculated accordingly.

Analysis of data: The collected data of different experiments were subjected to one-way ANOVA using Software Package for Social Sciences (SPSS, version 22.0) to test the difference between various treatments. Further, the treatment means were compared by Duncan's Multiple Ranged Test (Duncan 1995) at 5% level of significance ($P \leq 0.05$).

RESULTS AND DISCUSSION

Chemical composition of mineral mixture: The specific mineral mixture was prepared by mixing and processing of different inorganic compounds of di-calcium phosphate, limestone powder, ferrous sulphate, zinc sulphate, copper sulphate, and mangnese sulphate and potassium iodate. The chemical composition of mineral mixture is presented in Table 1. This mineral mixture meets out the requirement of calcium, phosphorus, iron, zinc, copper, mangnese and iodine. The content of other minerals, i.e. magnesium, potassium, sulphur, chlorine, chromium or molybdenum are much higher in raw materials, compared to the requirements of the pig, so specific supplementation of these mineral is quite rare (Gaudre and Quinio 2009).

Table 1. Nutrient composition of pig specific mineral mixture

Mineral	Percentage in MM
Calcium	23.4
Phosphorus	15.0
Fe	0.55
Zn	0.55
Cu	0.028
Mn	0.022
Iodine	0.0015

Chemical composition and nutrient density of pig ration: The pig ration was prepared by mixing of maize, soybean meal, groundnut extraction, de-oiled rice bran, rice polish, common salt and specific mineral mixture. The specific mineral mixture was added @ 1.5 and 2% in T_2 and T_3 treatments, respectively. These treatments feed contained 20.09, 19.97 and 19.85% CP and 3437.9, 3390.8 and 3374.7 Kcal ME/kg of feed in T1, T2 and T3, respectively. The chemical composition and nutrient density of various treatment pig ration is shown in Table 2.

Growth performance: The data pertaining to the initial body weight, final body weight, average body weight gain and average feed intake and feed conversion ratio at 45 days, 90 days and for overall period (1–90 days) are presented in Table 3. During early 45 days of experimental period, no significant difference was observed in average body weight and average daily body weight gain among

Table 2. Ingredients and nutrient composition of experimental diet

Feed ingredients (%)	Treatments		
	Control (No MM)	T_1 (1.5% MM)	T_2 (2.0% MM)
Maize	48.50	48.50	48.50
Soybean meal	11.60	11.60	11.60
Groundnut extraction	19.00	19.00	19.00
De-oiled rice bran	10.00	10.00	10.00
Rice polish	10.60	9.10	8.60
Common salt	0.30	0.30	0.30
Specific mineral mixture	0	1.50	2.00
Total (kg)	100.00	100.00	100.00
Proximate values			
CP (%)	20.09	19.97	19.85
CF (%)	7.36	7.24	7.12
EE (%)	2.93	2.79	2.65
TA (%)	7.17	8.36	8.73

Table 3. Growth performances of pigs supplemented with different levels of pig specific mineral mixture

Period (Age)	Parameter	Control (No MM)	T_1 (1.5% MM)	T_2 (2.0% MM)	P value
I	Initial body wt (kg)	47.25	47.25	47.00	0.970 (NS**)
(1–45 days of experiment)	Final body wt (kg)	61.00	61.50	61.20	0.889 (NS**)
	Average body wt gain (kg)	13.75	14.75	14.20	0.788 (NS**)
	Average daily body wt gain (g)	305.55	316.16	315.55	0.788 (NS**)
	Average daily feed intake (kg/d)	1.18	1.18	1.18	NS*
	FCR	3.86	3.72	3.74	NS*
II	Initial body wt (kg)	61.00	61.50	61.20	0.889 (NS**)
(46–90 days of experiment)	Final body wt (kg)	64.50^a	72.00^b	72.00^b	0.003 (S*)
	Average body wt gain (kg)	3.50^a	10.50^b	10.80^b	0.000 (S*)
	Average daily body wt gain (g)	77.78^a	233.33^b	240.00^b	0.000 (S*)
	Average daily feed intake (kg/d)	1.20	1.20	1.20	
	FCR	15.43	5.14	5.00	S*
Overall (1–90 days of experiment)	Initial body wt (kg)	47.25	47.25	47.00	0.970 (NS**)
	Final body wt (kg)	64.50^a	72.00^b	72.00^b	0.003 (S*)
	Average body wt gain (kg)	17.25^a	24.75^b	25.00^b	0.001 (S*)
	Average daily body wt gain (g)	191.67^a	275.00^b	277.78^b	0.001 (S*)
	Average daily feed intake (kg/d)	1.19	1.19	1.19	
	FCR	6.20	4.32	4.22	S*

NS** Nonsignificant, S* significant at (P<0.05).

control and different treatment groups. However, ADG in T_1 and T_2 was numerically higher than that in control. Similarly, feed conversion ratio in T_1 and T_2 was also nonsignificantly better than in non supplemented control group. This not significant variation in growth performance and feeding efficiency among mineral mixture supplemented and non supplemented groups during early experimental phase could be attributed to nonsignificant variation in digestibility of different nutrients. Minerals play key role in absorption and metabolism of different major energy and protein nutrients through a number of biochemical process. In early phase of experiment deficiency of minerals was not evident, and it might be as these critical minerals would have been supplied by body tissues and fluid mineral reserve.

But after 90 days of experimental feeding, average body weight and ADG in T_1 was significantly (< 0.05) higher than that in control. However there was no significant difference between T_1 and T_2. Similarly significantly (< 0.05) better feed conversion ratio was reported with 1.5% pig specific mineral mixture supplementation. These results indicated that subsequent to 45 days, mineral contents of feed ingredients and body reserve in animals in control group was insufficient to sustain high growth and feed efficiency. Again cumulative average body weight, average body weight gain and feed conversion ratio for entire experimental period was significantly better for animals supplemented with 1.5% of pig specific mineral mixture without further improvement with higher inclusion levels of 2%. Similar to these findings, Upadhaya *et al*. (2017) in a 35 days study also reported better growth performance due to dietary supplementation of chelated water-soluble mineral mixture in crossbred pigs. Cho *et al.* (2019) also observed better growth performance due to zinc oxide supplementation in piglet diet. Better growth performance in piglet is also observed by Zhang *et al*. (2013) due to supplementation of chelated copper and zinc in piglet ration.

Effect of mineral mixture supplementation on digestibility coefficient: The digestibility coefficients (Table 4) for various nutrients was nonsignificant except calcium retention which is significantly better in mineral mixture supplemented treatments at 45th day of experiment. But for overall period DM, DCP and DEE values are significantly better than control treatment. Moreover, calcium and phosphorus retention were also significantly better in mineral mixture supplemented treatments as compared to control. It indicated that mineral mixture supplementation was beneficial to improve the nutrient digestibility for various nutrients. But there was no difference in nutrient digestibility in different dose rates of mineral mixture. It indicated that mineral mixture supplementation at the dose rate of 1.5% and 2% had no significant difference on growth performance and nutrient digestibility. Better DM digestibility was also observed by Upadhya *et al*. (2017) due to chelated water-soluble mineral mixture in crossbred pigs. Better nutrient digestibility is also reported by Jin *et al*. (2019).

Production economics of pigs fed various level of pig specific mineral mixture: Though per kg feed cost and total feed cost per pig were higher in specific mineral mixture supplemented treatments but income from sale was also higher in specific mineral mixture treatments as compared to control (Table 5). Margin of receipt over feed cost per pig was improved from ₹5294.91 to 6128.51 and ₹ 6107.09 in pig specific mineral mixture supplemented treatments. Moreover, there was difference in margin of receipt over control of ₹ 833.60 and ₹ 812.18 in T_2 and T_3, respectively. It indicated that supplementation of pig specific mineral mixture was beneficial to increase the difference in margin

Table 4. Effect of supplementation of different levels of pig specific mineral mixture on nutrient digestibility

Period	Parameter	Control (No MM)	T_1 (1.5% MM)	T_2 (2.0% MM)	Significance level
45th day of experiment	DDM (%)	74.89	75.62	75.85	0.020(NS*)
	DEE (%)	75.35	75.75	75.60	0.476(NS**)
	DCP (%)	73.45	74.10	73.90	0.208(NS**)
	DCF (%)	35.48	35.02	35.03	0.192(NS**)
	Ca retention (%)	40.21[a]	41.03[b]	41.31[b]	0.010(S*)
	P retention (%)	39.33	39.85	39.01	0.070(NS**)
90th day of experiment	DDM (%)	73.68[a]	75.04[b]	75.77[b]	0.003(S*)
	DEE (%)	75.04[a]	75.90[b]	76.12[b]	0.001(S*)
	DCP (%)	72.94[a]	75.15[b]	74.83[b]	0.000(S*)
	DCF (%)	35.24	35.36	35.51	0.765(NS**)
	Ca retention (%)	42.53[a]	43.02[b]	43.09[b]	0.010(S**)
	P retention (%)	38.72[a]	38.94[ab]	39.11[b]	0.027(S**)

NS** nonsignificant, S* significant at (P<0.05).

Table 5. Effect of supplementation of different levels of pig specific mineral mixture on production economics (on per live animal basis)

Economic parameter	Treatment		
	T_1 (No MM)	T_2 (1.5% MM)	T_3 (2% MM)
Feed price (₹/kg)	22.83	23.45	23.65
Total feed consumption per pig (kg)	107.10	107.10	107.10
Total feeding cost per pig (₹)	2,445.09	2,511.50	2,532.92
Average final body weight of pig (kg)	64.50	72.00	72.00
Income from sale from per pig (sold at ₹ 120/kg live weight basis)	7,740.00	8,640.00	8,640.00
Margin of receipt over feed cost per pig (₹)	5,294.91	6,128.51	6,107.09
Difference in margin of receipt over control (₹)	0.00	833.60	812.18

of receipt over non-supplemented treatment.

The study concluded that instead of 2%, indigenously formulated pig specific mineral mixture @1.5% was sufficient to improve nutrient digestibility and feed utilization and resulted better growth performance of superior quality pigs, culminated to higher economic return to pig farmers.

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