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GROWTH AND NUTRIENT UTILISATION OF CROSSBRED PIGS SUPPLEMENTED WITH PROBIOTIC, PREBIOTIC AND SYNBIOTIC

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ABSTRACT

A study was conducted out for a period of 131 days in forty weaned crossbred (Large White Yorkshire x Desi) piglets to study the effect of dietary supplementation of probiotic, prebiotic and synbiotic on growth and utilisation of nutrients. The piglets were divided into four groups with five replicates having two piglets in each replicate and were randomly allotted to four dietary treatments, T1 (control ration as per NRC, 1998), T2 (control ration + 0.2 per cent yeast as probiotic), T3 (control ration + 0.2 per cent mannan oligosaccharide (MOS) as prebiotic) and T4 (control ration + 0.2 per cent of synbiotic containing 0.1 per cent yeast and 0.1 per cent MOS) following completely randomized design. The findings of the study indicated that all the four dietary treatments had similar (P>0.05) average daily gain and digestibility of nutrients. However, the animals fed diet supplemented with synbiotic had better body weight gain at second and third fortnight. The cumulative feed conversion efficiency of synbiotic supplemented group was higher (P<0.05) throughout the experimental period except for fourth and fifth fortnight. Results concluded that synbiotic at 0.2 per cent level (0.1 per cent yeast + 0.1 per cent MOS) can be used as beneficial feed additive in growing crossbred pigs.

Keywords: Crossbred pigs, Probiotics, Prebiotics, Synbiotics, Growth characteristics, Nutrient digestibility

INTRODUCTION

Feed additives such as antibiotics, probiotics, prebiotics, organic acids, enzymes and immune modulators have been used widely to improve the gut health and growth rate in pigs. Among these, antibiotics were the most popular feed additive during the past decade. However, development of antibiotic-resistant bacteria in human and concerns associated with antibiotic residues in pork had led to its ban in European Union and South Korea. This has intensified the need for viable alternatives such as prebiotics and probiotics as growth promoters (Haupenthal *et al*., 2020; Joysowal *et al*., 2018). Probiotics are beneficial gut microbes (Park *et al*., 2016); while prebiotics are a class of complex carbohydrates, acting as substrates for beneficial gut microbes. Synergistic effects of probiotics and prebiotics (synbiotics) may also be important in favouring the growth of beneficial microorganisms in the gastrointestinal tract especially the large intestine. To better understand the effects of these feed additives in intensive pig production, it is necessary to study their effect on growth characteristics and digestibility of nutrients. Moreover, systematic studies comparing the effect of probiotic, prebiotic and synbiotic in crossbred pigs are scanty in literature (Rybarczyk *et al*., 2021). Hence, the present experiment was conducted to study the effect of dietary supplementation of probiotic, prebiotic and synbiotic on growth and digestibility of nutrients in crossbred pigs.

MATERIALS AND METHODS

Experimental animals

A feeding experiment was conducted at the Centre for Pig Production and Research, Mannuthy for a period of 131 days in forty crossbred (Large White Yorkshire X Desi) pigs (twenty castrated male and twenty females). All the animals were dewormed and vaccinated against Classical Swine Fever (CSF) and Foot and Mouth Disease (FMD) before the start of the experiment. The piglets were divided as uniformly as possible into four groups of ten animals each and were randomly allotted to five pens with two animals in each pen, forming five replicates for each treatment. The four groups of animals were randomly allotted to four dietary treatments following completely randomised design.

Housing and management

The pigs were maintained under identical management conditions, fed twice daily (9.00 am in the morning and 3.00 pm in the evening) and were allowed to consume as much as they could, within a period of one hour. Balance of feed if any, was collected and weighed before the next feeding. Fresh and clean drinking water was provided *ad libitum*.

Experimental ration and feeding

The experimental ration consisted of grower ration (18 per cent crude protein (CP) and 3265 kcal of metabolizable energy (ME) per kg feed), up to 50 kg body weight and finisher ration (16 per cent CP and 3265 kcal of ME per kg feed) from 50 kg body weight onwards (NRC, 1998).

The xperimental rations were formulated as given below.

T1 – Control ration (NRC, 1998)

T2 – Ration containing 0.2 per cent yeast as the probiotic

T3 – Ration containing 0.2 per cent mannan oligosaccharide as the prebiotic

T4 – Ration containing 0.2 per cent synbiotic (combination of 0.1 per cent yeast and 0.1 per cent mannan oligosaccharide)

All the rations were made isocaloric and isonitrogenous. Ingredient composition of grower and finisher rations are furnished in Tables 1 and 2, respectively. Piglets were fed with their respective grower ration until they attained an average body weight of 50 kg and thereafter with finisher ration until the animals attained an average body weight of 70 kg. Records of daily feed intake and fortnightly body weight were taken throughout the experimental period.

Bioyeast (Varsha Group, Bangalore) containing 20 billion cfu per gram of *Saccharomyces cerevisiae*

Mannan oligosaccharide (Varsha Group, Bangalore) containing 50 per cent mannans and glucans

Nicomix AB_2D_3K (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.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.

Bioyeast (Varsha Group, Bangalore) containing 20 billion cfu per

Table 1. Ingredient composition of experimental starter rations, %

Ingredients	Starter rations			
	T_1	T_2	T_3	T_4
Yellow maize, kg	69.80	69.80	69.80	69.80
Soyabean meal, kg	28.00	28.00	28.00	28.00
Dicalcium phosphate, kg	0.90	0.90	0.90	0.90
Calcite, kg	0.80	0.80	0.80	0.80
Salt, kg	0.50	0.50	0.50	0.50
Total	100	100	100	100
To 100 kg of the above mixture were added				
Bioyeast, g	-	200	-	100
Mannan oligosaccharide, g	-	-	200	100
Nicomix AB_2D_3K [1], g	25	25	25	25
Nicomix BE [2], g	25	25	25	25
Zinc Oxide, g	75	75	75	75

Table 2. Ingredient composition of experimental finisher rations, %

Ingredients	Finisher rations			
	T_1	T_2	T_3	T_4
Yellow maize, kg	75.30	75.30	75.30	75.30
Soyabean meal, kg	22.50	22.50	22.50	22.50
Dicalcium phosphate, kg	0.90	0.90	0.90	0.90
Calcite, kg	0.80	0.80	0.80	0.80
Salt, kg	0.50	0.50	0.50	0.50
Total	100	100	100	100
To 100 kg of the above mixture were added				
Bioyeast, g	-	200	-	100
Mannan oligosaccharide, g	-	-	200	100
Nicomix AB_2D_3K, g	25	25	25	25
Nicomix BE, g	25	25	25	25
Zinc Oxide, g	75	75	75	75

gram *Saccharomyces cerevisiae*

Mannan oligosaccharide (Varsha Group, Bangalore) containing 50 per cent mannans and glucans

Nicomix AB_2D_3K (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.

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.

Digestibility trial

A digestibility trial was conducted at the end of the feeding experiment to determine the digestibility coefficient of the nutrients and availability of minerals such as Ca and P, by total collection method. Before commencement of the actual collection period, animals were subjected to a preliminary adaptation period of three days during which they were offered the same quantity of the feed. Total faecal matter voided was collected for three days, uncontaminated with feed, dirt or urine and weighed. Representative samples were taken each day during the period of three days. Feed and faecal samples collected each day were placed in double lined polythene bags, labeled and stored in deep freezer for further sampling and analysis.

Chemical analysis

The feed and faecal samples collected for three days for each animal were pooled, mixed thoroughly and sub samples were taken for analysis. The apparent digestibility coefficients of nutrients (dry matter, crude protein, ether extract and crude fibre) and apparent mineral availability (Ca and P) were calculated using appropriate formulae. Chemical composition of feed and faecal sample were analyzed as per methods described in Association of Official Analytical Chemists (AOAC, 1990). Minerals such as Ca and P in feed and faeces were analyzed using Atomic Absorption Spectrophotometer (Perkin – Elmer Model Pinnacle 900H), after wet digestion with nitric acid and perchloric acid (2:1).

Table 3. Chemical composition of grower rations

Parameter	Grower rations			
	T1	T2	T3	T4
Dry matter, %	90.17 ± 0.24	90.18 ± 0.21	89.53 ± 0.32	89.95 ± 0.28
Crude protein, %	18.65 ± 0.03	18.80 ± 0.07	18.53 ± 0.11	18.90 ± 0.08
Ether extract, %	2.97 ± 0.05	2.82 ± 0.04	2.83 ± 0.03	2.91 ± 0.03
Crude fibre,%	4.07 ± 0.09	3.61 ± 0.29	3.53 ± 0.08	3.49 ± 0.06
Total ash, %	5.60 ± 0.22	5.68 ± 0.17	5.48 ± 0.27	5.57 ± 0.14
Nitrogen free extract, %	68.71 ± 0.25	69.09 ± 0.23	69.63 ± 0.23	69.13 ± 0.08
Acid insoluble ash, %	1.32 ± 0.06	1.25 ± 0.02	1.43 ± 0.25	1.31 ± 0.07
Gross energy, kcal/kg	3616.87 ± 41.88	3584.89 ± 31.56	3614.79 ± 42.73	3640.15 ± 25.32
Calcium, %	0.69 ± 0.04	0.61 ± 0.27	0.78 ± 0.09	0.66 ± 0.32
Phosphorus, %	0.58 ± 0.38	0.64 ± 0.03	0.72 ± 0.91	0.65 ± 0.32

Table 4. Chemical composition of finisher rations

Parameter	Finisher rations			
	T1	T2	T3	T4
Dry matter, %	90.70 ± 0.07	89.65 ± 0.06	89.08 ± 0.05	89.08 ± 0.05
Crude protein, %	16.64 ± 0.01	16.83 ± 0.07	16.49 ± 0.03	16.37 ± 0.01
Ether extract, %	3.01 ± 0.03	3.12 ± 0.02	3.23 ± 0.02	2.93 ± 0.03
Crude fibre, %	4.17 ± 0.02	4.17 ± 0.03	4.01 ± 0.06	4.19 ± 0.01
Total ash, %	4.59 ± 0.10	4.42 ± 0.16	4.56 ± 0.16	3.83 ± 0.08
Nitrogen free extract, %	71.59 ± 0.10	71.46 ± 0.16	71.71 ± 0.15	72.68 ± 0.08
Acid insoluble ash, %	1.43 ± 0.09	1.26 ± 0.02	1.14 ± 0.04	1.25 ± 0.03
Gross energy, kcal/kg	3827.39 ± 45.50	3755.94 ± 34.99	3870.81 ± 39.31	3810.19 ± 45.19
Calcium, %	0.67 ± 0.08	0.70 ± 0.13	0.73 ± 0.52	0.55 ± 0.47
Phosphorus, %	0.73 ± 0.19	0.62 ± 0.44	0.51 ± 0.38	0.59 ± 0.51

Statistical analysis

Data collected on various parameters were statistically analyzed by ONE WAY ANOVA method as described by Snedecor and Cochran (1994). Means were compared by Duncan Multiple Range Test (DMRT) using Statistical Package for Social Studies (SPSS. 17.0.1v, 2008) software.

RESULTS AND DISCUSSION

Chemical composition of experimental rations

Data on chemical composition of the experimental grower and finisher swine rations are given in Tables 3 and 4, respectively.

The percentage of dry matter (DM) in grower rations varied between 89.53 and 90.18, ether extract (EE) between 2.82 and 2.97 per cent and crude fibre (CF) between 3.49 and 4.04 per cent. The total ash, nitrogen free extract (NFE) and acid insoluble ash fraction varied between 5.48 and 5.68, 68.71 and 69.63 and 1.25 and 1.43 per cent, respectively. In the finisher rations the percentage of DM varied between 89.08 and 90.70, EE between 2.93 and 3.23 and CF between 4.01 and 4.19 per cent, respectively. The total ash, NFE and acid insoluble ash content varied between 3.83 and 4.59, 71.46 and 72.68 and 1.14 and 1.43 per cent, respectively in the finisher rations. The crude protein (CP) of the grower ration ranged from 18.53 to 18.90 per cent and that of the finisher ration from 16.37 to 16.83 per cent. As per NRC (1998) the grower and finisher ration should contain 18 and 16 per cent CP, respectively.

Body weight and body weight gain

Average final body weight recorded at the end of feeding trial in pigs of the four dietary treatments T1, T2, T3 and T4 were 72.00, 70.75, 69.95, 73.75 kg, respectively (Table 5) and the corresponding average total body weight gains were 54.31, 53.09, 52.31 and 56.06 kg, respectively (Table 6). There was no difference ($P>0.05$) in the final body weights among the treatments. From Table 6 it could be seen that the average fortnightly body weight of pigs maintained on the dietary treatment T4 was higher ($P<0.05$) in second and third fortnight as compared to the treatment groups T1, T2 and T3.

The results obtained in the present study shows that supplementation of yeast did not enhance the growth performance, which agrees with previous reports that supplementation of yeast at 0.2 per cent (van Heugten *et al*., 2003) and 0.3 per cent (Keegan *et al*., 2005) levels did not improve the body weight gain. However, an improvement in weight gain upon

Table 5. Fortnightly average body weight of pigs maintained on four dietary treatments

Fortnight	Average body weight, kg				
	T1	T2	T3	T4	P value
0	17.69 ± 0.31	17.66 ± 0.12	17.64 ± 0.66	17.69 ± 0.55	1.00
1	24.20 ± 0.32	23.95 ± 0.50	23.75 ± 0.73	24.60 ± 0.56	0.72
2	31.30 ^{b} ± 0.32	30.85 ^{b} ± 0.82	31.05 ^{b} ± 0.70	33.50 ^{a} ± 0.66	0.03*
3	38.05 ^{ab} ± 0.31	37.20 ^{b} ± 0.82	37.40 ^{b} ± 0.74	39.90 ^{a} ± 0.70	0.04*
4	44.55 ± 0.30	43.45 ± 1.03	43.30 ± 0.72	45.90 ± 0.75	0.08
5	50.50 ± 0.44	49.15 ± 1.10	49.20 ± 0.82	51.65 ± 0.73	0.12
6	56.45 ± 0.46	55.00 ± 1.13	54.90 ± 0.70	57.65 ± 1.03	0.12
7	62.00 ± 0.58	60.85 ± 1.13	60.35 ± 0.65	63.55 ± 1.09	0.09
8	67.20 ± 0.70	66.15 ± 1.02	65.20 ± 0.66	68.85 ± 1.26	0.07
9	72.00 ± 0.72	70.75 ± 1.08	69.95 ± 0.80	73.75 ± 1.21	0.06

*a, b- Means with different superscripts within the same row differ significantly (P<0.05)

Table 6: Fortnightly average of cumulative body weight gain of pigs maintained on four dietary treatments

Fortnight	Average body weight gain (kg)				
	T1	T2	T3	T4	P value
1	6.51 ± 0.08	6.29 ± 0.53	6.11 ± 0.39	6.91 ± 0.29	0.46
2	13.61 ^{b} ± 0.12	13.19 ^{b} ± 0.85	13.41 ^{b} ± 0.49	15.81 ^{a} ± 0.28	0.008*
3	20.36 ^{b} ± 0.15	19.54 ^{b} ± 0.86	19.76 ^{b} ± 0.46	22.21 ^{a} ± 0.47	0.01*
4	26.86 ± 0.30	25.79 ± 1.07	25.66 ± 0.54	28.21 ± 0.60	0.06
5	32.81 ± 0.36	31.49 ± 1.14	31.56 ± 0.49	33.96 ± 0.71	0.09
6	38.76 ± 0.30	37.34 ± 1.17	37.26 ± 0.38	39.96 ± 0.99	0.09
7	44.31 ± 0.49	43.19 ± 1.16	42.71 ± 0.55	45.86 ± 1.13	0.09
8	49.51 ± 0.53	48.49 ± 1.06	47.56 ± 0.67	51.16 ± 1.35	0.08
9	54.31 ± 0.50	53.09 ± 1.12	52.31 ± 0.71	56.06 ± 1.37	0.07

*a, b- Means with different superscripts within the same row differ significantly (P<0.05)

supplementation of probiotic was also reported (Bontempo *et al*., 2006; van der Peet-Schwering *et al*., 2007). Variability in results can be attributed to several factors, including variations in age, environmental conditions, health status within herds and the strain of probiotic itself (van der Peet-Schwering *et al*., 2007).

The growth performance observed on prebiotic supplementation of this study are consistent with previous results. LeMieux *et al*. (2003) had reported no improvement in growth performance in growing pigs with dietary supplementation of mannan oligosaccharide (MOS) at 0.2 and 0.3 per cent levels. Similarly, Castillo *et al*. (2008) and Che *et al.* (2012) reported no change in body weights of pigs supplemented with prebiotic compared to those fed basal diet. On the other hand, improved growth performance on prebiotic supplementation were also reported by Davis *et al*. (2002), Rozeboom *et al*. (2005) and Poeikhampha and Bunchasak (2011).

From the results obtained in the current study, the synbiotic supplemented group showed improved weight gain in second and third fortnight, in accordance with the earlier studies conducted by Shim *et al.* (2005) and van der Peet-Schwering *et al*. (2007), were higher body weight gains were observed during the grower stage in crossbred pigs. On contrary, no improvement in weight gain was reported by Krause *et al.* (2010) and Lee *et al.* (2009) on synbiotic supplementation. The improved growth observed in symbiotic supplemented group can be attributed to the complementary effects of yeast and MOS in altering the immune function (Spring *et al*., 2000) and microbiota in the intestinal tract (Van Heugten *et al.,* 2003).

Feed intake and feed conversion efficiency

Data on fortnightly average cumulative feed intake and cumulative feed conversion efficiency are given in Table 7 and 8 respectively. There was no significant difference among the animals in four dietary treatments with regards to feed intake.

Yang *et al.* (2003) also observed that FCE of pigs was unaffected by probiotic supplementation as observed in the present study. Similarly, no difference (P>0.05) in FCE was observed in the current study when pigs were fed diet supplemented with prebiotic compared to those fed control diet. This observation is in consistent with previous observations of Zhao *et al*. (2012)

Table 7: Fortnightly average of cumulative feed intake of pigs maintained on four dietary treatments

Fortnight	Average feed intake (kg)				
	T1	T2	T3	T4	P value
1	17.52 ± 0.27	16.37 ± 0.88	15.95 ± 0.40	16.30 ± 0.38	0.20
2	38.00 ± 0.31	36.00 ± 1.32	36.87 ± 0.71	38.72 ± 0.68	0.14
3	60.13 ± 0.34	56.86 ± 1.61	58.29 ± 0.37	59.40 ± 1.14	0.16
4	82.46 ± 0.62	78.74 ± 2.23	79.91 ± 0.84	80.46 ± 1.38	0.33
5	105.16 ± 1.20	100.45 ± 2.46	102.42 ± 1.18	101.97 ± 1.64	0.30
6	128.52 ± 1.30	123.61 ± 2.55	125.90 ± 1.76	125.28 ± 1.65	0.34
7	152.16 ± 2.24	147.84 ± 2.73	149.96 ± 2.63	149.30 ± 2.02	0.65
8	175.45 ± 2.75	171.38 ± 2.88	172.63 ± 3.44	171.62 ± 2.34	0.74
9	198.54 ± 2.83	193.86 ± 3.08	195.56 ± 3.71	193.67 ± 2.54	0.66

Table 8: Fortnightly average of cumulative feed conversion efficiency of pigs maintained on four dietary treatments

Fortnight	Average feed conversion efficiency				
	T1	T2	T3	T4	P value
1	2.69 ± 0.02	2.63 ± 0.09	2.64 ± 0.13	2.37 ± 0.06	0.05
2	2.79^{b}± 0.03	2.75^{b}± 0.11	2.76^{b} ± 0.09	2.45^{a} ± 0.01	0.01*
3	2.95^{b}± 0.03	2.92^{b}± 0.11	2.96^{b}± 0.07	2.68^{a} ± 0.04	0.02*
4	3.07 ± 0.03	3.07 ± 0.11	3.12 ± 0.05	2.86 ± 0.06	0.05
5	3.21 ± 0.03	3.20 ± 0.09	3.25 ± 0.04	3.01 ± 0.06	0.05
6	3.32^{ab}± 0.03	3.32^{ab} ± 0.08	3.38^{b}± 0.04	3.14^{a}± 0.06	0.05*
7	3.43^{b}± 0.03	3.43^{b}± 0.07	3.51^{b}± 0.03	3.26^{a}± 0.07	0.02*
8	3.54^{b}± 0.03	3.54^{b}± 0.06	3.63^{b}± 0.03	3.36^{a}± 0.07	0.01*
9	3.66^{b}± 0.03	3.65^{b}± 0.05	3.74^{b}± 0.03	3.46^{a}± 0.06	0.003*

*a, b- Means with different superscripts within the same row differ significantly (P<0.05)

Table 9. Average daily gain of pigs maintained on four dietary treatments

Parameter	Treatments				
	T1	T2	T3	T4	P value
Initial body weight, kg	17.69 ± 0.31	17.66 ± 0.12	17.64 ± 0.66	17.69 ± 0.55	1.00
Final body weight, kg	72.00 ± 0.72	70.75 ± 1.08	69.95 ± 0.80	73.75 ± 1.21	0.06
Total body weight gain, kg	54.31 ± 0.50	53.09 ± 1.12	52.31 ± 0.71	56.06 ± 1.37	0.07
Average daily gain, g	414.58 ± 0.00	405.26 ± 0.01	399.31 ± 0.01	427.94 ± 0.01	0.07

in pigs were no improvement in FCE was observed on prebiotic supplementation. However, White *et al*. (2002) reported a lowered FCE in pigs supplemented with prebiotic, as against control. In contrary to the above reports, Davis *et al*. (2000) had reported better FCE in pigs when they were fed diet supplemented with 0.2 per cent prebiotic.

van der Peet-Schwering *et al*. (2007) observed that supplementation of synbiotic (0.125 per cent yeast + 0.2 per cent MOS) improved the FCE in weanling pigs as compared to those fed control diet. The results obtained in the present study agrees with the above observations, indicating better FCE in pigs when fed diet supplemented with synbiotic. This improvement in FCE could be due to the beneficial effects of synbiotic on the gut parameters, possibly by stimulating growth of beneficial bacteria or by decreasing the number of pathogens such as coliforms or by altering the villus height (Kim *et al*., 2010).

Average daily gain

From the data presented in the Table 9. it could be inferred that the average daily gain (ADG) of pigs maintained on the four dietary treatments were similar (P>0.05).

In the current study, pigs fed diet supplemented with probiotic showed no improvement in ADG when compared to the group fed control diet. Similar results were also observed by van Heugten *et al.* (2003) and Keegan *et al.* (2005). However, Bontempo *et al*. (2006), Shen *et al*. (2009) and Datt *et al*., (2011) observed an increase (P<0.05) in ADG with probiotic supplementation in rations of pig.

Improvement in ADG of pigs with prebiotic supplementation were reported earlier (Davis *et al*., 2000; Poeikhampha and Bunchasak, 2011 and Zhao *et al*., 2012). However, the results of current study revealed that supplementation of prebiotic had no effect on ADG and this observation was consistent with those of Rekiel *et al*. (2007), Castillo *et al*. (2008) and Che *et al*. (2012) who reported no improvement in ADG upon supplementation of prebiotic.

Shim *et al.*(2005), van der Peet-Schwering *et al*.(2007) and Awad *et al.*(2008) reported an increase in ADG of pigs when diet was supplemented with synbiotic. However, in the current study, there is no difference (P>0.05) in ADG of pigs fed synbiotic supplemented diet when compared to those fed basal diet. This observation is in agreement with the earlier other reports (Lee *et al.,* 2009; Krause *et al.,* 2010). Bontempo *et al*. (2006) suggested that differences in sanitary conditions of farm, composition of diet, quantity and type of probiotic or prebiotic added to diet can be the reasons for the variable responses.

Digestibility of nutrients

Chemical composition of faeces of pigs fed with four experimental diets

Table 10. Chemical composition of faecal samples*of pigs maintained on four dietary treatments

Parameter	Treatments			
	T1	T2	T3	T4
Dry matter, %	30.24 ± 0.24	29.96 ± 0.69	31.80 ± 2.04	29.37 ± 0.94
Crude protein, %	18.47 ± 0.05	17.66 ± 0.12	17.04 ± 0.06	17.01 ± 0.06
Ether extract, %	5.52 ± 0.18	5.81 ± 0.21	5.78 ± 0.25	5.72 ± 0.09
Crude fibre, %	8.78 ± 0.24	9.23 ± 0.34	8.77 ± 0.52	9.71 ± 0.08
Total ash, %	18.22 ± 0.22	18.07 ± 0.21	17.65 ± 0.16	17.95 ± 0.13
Nitrogen free extract, %	49.01 ± 0.51	49.23 ± 0.43	50.76 ± 0.71	49.61 ± 0.17
Acid insoluble ash, %	7.67 ± 0.17	8.03 ± 0.04	8.08 ± 0.29	7.90 ± 0.15
Gross energy of faeces, kcal/kg	2811.01 ± 47.73	2836.74 ± 66.13	3434.90 ± 14.11	3194.10 ± 15.89
Calcium, %	0.93 ± 0.48	1.01 ± 0.89	0.97 ± 1.01	0.88 ± 0.09
Phosphorus, %	1.86 ± 0.73	1.26 ± 0.13	1.40 ± 0.82	1.01 ± 0.66

*On dry matter basis

Table 11. Digestibility of nutrients and availability of minerals of four experimental rations

Parameter	Treatments				
	T1	T2	T3	T4	P value
Dry matter, %	82.21 ± 0.49	82.93 ± 0.87	82.31 ± 1.28	84.05 ± 0.20	0.39
Organic matter, %	84.47 ± 0.47	84.50 ± 0.73	83.72 ± 1.19	85.54 ± 0.16	0.43
Crude protein, %	80.27 ± 0.51	82.15 ± 0.89	81.66 ± 1.39	83.44 ± 0.20	0.12
Ether extract, %	67.91 ± 0.78	68.39 ± 0.71	68.88 ± 1.08	68.82 ± 0.68	0.82
Crude fibre, %	62.34 ± 0.40	62.41 ± 0.70	62.92 ± 0.48	62.95 ± 0.40	0.75
Nitrogen free extract, %	87.77 ± 0.46	88.10 ± 0.69	87.37 ± 1.09	88.04 ± 0.34	0.45
DE, kcal/kg	3442.61 ± 15.71	3379.36 ± 24.52	3374.48 ± 36.75	3444.93 ± 6.03	0.08
Calcium, %	51.34 ± 0.82	54.28 ± 0.69	49.68 ± 0.53	55.38 ± 0.51	0.31
Phosphorus, %	54.53 ± 1.30	50.31 ± 0.52	48.94 ± 0.22	53.18 ± 0.08	0.08

is shown in Table 10 and data on apparent digestibility (per cent) of nutrients is presented in Table 11.

In the current study no change was observed in the percentage digestibility of nutrients when probiotic, prebiotic or synbiotic were added to the diet. Wang *et al*. (2009) and Giang *et al*. (2011) also reported no change in the digestibility of DM, CP, NDF, ADF and EE when prebiotic was added in the swine diet. However, van Heugten *et al*. (2003) concluded that live yeast supplementation (1.6 x 10^7 cfu of *Saccharomyces cerevisiae* SC47 per gram of feed) reduced the digestibility of DM, EE and energy in pre-starter and starter phase in young growing pigs.

On the other hand, significantly higher digestibility coefficients of DM and CP were observed by Shen *et al*. (2009) upon dietary supplementation of yeast at 0.5 per cent level. Similar observations regarding improved digestibility of CP and CF were also noted by Meng *et al*.(2010) and Giang *et al*.(2011b). Supplementation of probiotic at higher level (0.5 per cent) may increase the villus height and villus to crypt ratio in jejunum which might promote the digestibility. But no such effects were observed at lower level of supplementations (Shen *et al*., 2009) as in the case of present study.

Supplementation of prebiotic also did not alter the digestibility of nutrients in the current study. Suryanarayana *et al*. (2013) reported no significant improvement in apparent digestibility of DM, CF, EE and NFE when fructo-oligosaccharide was supplemented at 1.0 per cent level to weanling crossbred pigs. Similarly, Chen *et al.* (2009) observed no improvement (P>0.05) in digestibility of DM and CP at low level (0.25 per cent) of supplementation of chito-oligosachharide. However, significant improvement in digestibility of DM and CP was noted at higher level (0.5 per cent) of inclusion of chito-oligosachharide. On the other hand, Nochta *et al.* (2010) reported enhanced (P<0.05) apparent digestibility of DM, CP and EE in pigs fed diet supplemented with 0.2 per cent MOS as prebiotic.

The per cent digestibility of nutrients were also similar (P>0.05) for pigs fed diet supplemented with synbiotic and those fed basal diet. This observation agrees with the previous reports of Bohmer *et al.* (2005) who observed no improvement (P>0.05) in digestibility of DM, OM, CP, EE and CF in pigs supplemented with synbiotic compared with control. On the other hand, Lee *et al.* (2009) noted significantly higher DM and CP digestibility in pigs supplemented with 0.2 per cent synbiotic (yeast + MOS, lactose, sodium acetate and ammonium citrate).

Availability of minerals

The availability of minerals for the pigs fed four experimental rations T1, T2, T3 and T4 were 51.34, 54.28, 49.68 and 55.38 per cent for Ca and 54.53, 50.31, 48.94 and 53.18 per cent for P, respectively (Table 11). From the observed data, it could be inferred that the availability of minerals for pigs maintained on the four dietary treatments T1, T2, T3 and T4 were statistically similar.

Similar observations were also noted by Li *et al*. (2006), who have noted no change in availability of P. Shen *et al*. (2009) also reported that supplementation of different levels of probiotic (0.25 and 0.5 per cent) in the ration did not improve availability of Ca and P when compared to groups fed control ration. However, Nochta *et al.* (2010) observed increased availability of Ca (55.5 vs 47.1 per cent) and P (62.8 vs 55.1 per cent) when the diet was supplemented with 0.3 per cent MOS compared to control ration in weanling piglets.

CONCLUSION

The results of the study indicated that all the four dietary treatments were similar (P>0.05) in average daily gain and digestibility of nutrients. However, the animals fed diet supplemented with synbiotic had better body weight gain at second and third fortnight. The cumulative feed conversion efficiency of synbiotic supplemented group was higher (P<0.05) throughout the experimental period except for fourth and fifth fortnight. Results concluded that synbiotic at 0.2 per cent level (0.1 per cent yeast + 0.1 per cent MOS) can be used as beneficial feed additive in growing crossbred pigs.

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