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Performance and Total Tract Digestibility Responses of Probiotic, Xylanase and Phytase in the Diets of Grower Pigs

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Abstract. A basal diet was evaluated in 24 male pigs (15.8 kg ±1.07) divided into four groups at random which was fed to all the animals *adlibitum*. The experiment was carried out in two phases. In phase one, group one (T_1) was the control without any feed additive, T_1 was added (per quintal) with (g) 100, 120 & 80; 0.305, 0.366 & 0.244 and 12, 14.4 & 9.6 of probiotic (Sacchyromycescerevisiae), xylanase and phytase enzymes, to make T_2, T_3 and T_4 diets, respectively. Initial, final and total weights (kg) in both the phases of the experiment were not significant. Number of days taken to reach the target weight (35 kg) was lower ($P<0.05$) in T_3 and T_2 for phases 1 and 2, respectively. Average daily feed intake (kg) and average daily gain (g) were lower and higher in T_3 and T_2 in phases 1 and 2, respectively and were not significant. The trend was similar for total feed intake (kg), feed conversion ratio and cost of feed per kg production (Rs). The total feed intake in phase one was lower ($P<0.05$) in T_3 than others. The digestibility of organic matter, crude fibre, ether extract and nitrogen-free extract among groups were not significantly different, but the digestibility of crude fibre (CF) and nitrogen-free extract (NFE) tended to be more in T_3. Crude protein (CP) and dry matter (DM) digestibility were significantly higher ($P<0.05$) in T_3. It was concluded that the synergism between xylanase, phytase and probiotic enhanced the performance of pigs with a considerable influence on age of the animals and production economy.

Keywords: Age, Nutrient digestibility, Performance, Phytase, Probiotic, Synergism, Xylanase

INTRODUCTION

The digestibility of carbohydrates contained in corn-soybean meal based diets is an important determinant of the available energy content which is hindered by many anti -nutritional principles like arabinoxylans (non-starch polysaccharides). Pigs do not produce endogenous enzyme to digest NSP (Slominski et al., 2004). The NSP hydrolyzing enzymes have several modes of action such as partial hydrolysis of soluble and insoluble NSP, decreasing the digesta viscosity and rupturing the NSP containing cell wall and there by promoting the nutrient digestibility (Vahjen et al., 1998; Simon, 1998; Bedford and Schulze, 1998).

To achieve high production efficiency in pig industry a continuous improvement in the utilization of the diets and of a wide variety of dietary ingredients is crucial. For these reasons, a continuous effort had been made to understand the complex nature of feed components. Many approaches like use of acidifiers, probiotics, prebiotics, enzymes and a lot many substances with a wide range of reported actions on animal health and production have been tried.

Supplementation of pig diets with NSP-degrading enzymes improves the utilization of plant derived nutrients. These improvements are achieved by several mechanisms, including degradation of anti-nutrient factors and cleavage of glycolytic bonds that are not hydrolyzed by endogenous enzyme activity (Kim et al., 2008). Exogenous xylanase is used to improve the digestibility of energy and other nutrients by breaking down arabinoxylans that are poorly digested in pigs (Partridge and Bedford, 2000)

It was also reported that all grains contain phosphorus in the form of an insoluble complex, phytate phosphorus which is unavailable and pigs are very inefficient in utilizing phytate phosphorus as they do not possess the enzyme phytase required to hydrolyze phytate molecule (Pointillart et al., 1984; Oatway et al., 2001**).** This leads to the use of inorganic phosphorus contributing to more cost of the feed and also increasing the environmental P excretion. Exogenous addition of phytase enzyme breaks the phytate bonds and release P for better bioavailability of the mineral in GI-tract of pigs

A recent study in pigs showed that *Saccharomyces cerevisiae* supplementation improves post weaning growth performance and modulates the proliferation rate of epithelial cells and the number of macrophages in the ileum (Bontempo et al., 2006). Another mechanism of action for probiotics might involve interaction with micro nutrients such as vitamins like thiamine, riboflavin, pantothenic acid, and biotin (Branner and Roth-Maier, 2006).

The present experiment was planned with the aim to study the effect of a combination of xylanase and phytase enzymes along with probiotic on age, nutrient digestibility and growth performance in growing cross-bred pigs. The cost of production was calculated.

MATERIALS AND METHODS

One basal diet formulated (NRC, 1998) was evaluated during grower (15-35 kg) phase. The diet was fed to 24 male pigs with an average body weight of 15.8 kg ±1.07, divided into four groups at random such that a basal diet was fed to all the animals *adlibitum*. The experiment was carried out in two phases. In phase one, group one (T_1) was the control without any feed additive, T_1 was added (per quintal) with (g) 100, 120 & 80; 0.305, 0.366 & 0.244 and 12, 14.4 & 9.6 of probiotic (*Sacchyromycescerevisiae*), xylanase and phytase enzymes, to make T_2, T_3 and T_4 diets respectively. The enzyme activity of xylanase enzyme was found to be 11, 48,807 U per gm and Phytase was with an assayed activity of 2500 FTU/gm.

The feed additives were added at three different levels to study their associated effect on the performance.In phase two, T_2, T_3 and T_4 diets were made by adding (per quintal) with (g) 100, 140 & 60; 0.305, 0.427 & 0.183 and 12, 16.8 & 7.2 of probiotic (*Sacchyromycescerevisiae*), xylanase and phytase enzymes. The present experiment was planned with the objective to study the effect of age and the feed additives on the performance and nutrient digestibility in growing pigs. The cost economics was also studied.

The pigs were housed individually in separate pens and had unlimited access to water. All the pigs were dewormed before the start of the grower phase. The daily feed offered and the left over was recorded and the body weights of the pigs were recorded at weekly intervals. One digestion trial was conducted after the animals attained a body weight of about 30 kg. The pigs were individually placed in metabolic cages and had free access to water. Feed was offered according to the groups. The pigs were acclimatized to the cages for 3 days followed by a collection period of 5 days. During the collection period, faeces were collected daily from each pig. The daily feed intake, left over and faeces voided were recorded. An aliquot of $1/10^{th}$ of the total faeces voided was preserved for further laboratory analysis. The diet and faecal samples were analyzed for proximate composition (AOAC, 1995). The data were subjected to one-way classification of analysis of variance (Snedecor and Cochran, 1989) and the means were tested by least significant difference.

Results and Discussion

The ingredient composition (%) of the basal diet was 45, 15, 37 2 and 1 for maize, soybean meal, deoiled rice bran, mineral mixture and salt, respectively.

Growth performance

Initial, final and total weights (kg) in both the phases of the experiment (Table.1) were not significant. Number of days taken to reach the target weight (35 kg) was lower ($P<0.05$) in T_3 for phase one. Average daily feed intake (kg) and average daily gain (g) were lower and higher in T_3 and T_2 in phases 1 and 2, respectively and were not significant. The trend was similar for total feed intake (kg), feed conversion ratio and cost of feed per kg production (Rs). The total feed intake in phase one was lower ($P<0.05$) in T_3 than others.

The digestibility of organic matter, crude fibre, ether extract and nitrogen-free extract (Table.2) among groups were not significantly different, but the digestibility of CF and NFE tended to be more in T_3. CP and DM digestibility were significantly higher ($P<0.05$) in T_3.

Addition of brewers dried Yeast and *Saccharomyces cerevisiae*(probiotic) alone recorded higher total weight gain (kg), ADG (g) and lower feed: gain ratio since it was reported that the yeast cells contain the cell wall oligosaccharides, peptides and amino acids which may stimulate appetite and improve feed intake (Gao et al., 2008). It was reported that the nucleotides present in yeast protein reportedly stimulated the development of GI tract (Silva *et al.,* 2009). It was hypothesized in the present study that these effects would increase the nutrient uptake from the small intestines contributing more growth rate with probiotic supplementation. The present findings also are in agreement with Schwering et al., (2007), Shen et al., (2009) and Price et al., (2010) who reported growth-promoting and potential antibiotic alternative properties of yeast culture products. In previous studies, benefits of yeast culture products in swine production were attributed to promoting feed intake (Shen et al., 2009), increasing ADG (Schwering et al., 2007) and improving the feed efficiency of pigs (Schwering et al., 2007). In the present findings, the associated effect of xylanase, phytase and probiotic could have improved the growth rate both in terms of daily gain and total weight gain.

Animals fed with *Saccharomyces cerevisiae* showed higher ($P<0.05$) average daily gain (g) (Suryanarayana et al., 2012). It was justified that the functional status of the small intestines is characterized partially by villus height and crypt depth (Branner et al., 2006) and supplementation of yeast pellets caused a major increase in the height of villi in the duodenum. At this instance the indigenous bacteria stimulate vascularization and development of the intestinal villi thus enhancing the efficiency of digestion and absorption. It was also reported that long villi is correlated with improved gut health (Baurhoo et al., 2007). Probably these could be the reasons for improved performance for the pigs supplemented with probiotic (Manzanilla et al., 1999).

The combination of xylanase and phytase showed an associated beneficial effect on nutrient digestibility and growth rate among the treatments in the present study which corroborates with the results of Nortey et al., (2007); Olukosi et al., (2007); Woyengo et al., (2008). Similar combination improved ADG, ADFI, FCR (Nortey et al.,2007) in grower pigs in corn- based diets.

Oryschak et al., (2002) reported that enzyme synergy exists if the effect of the 2 enzyme combination is greater than the cumulative effect of each single enzyme. The synergy exists because supplemental xylanase disrupts the cell wall matrix and hydrolyses the otherwise unavailable carbohydrates, while at the same time allowing the supplemental phytase to gain access to phytase bound nutrients like phosphorus, proteins and starch. The synergy might also be caused by changes in digesta passage rate, thereby allowing a prolonged contact time of the phytase with its substrate at the optimum pH and these changes would increase the digestibility of nutrients. Kim et al., (2005) observed that the sequence of synergism for the beneficial effects of supplementation of xylanase + phytase is breakdown of NSP structure by xylanase and then the action of phytase on the released phytic acid to free components. Phytase acts in the stomach and xylanase in the small intestine.

The positive response of N digestibility to phytase supplementation (Nyachoti, 2006) was attributed to the hydrolysis of dietary phytate – protein complexes and thus preventing phytate from binding proteolytic enzymes which in turn enhanced N and amino acid digestion and was suggested that the improvements in N digestion indicated the potential benefits of phytase supplementation in minimizing potential environmental pollution due to N excretion.

The ADG (g) was higher for T_3 in phase one and FCR, total feed intake and cost of feed per kg gain was lower in phase one which could be attributed to higher organic matter digestibility (Suryanarayana and Suresh, 2011) with higher dose of enzyme mixture (Suryanarayana et al., 2011) and in phase two, T_2 recorded this trend which might be due to lower response of older pigs to NSP degrading enzyme supplementation than in younger pigs which is an agreement to the earlier reports (Olukosi et al., 2007).This could be the probable reason for higher DM and CP digestibility in T_3 fed animals.

CONCLUSIONS

Supplementation of feed additives enhance the barrier properties of the intestinal wall and stimulates immunity and intestinal defence against infection which indirectly paves the way for improved performance both in terms of nutrient digestibility and growth. Based on the present study it can be concluded that the productive indices can be enhanced by synergistic effect of xylanase, phytase and probiotic showing their considerable influence on age of the animals and production economy.

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TABLE : 1 Growth Performance from 15-25 Kg Body Weight

Parameter	TI	T2	T3	T4
Initial Weight (kg)	13.7 ± 0.92	13.4 ± 0.73	13.5 ± 0.81	13.7 ± 0.83
Final Weight (kg)	25.2 ± 0.36	25.2 ± 0.44	24.6 ± 0.44	25.3 ± 0.29
Total Weight Gain (kg)	11.7 ± 0.64	11.1 ± 0.75	11.1 ± 0.42	11.6 ± 0.97
No. of Days *	51.5^{c} ± 0.61	48.5^{b} ± 1.33	42.8^{a} ± 0.79	51.5^{c} ± 0.76
ADFI (kg)	1.06 ± 0.33	1.1 ± 0.52	1.01 ± 0.06	1.11 ± 0.05
Total feed intake (kg)*	45.2^{a} ± 2.65	51.6^{b} ± 2.20	41.9^{a} ±2.73	53.9^{b} ± 3.75
ADG (g)	228.2 ± 13.4	231.8 ± 21.4	259.3 ± 13.2	223.5 ± 16.4
FCR	3.76 ± 0.14	4.12 ± 0.23	3.38 ± 0.19	3.97 ± 0.23
Cost of feed / kg gain (Rs)	65.8 ± 2.32	71.5 ± 4.26	59.2 ± 3.14	69.5 ± 3.40
Growth Performance from 25-35 Kg Body Weight				
Initial Weight (Kg)	25.1 ± 0.36	24.5 ± 0.44	25.1 ± 0.44	25.2 ± 0.30
Final Weight (Kg)	35.3 ± 0.35	34.9 ± 0.44	35.4 ± 0.56	34.9 ± 0.19
Total Weight Gain (Kg)	10.1 ± 0.43	10.3 ± 0.38	10.3 ± 0.43	9.7 ± 0.31
No. of Days	36.3 ± 1.80	31.3 ± 2.48	38 ± 3.04	34.5 ± 3.31
ADFI (Kg)	1.26 ± 0.11	1.25 ± 0.09	1.46 ± 0.07	1.33 ± 0.04
Total feed intake (kg)	46.2 ± 5.16	39.8 ±5.63	55.6 ± 4.71	46.3 ± 5.29
ADG (g)	228.6 ± 14.68	339.8 ± 30.4	278.5 ± 22.4	287.7 ± 16.5
FCR	4.57 ± 0.51	3.91 ± 0.61	5.42 ± 0.46	4.73 ± 0.39
Cost of feed / kg gain (Rs)	79.9 ± 8.86	68.4 ± 10.7	94.9 ± 8.15	82.7 ± 6.94

^{abc} values in a column not sharing common superscripts differ significantly * ($P<0.05$)

TABLE: 2 Digestibility of nutrients among treatments

Nutrient	T_1	T_2	T_3	T_4
DM *	$73.2^{bc} \pm 0.84$	$74.6^{b} \pm 0.81$	$80.1^{a} \pm 0.94$	$76.1^{b} \pm 0.58$
OM	78.6 ± 0.98	81 ± 1.12	81.6 ± 0.82	79.8 ± 0.91
CP *	$73.6^{a} \pm 0.97$	$75.4^{b} \pm 0.73$	$78.1^{b} \pm 1.22$	$75.8^{b} \pm 0.32$
CF	34.4 ± 1.34	33.6 ± 1.64	35.3 ± 1.13	32.1 ± 1.75
EE	54.7 ± 1.86	55.1 ± 0.97	54.3 ± 1.22	55.7 ± 1.16
NFE	80.3 ± 1.54	82.5 ± 1.23	85.6 ± 1.57	84.5 ± 2.33

^{abc} values in a column not sharing common superscripts differ significantly * ($P<0.05$)