Pakistan Vet. J., 2006, 26(3): 109-114.

INFLUENCE OF ENZYMES ON PERFORMANCE OF BROILERS FED SUNFLOWER-CORN BASED DIETS

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ABSTRACT

A 42-days trial was conducted to study the influence of exogenous enzymes supplementation to sunflower-corn based diet on digestive and performance traits in broilers. There were three treatments (control, Hamecozyme and Rovabio supplemented diets) and three replicates (20 broiler chicks per replicate) per treatment. At the end of the trial, birds fed the enzymes supplemented diets ate more and grew faster ($p<0.05$) and had better feed conversion ($p<0.05$) than those fed the control diet. Also enzymes supplementation improved ($p<0.05$) apparent faecal digestibilities of dry matter, organic matter, crude protein, ether extract, starch and gross energy. Enzymes supplementation improved ($p<0.05$) the dressing percentage; however, reduced ($p<0.05$) relative proventriculus and gizzard weight and also reduced ($p<0.05$) relative length of total GIT, duodenum and jejunum and ileum. Whereas, non-significant ($p>0.05$) difference was observed in meat composition among the all groups. Mortality rate was considerably low in enzyme treated groups. Sticky droppings caused by sunflower-corn based feeding were also mitigated by enzyme feeding. The results indicated that enzyme supplementation reduced the relative cost per unit weight gain. It was concluded that enzymes supplementation to sunflower-corn based diets improved digestibility of nutrients and performance of broilers.

Keywords: Broiler, enzyme, body weight, feed conversion ratio, digestibility.

INTRODUCTION

In Pakistan, broiler feed is based primarily on cereal grains and vegetable protein meal, which is supplied for meeting most of energy and protein requirements in the poultry diet. Sunflower oil meal (SFM) is a byproduct obtained after the extraction of oil from decorticated sunflower seeds. Being a good source of vegetable protein (40% CP), the SFM can be developed as a good vegetable protein supplement for different poultry diets.

However, high level of inclusion of SFM in poultry diet poses certain problems like increased viscosity of gut contents, poor digestibility and poor chick performance due to its high fibre content (14-18% CF; Rad and Keshavarz, 1976). The testa of SFM and cereal grains is rich in non-starch polysaccharides (NSP) which reduce the digestibility of the SFM/cereal grains. These NSP are polymeric carbohydrates which differ in composition and structure from starch (Annison, 1992) and possess chemical cross linking among them and therefore are not well digested by poultry (Annison, 1993). A part of these NSP is water soluble which is notorious for forming a gel like viscous consistency in the intestinal tract (Pettersson, 1987). Predominantly water soluble and viscous arabinoxylans (belongs to pentasan group) are assumed to be the factor responsible for the low metabolizeable energy (ME) in cereal grains (Choct and Annison, 1990), resulting in relatively poor chick performance (Friesen *et al.,* 1992). These pentasans, which are the main constituents of the endosperm cell wall of cereal grains, greatly increase the water intake by the bird which leads to un-manageable litter problems caused by wet and sticky droppings (Dunn, 1996). Similarly, β-glucans also adversely affect all nutrients, especially protein and starch utilization and are known to give rise to highly viscous conditions in the small intestine of the chicks (Hesselman and Aman, 1986).

Research work has suggested that these negative effects of NPS can be overcome by supplementation of diets with suitable exogenous enzyme preparations (Zanella *et al.,* 1999; Gracia *et al.,* 2003). Rovabio Excel is a stabilized multi-enzyme combination, naturally produced by the non-genetically modified fungus *penicillium funicullosum*. It contains xylanases, β-glucanases and cellulases. Similarly, hamecozyme-II is also multi-enzyme product (Hameco Agro B.V.Z wolle, Holand), which contains protease, amylase, xylanase, β-glucanase and cellulase. Both enzyme mixtures are claimed to break down the NSP, reduce the viscosity of gut content and improve the utilization of nutrients. These enzymes are assumed to degrade high amount of NSP in SFM and cereal grains, resulting in increased nutrient availability to poultry birds. Therefore, a trial was conducted to study the effects of supplementing a sunflower-corn meal based diet with Rovabio and Hamecozyme-II multi-enzymes on nutrient

digestibility, weight gain and carcass characteristics of broilers.

MATERIALS AND METHODS

Experimental birds

One hundred and eighty day-old broiler chicks were obtained from a commercial hatchery. These chicks (average 40 $\pm$ 0.4g body weight) were weighed individually and then randomly divided into 9 experimental units (replicates) of 20 chicks each. The chicks in each replicate were housed in clean and disinfected separate pens. A 2-3 inch thick layer of saw dust was used as litter material in each pen and the litter was regularly stirred once a day to keep it dry and clean. The brooding temperature was kept at 35^{o}C during the first week of age and it was gradually lowered by 3^{o}C till 4th week. Thereafter, the temperature of 22^{o}C was maintained for the rest of experimental period. All the chicks were vaccinated against Newcastle disease, hydro-pericardium syndrome and infectious bursal disease.

There were three dietary treatments: a corn-sunflower diet (A) and the same diet supplemented with 500 g per tone (t) of one of the two Hamecozyme (H) and Rovabio (R) enzymes preparation (Table 1). All three diets were formulated to meet or exceed the minimum nutrient requirements recommended by the National Research Council (NRC, 1994). Each experimental diet was randomly allotted to three experimental units. The experiment was conducted for a period of 42 days. Weekly weight gain, feed consumption and feed conversion ratio were recorded.

Digestibility of nutrients

Apparent faecal digestibilities of dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), starch and gross energy (GE) of the diets were measured at 28 days of age by the total collection method (Bourdillon *et al.*, 1990). Three birds from each replicate were housed in the metabolic cages, after a three days adaptation period, excreta samples were collected daily from each cage for 4 consecutive days, frozen and store in plastic bags (-20^{o}C) until analysis. Prior to analysis, excreta samples were thawed over night, homogenized, dried (72 hours; 60^{o}C) and ground (1mm screen).

Slaughtering data

At the end of experiment, two birds from each replicate were slaughtered to obtain their dressing percentage and proventriculus, gizzard weight and relative length of total gastro-intestinal tract (GIT), duodenum and jejunum and ileum. Organ to body weight ratio was calculated, using the formula described by Sharma *et al.* (1989). Composition of meat was also determined.

Chemical analysis

Diets, carcass and faeces were analyzed for DM by oven drying method, ash by muffle furnace, CP by Kjeldahl method, EE by Soxhlet fat analysis, CF and starch by alfa–amylase glucosidase method, as described by the AOAC (2000). Nitrogen free extract (NFE) and metabolisable energy (ME) were calculated by the method of Wardeh (1981).

Economic efficiency

Economic analysis of live weight gain of broiler chicks was calculated. For this purpose, total expenditure cost of chick was deducted from the gross income of the live weight gain.

Statistical analysis

Completely randomized design was used for the study. The data thus collected were subjected to statistical analysis using analysis of variance technique. Multiple means comparisons were made using Duncan's Multiple Range test (Steel and Torrie, 1982).

RESULTS AND DISCUSSION

In general, enzyme supplementation improved productive performance of birds fed sunflower-corn based diets. At the end of the trial, birds fed the enzyme-supplemented diets ate more ($p>0.05$), grew faster ($p<0.05$) and tended to have better feed conversion ($p<0.05$) than that of control diet (Table 2).

The results of the present study substantiated the findings of Gracia *et al.* (2003) and Lazaro *et al.* (2003), who reported that fungal enzyme preparation significantly improved the weight gain of birds fed on barley, rye, wheat and corn based diets. They explained that inclusion of cereal grain in broiler diets without enzyme decreased performance due to increased viscosity of the intestine content of birds. Higher NSP contained in the cereal grains might be responsible for the higher viscosity and consequent impairment in productivity.

Apparent digestibilities of DM, OM, CP, EE, starch and energy were increased ($p<0.05$) with supplementation of enzymes (Table 3). These results are in line with those of Noy and Sklan (1995); Vukic and Wenk (1996) and Zanella *et al* (1999), who reported that supplementation of broiler diet with exogenous enzyme improved starch digestibility and consequently DM, OM, CP and energy digestibilities. They explained that the solubilization and disruption of grains endosperm cell walls by enzyme supplementation was primarily responsible for the improvement in digestibility.

Table 1: Composition of experimental diets

Ingredients	Diets (%)		
	A	H	R
Maize	36.84	36.84	36.84
Rice broken	27.56	27.56	27.56
Cotton seed meal	3.01	3.01	3.01
Corn gluten meal (60%)	2.51	2.51	2.51
Corn gluten meal (30%)	2.00	2.00	2.00
Canola meal	3.01	3.01	3.01
Rape seed meal	3.01	3.01	3.01
Guar meal	2.51	2.51	2.51
Sunflower meal	8.02	8.02	8.02
Soyabean meal	3.26	3.26	3.26
Fish meal (50%)	3.76	3.76	3.76
Bone meal	1.75	1.75	1.75
Marble chips	1.30	1.30	1.30
Salt	0.25	0.25	0.25
L-Lysine	0.25	0.25	0.25
DL-Mathionine	0.07	0.07	0.07
Premix	0.40	0.40	0.40
Choline chloride	0.50	0.50	0.50
Hamecozyme	-	0.05	-
Rovabio	-	-	0.05
Nutrient composition of diets			
Gross energy (KCal/kg)	4577.51	4590.00	4588.00
Metabolizeable energy (Keal/Kg)	3204.26	3213.00	3212.00
Crude protein (%)	19.90	20.00	20.00
Crude fat (%)	2.81	2.75	2.80
Crude fibre (%)	5.31	5.25	5.10
Total ash (%)	6.48	6.25	6.30
Nitrogen free extract (%)	65.50	65.75	65.80
Starch (%)	28.00	25.80	26.50
Calcium (%)	1.14	1.18	1.16
Phosphorus (available) (%)	0.40	0.40	0.40
Lysine (%)	1.03	1.05	1.05
Methionine (%)	0.44	0.45	0.44
Mathionine + cystine (%)	0.74	0.75	0.74
Sodium (%)	0.18	0.18	0.18
NaCl (%)	0.44	0.43	0.44
Linolinic acid (%)	1.08	1.08	1.05
Hamecozyme (g/ton)	-	500	-
Rovabio (g/ton)	-	-	500

*A: Diet without enzymes (control); H: Diet with Hamecozyme; R: Diet with Rovabio™

Myashkauskene *et al.* (1984) reported that use of an enzyme in broiler feed caused greater proteolytic activity in the stomach and duodenum that ultimately improved digestibility of CP. According to Ritz *et al.* (1995), enzyme supplementation increased the length of villi within the jejunal and ileal sections of 3 weeks old turkey pullets fed corn soybean meal diets. The increase in surface area suggested by the increased villus length might enhance nutrients absorption and improve nutrient digestibility (Caspary, 1992). Viveros *et al.* (1993) reported that the improvement in digestibility by using an enzyme might get a little better nutrients absorption, but the bigger thing was the change in microbial flora and better gut health. They explained how enzyme can break down some NSP in wheat and barley and help promote growth of 'useful' bacteria. Without the enzyme, indigestible fibre promotes the growth of 'harmful' bacteria but with the enzyme, the fibre is

Table 2: Average weight gain, feed consumption and feed conversion ratio of broilers fed experimental diets (0-6 weeks)

Parameters	Diets*		
	A	H	R
Weight gain (g)	1450 ± 28.87c	1656.66 ± 28.48b	1876.66 ± 30a
Feed consumption (g)	3290.33 ± 96.92	3348 ± 119.60	3733.66 ± 150
Feed conversion ratio	2.27 ± 0.003a	2.02 ± 0.006b	1.986 ± 0.005b

Means in the same rows bearing different letters differ significantly ($p< 0.05$).
***** A: Diet without enzymes (control); H: Diet with Hamecozyme
R: Diet with Rovabio™

Table 3: Apparent digestibility (%) of DM, OM, CP, EE, Starch & GE of the experimental diets

Parameters	Diets*		
	A	H	R
DM	71.6 ± 0.40b	76.8 ± 0.32a	77.0 ± 0.59a
OM	77.4 ± 0.80b	81.3 ± 0.60a	81.5 ± 0.55a
CP	61.5 ± 0.53b	68.1 ± 0.62a	68.3 ± 0.60a
EE	78.3 ± 1.60b	85.8 ± 1.75a	86.5 ± 1.83a
Starch	90.3 ± 0.78b	98.0 ± 0.61a	98.2 ± 0.70a
GE	77.2 ± 0.41b	81.7 ± 0.45a	81.9 ± 0.31a

Means in the same rows bearing different letters differ significantly ($p< 0.05$).
***** A: Diet without enzymes (control); H: Diet with Hamecozyme
R: Diet with Rovabio™

broken down and promotes the growth of 'useful' bacteria. With the addition of the enzyme the indigestible starch works like a prebiotic (starch can be fermented by microbes in the gut of the bird, as pre-biotic may selectively enhance beneficial bacteria population in the gut like *bifido* bacteria and *lacto bacilli*).

Lower dressing percentage was observed in birds fed on un-supplemented diet compared to those of diets with enzymes supplementation (Table 4). These results showed that enzymes treated sunflower-corn based diets improved ($p<0.05$) the dressing percentage of birds. Abbas *et al.* (1998) also found that enzyme supplementation to fibrous diet improved the growth rate, thereby increasing the dressing percentage.

Maximum relative weight of proventriculus and gizzard was obtained from diet without supplementation of enzymes**,** whereas minimum relative weight of both organs was observed for diets with supplementation of enzymes (Table 4). These results indicated that enzymes treatment reduced ($p<0.05$) the size of proventriculus and gizzard. A similar trend was observed in relative length of whole GIT (including duodenum and jejunum + ileum length) of birds. Viveros *et al.* (1993) reported that addition of enzyme to barley-based diets also produced an effect on digestive tract of the bird, reducing the relative weight of upper tract (mainly proventriculus and gizzard), and the size of the small intestine and colon of chicks. In experiments using rats, Ikegami *et al.* (1990) demonstrated that the addition of various indigestible polysaccharides (sodium alignate, pectin and glucomanan) to the diets caused an enlargement of the digestive organs and reduction in apparent digestibilities of nutrients. The presence of fibre in sunflower could have also been responsible for the effects obtained in the current study, with its effects being counteracted by enzyme treatment (Salih *et al.*, 1991; Hesselman and Aman, 1996).

Furthermore, the present study showed that enzyme supplementation did not change the broiler meat composition (Table 4). El-Sherif *et al.* (1997) also reported non significant difference in meat composition of broiler fed sunflower base diets with or without enzymes.

In the present experiment, maximum mortality was observed in control group compared to those of enzymes treated groups. Strelec and Volk (1995) reported that mortality rate was considerably low in enzyme treated group. The main cause of mortality in control group was high fibre diet that caused increasing incidence of pasting vents and wet litter (Coccidiosis cases occurred). Pettersson (1987) reported that use of high levels of fibre diets increased the incidence of sticky droppings in broilers.

Table 4: Slaughtering data and carcass characteristics of broilers fed on experimental diets (0-6 Weeks)

Parameters	Diets*		
	A	H	R
Av. total body weight (g/bird)	1465 ± 3.58c	1690 ± 7.76b	1887.50 ±7.70a
Av. dressed carcass weight (g/bird)	822 ± 6.36c	1000 ± 5.58b	1125 ± 6.57a
Dressing percentage	56.11 ± 0.42b	59.17 ± 0.10a	59.60 ± 1.69a
Av. proventriculs weight (g/100g B.wt)	0.7887 ± 0.02a	0.5894 ± 0.01b	0.5775 ± 0.01b
Av. gizzard weight(g/100g B.wt)	2.553 ± 0.62a	1.800 ± 0.52b	1.748 ± 0.30b
Whole GIT length (cm/100g B.wt)	16.31 ± 0.54a	11.71 ± 0.61b	11.42 ± 0.33b
Duodenum length (cm/100g B.wt)	2.136 ± 0.13a	1.531 ± 0.12b	1.490 ± 0.10b
Jejnum + Ileum length (cm/100g B.wt)	10.32 ± 0.45a	7.416 ± 0.30b	7.246 ± 0.38b
Carcass composition (%):			
Moisture	67.8 ± 1.5	67.7 ± 1.5	67.0 ± 1.3
Crude protein	22.5 ± 1.1	22.2 ± 1.5	23.0 ± 0.9
Crude fat	11.5 ± 0.5	10.7 ± 0.4	10.9 ± 0.3
Total ash	4.1 ± 0.7	4.4 ± 0.0	4.1 ± 0.4

Means in the same rows bearing different letters differ significantly ($p< 0.05$).

*****A: Diet without enzymes (control) ; H: Diet with Hamecozyme
R: Diet with Rovabio™

Finally, the economics of enzymes was more encouraging where treated groups generated more profit than that of control group. The results revealed that per bird total return on sale was Rs.69.60, 79.52 and 90.08 at total expenditure of Rs.68.27, 69.44 and 75.05 for groups A, H and R, respectively (Table 5). The net per bird income was Rs.1.33, 10.08 and 15.03 for groups A, H and R, respectively. Economic data clearly indicated that enzymes supplementation is more feasible and economical to obtain maximum profitability from broiler production. Mikulski *et al.* (1999) also reported that enzyme supplementation decreased the relative cost of broiler feeds by 4 to 18% compared to that of without enzyme supplement feed.

In conclusion, enzyme supplementation to sunflower-corn based diet increases digestibilities of all nutrients of the diet and can be used to improve performance of broiler and economic viability.

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Table 5: Economic analysis of broiler fed on experimental diets (0-6 weeks)

Parameters	Diets*		
	A	H	R
Chick cost (Rs.)[1]	18.00	18.00	18.00
Feed intake (g/bird)	3290.33	3348	733.66
Cost of feed consumed (Rs/bird)[2]	50.27	51.15	57.05
Enzyme cost (Rs.)[2]	-	0.29	0.33
Total cost (Rs.)	68.27	69.44	75.05
Average live weight after 42 days (g)	1450	1656.66	1876.66
Return on sale @ Rs.48 per Kg (Rs)	69.60	79.52	90.08
Per bird net profit (Rs)	1.33	10.08	15.03
Profit per bird over control group (Rs)	-	8.75	13.70

[1]One US $ was equal to about 60 Pakistani rupees (Rs.).
[2]Cost of ration = Rs.15.28 /Kg and enzymes (supplemented) = Rs.0.175/ gm
***** A: Diet without enzymes (control) ; H: Diet with Hamecozyme
R: Diet with Rovabio™

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