EFFECT OF ENZYME SUPPLEMENTATION ON CARCASS QUALITY, INTESTINAL VISCOSITY AND ILEAL DIGESTIBILITIES OF BROILERS TO NUTRIENT REDUCED DIET

A.Bharathidhasan[1], D.Chandrasekaran[2], A.Natarajan[3], R.Ravi[4] and S.Ezhilvalavan[5]

University Research Farm,
Tamil Nadu Veterinary and Animal Sciences University,
Madhavaram milk colony, Chennai-51.

ABSTRACT

An experiment was conducted to assess the effect of enzyme supplementation on carcass quality, intestinal viscosity and tibial bone ash of broilers (0-6 wks). Broilers were supplemented with enzyme level at 0, 250, 500, 750 and 1000 g/ ton of feed with a proportionate reduction in metabolizable energy (ME-1.25, 2.5, 3.75 and 5 %), crude protein (CP-0.75, 1.5, 2.25 and 3 %), methionine+cystine (0.5, 1, 1.5 and 2 %) and available phosphorus (AP-2.2, 4.4, 6.6 and 8.8 %). There was no significant difference in carcass yield, dressing percentage, giblet weight, carcass weight, intestinal length and organoleptic characteristics of the meat. A significant decrease ($P<0.05$) in the intestinal viscosity was observed with 500 g/ton ($1.67 x 10^{-3}$ NSm^{-2}) of enzyme supplementation over the control ($2.26 x 10^{-3} NSm^{-2}$). The dry matter (DM) content of excreta and tibial bone ash content were significantly ($P<0.05$) increased in all the enzyme supplemented groups than the control. A significant ($P<0.05$) increase in tibial bone phosphorus was observed in 1000 g/ton of enzyme supplemented group when compared to control.

Keywords: Enzyme supplementation, Carcass quality and Intestinal viscosity

INTRODUCTION

Major part of poultry feed contains considerable amount of Nonstarch polysaccharides (NSPs) and phytates. These NSPs and phytates are antinutritive to poultry. The ingestion of soluble NSPs like b- glucans increased the digesta viscosity (Choct and Annison, 1992) and depressed the growth rate (White *et al*, 1981) in broiler chicken. Phytate or phytic acid is a naturally occurring organic complex found in plants and 60-80 % of phosphorus found in the cereal grains and oilseeds exists as phytic acid (Simons and Versteegh, 1990). Phytate forms stable complexes with minerals like Ca, Zn, Cu etc., and with protein (Cheryan, 1980) in the poultry gut thereby reducing their utilization. The feed enzymes including NSP degrading enzymes and phytase would alleviate the antinutritive activities of NSPs and phytate phosphorus (PP) contents of feed and enhance the utilization of the same. Hence the present study was conducted to evaluate the effect of enzyme supplementation on carcass

*Part of M.V.Sc thesis of the first author submitted to Tamilnadu Veterinary and Animal Sciences University, Chennai-51. [1]Assistant Professor, URF, TANUVAS, M.M.Colony, Chennai-51, [2]Professor and Head, Dept of Animal Nutrition, [3]Associate Professor, [4]Professor and Head, AFAQCL, VCRI, Namakkal. [5]Assistant Professor, DEE, TANUVAS, M.M.Colony, Chennai-51 quality, intestinal viscosity and tibial bone ash of broiler chicken

MATERIALS AND METHODS

Five experimental starter and finisher diets were formulated (BIS, 1992) to contain the commercial feed enzyme levels of 0, 250, 500, 750 and 1000 g per ton of feed with dose dependent reduction of metabolizable energy (ME-1.25, 2.5, 3.75 and 5 %), crude protein (CP-0.75, 1.5, 2.25 and 3 %), methionine+cystine (0.5, 1, 1.5 and 2 %) and available phosphorus (AP-2.2, 4.4, 6.6 and 8.8 %) as presented in Table1. The ingredient and chemical composition (AOAC, 1990) of broiler starter and finisher diets are also presented in Table 1.

One hundred and sixty five Vencobb broiler straight-run chicks were wing banded, weighed individually and distributed randomly to five experimental diets with three replicates of eleven chicks each. The birds were housed in deep litter pens and reared from day one to six weeks following uniform standard managemental practices. One hundred and sixty five Vencobb broiler straight run chicks were wing banded, weighed individually and distributed randomly to five experimental diets with three replicate of eleven chicks each. The birds were housed in deep litter pens and reared from day one to six weeks following uniform standard manage mental practices

At the end of six weeks of age, six birds from each experimental group were selected randomly and slaughtered (Gracey, 1986) for estimating digesta viscosity and studying carcass quality.

The relative viscosity of digesta supernatant was measured using Poisecillus method for coefficient of viscosity (Brijlal and Subramaniyan, 1989). The viscosity of polysaccharides in solution is a function of a number of factors including the concentration of the polysaccharides and other solutes. In order to compare the digesta supernatant it was necessary to adjust the volume of the supernatant so that the relative concentration of the digesta components were the same as the original digesta samples. This was achieved as follows; digesta was collected in 15 ml of water and centrifuged immediately (10,000 x g, 15 min). The volume of supernatant (Vt) was recorded and the water content of the original digesta (Vo) was calculated.

Digesta viscosity (η) calculated by

$$\eta = \pi g a^4 d\,(h) / 8l\,(v)$$

g = gravitational force d = density h = height
a = radius of the capillary tube
l = length of the capillary tube v =volume

The dry matter (DM) content of excreta was calculated. In carcass quality studies, the eviscerated carcass yield, dressing percentage, giblet percentage, the weights of gizzard, liver, heart, pancreas, proventriculus and intestinal length were measured and recorded. Breast muscle of uniform size was collected from all the slaughtered birds and analyzed for organoleptic characteristic following the standard procedure. The left tibial bone from all the slaughtered birds was removed, dried overnight in a hot air oven at 70^0C and defatted with petroleum ether and analyzed for tibial ash, Calcium (Ca) and Phosphorus (P) contents as per the methods of AOAC (1990). The data collected on various parameters were statistically analyzed as per the method of Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

The carcass characteristics in terms of carcass yield, dressing percentage, giblet weight (as percentage of live weight) and weights of gizzard, liver, heart, pancreas, proventriculus and intestinal length are presented in Table 2.

The mean carcass yield of the birds fed with diet containing enzyme level at 0, 250, 500, 750 and 1000 g/ton of feed was 67.17, 68.73, 68.99, 68.55 and 70.45 % respectively. There was a marginal increase in dressing percentage and carcass yield in enzyme supplemented groups. The giblet percentage and weight of organs among the treatment groups did not differ significantly, however there was a numerical decrease in the weights of proventriculus, liver and pancreas. Similar decrease in weight of organs was observed by Brenes *et al*., (1993a) with supplementation of enzyme (200 mg/kg) to a barley based diet but not in a wheat based diet. The authors attributed the reason for this reduction to an adaptive response to the increased nutrient digestibility and availability. The authors also opined that the reduction in the weight of organs with the enzyme supplementation had a direct economic benefit resulting in a proportionate increase in the dressing yield of broilers. The intestinal length was found to be numerically decreased but not significant in enzyme treated groups than the control. Brenes *et al*. (1993b) observed that the intestinal length was significantly reduced (duodenum 13 %, jejunum 18 %, ileum 18 % and caecum 7 %) due to addition of 0.1 % each of carbohydrase, protease and a-galactosidase to a diet of 70 % lupin in broiler chicken.

The mean values of organoleptic characteristics are presented in Table 3 and Intestinal Viscosity, DM content of excreta, tibial bone ash, Ca and P are presented in Table 4. The enzyme supplementation at various levels did not alter the organoleptic characteristics among the various treatment groups. The intestinal viscosity in the birds fed with diet containing enzyme at 0, 250, 500, 750 and 1000 g/ton of feed was 2.26, 1.85, 1.67, 2.01 and 2.00×10^{-3} NSm^{-2}, respectively. A significant ($P<0.05$) and gradual decrease in the intestinal viscosity was observed in birds fed up to 500 g of enzyme supplementation, beyond that a slight increase in intestinal viscosity was observed. Similarly, White *et al*., (1981) observed a reduction in the viscosity of the intestinal contents, when the broilers were supplemented with *Trichoderma viridae* (400 mg/kg) on b-glucan (10 g/kg) contained corn based diet. Also the finding was in close agreement with Bedford and Classen (1992), who reported that substituting wheat by rye (0, 200, 400 and 600 g/kg) in the diet of broilers increased the viscosity of proximal and distal gut contents. Addition of pentosanase at 1, 2, 4, 8 and 16 g/kg caused a dose dependent reduction in viscosity of both proximal and distal small intestinal contents. Significant ($P<0.05$) increase in DM content of excreta was observed in all the enzyme supplemented groups (22.18, 22.83, 22.21 and 22.03 % in 250, 500, 750 and 1000 g/ton respectively) when compared to control (20.54). Hesselman *et al*., (1982) found that the supplementation of b-glucanase at the rate of 0, 0.05, 0.1 and 0.5 g/kg to the barley based diet increased the DM content of excreta and the increase was highest (10 %) in the group supplemented with enzyme at the rate of 0.5 g/kg of feed.

The tibial ash content was significantly ($P<0.05$) increased in 500, 750 and 1000 g/ton of enzyme supplemented groups than control. The increase in tibial ash content was by 8.03 % in 1000g of enzyme supplemented group over the control. Similarly Nelson *et al*., (1971) reported increased bone ash content in broiler chicken fed with corn, soyabean meal based diet supplemented with phytase enzyme at 1 to 8 g/kg diet. Also a similar increase in tibial bone ash content was reported due to enzyme supplementation (Carlos and Edwards, 1998). No significant difference was observed in Ca content of bone ash between the treatment groups. There was a significant ($P<0.05$) increase (8.22 %) in P content of tibial bone only in the group supplemented with 1000 g of enzyme when compared to control. The gradual increase in P content in relation to percent of bone ash could be due to activity of enzyme phytase present in the enzyme preparation used in this study.

Table1:
Ingredient and chemical composition of broiler starter and finisher diets

Ingredients (%)	Broiler starter (Enzyme inclusion (g/ton))					Broiler Finisher (Enzyme inclusion (g/ton))				
	0	250	500	750	1000	0	250	500	750	1000
Maize	44	39.5	35	28	23	47.50	43.00	36.00	31.20	25.00
Broken rice	2.2	7.0	8.0	14.0	18.0	4.80	6.00	9.20	14.40	15.80
Cumbu	2.8	2.0	4.0	5.0	6.0	3.50	5.80	9.00	8.00	12.70
Deoiled rice bran	1.1	2.1	5.0	5.6	6.3	2.60	4.50	5.80	6.65	7.20
Sunflower meal	0.5	0.8	0.5	0.5	0.5	0.50	0.50	0.75	0.70	0.70
Deoiled groundnut cake	8.0	8.0	6.8	6.8	6.4	3.80	3.75	4.65	6.65	10.50
Soya bean oil cake	37.8	37.0	37.1	36.5	36.2	32.70	31.80	30.00	27.85	23.60
Calcite	1.45	1.52	1.59	1.62	1.66	1.35	1.47	1.47	1.48	1.51
Dicalcium phosphate	1.65	1.58	1.52	1.49	1.44	1.75	1.69	1.63	1.57	1.47
Oil	0.5	0.5	0.5	0.5	0.5	1.50	1.50	1.50	1.50	1.50
DLMethionine (g/100 kg)	267.8	268.5	272.6	274.4	275.0	140.00	135.00	140.60	140.30	137.00

Nutrients	Broiler starter (Enzyme inclusion (g/ton))					Broiler Finisher (Enzyme inclusion (g/ton))				
	0	250	500	750	1000	0	250	500	750	1000
Dry matter	91.69	91.72	91.62	91.72	91.69	90.44	90.70	90.77	90.63	90.49
Crude protein (% reduction)	22.99 (0)	22.80 (0.75)	22.56 (1.5)	22.46 (2.25)	22.30 (3)	20.07 (0)	19.83 (0.75)	19.70 (1.5)	19.56 (2.25)	19.39 (3)
Crude fibre	4.86	4.83	4.99	5.17	5.33	4.83	4.95	5.20	5.44	5.24
Ether extract	2.95	2.71	2.65	2.41	2.47	3.93	3.85	3.79	3.70	3.46
Total ash	9.13	8.99	9.02	9.06	8.87	9.31	9.47	9.20	9.89	9.93
NFE *	60.07	60.67	60.78	60.90	61.03	61.86	61.90	62.11	61.41	61.98
Acid insoluble ash	1.96	1.99	1.94	1.92	1.96	2.06	1.96	2.12	2.08	2.29
Calcium	1.14	1.14	1.04	1.15	1.19	1.05	1.09	1.05	1.05	1.09
Phosphorus	0.67	0.69	0.68	0.68	0.67	0.67	0.68	0.69	0.68	0.67
AvailablePhosphorus* (% reduction)	0.45 (0)	0.44 (2.2)	0.43 (4.4)	0.42 (6.6)	0.41 (8.8)	0.45 (0)	0.44 (2.2)	0.43 (4.4)	0.42 (6.6)	0.4 (8.8)
Cystine +methionine* (% reduction)	0.90 (0)	0.90 (0.5)	0.89 (1)	0.89 (1.5)	0.88 (2)	0.70 (0)	0.69 (0.5)	0.69 (1.0)	0.69 (1.5)	0.69 (2)
ME(kcal/kg)* (% reduction)	2799 (0)	2767(1.25)	2732(2.5)	2695 (3.75)	2669 (5)	2904 (0)	2869 (1.25)	2829 (2.5)	2794 (3.75)	2758 (5)

1.Mineral mixture 1g per kg feed added and contained calcium-32%, phosphorus-6%, manganese-0.27%, iodine-0.01%, zinc-0.26%, copper-100ppm and iron-1000ppm
2. Vitamin AB2D3K 0.2g per kg feed added and supplied vitamin A-8250 IU, B2-5 mg, D3 1200 IU and vitamin-K-1 mg.
3.Coccidiostat 0.5g per kg feed added and supplied 125 mg of Di-nitro-ortho Toluamide -
4.Antibiotic (TM 100) 0.5 g added per kg of feed.
5.Feed Enzyme at the level of cellulase146 IU/g, xylanase 241 IU/g, Pectinase 98 IU/g, Protease 74 IU/g, Amylase 778 IU/g Phytase 33 IU/g

*** Calculated values**

Table 2

Effect of different levels of enzyme supplementation on carcass characteristics in broilers.

Enzyme g/ton of feed	Eviscerated carcass weight as % of live weight (carcass yield)	Dressing percentage	Giblet (%)	Gizzard (g)	Liver (g)	Heart (g)	Pancreas (g)	Proventriculus (g)	Intestinal length (cm)
0	67.17 ± 1.48	72.68 ± 1.27	5.09 ± 0.21	33.17 ± 2.04	44.50 ± 2.42	5.67 ± 0.33	4.33 ± 0.21	7.00 ± 0.45	185.00±7.30
250	68.73 ± 0.73	73.67 ± 1.13	4.90 ± 0.47	31.0 ± 1.61	37.83 ± 4.13	6.67 ± 0.71	3.42 ± 0.37	5.75 ± 0.54	180.33±8.09
500	68.99 ± 0.56	74.19 ± 0.63	5.20 ± 0.08	32.17 ± 1.72	40.33 ± 1.56	5.33 ± 0.21	3.50 ± 0.34	6.83 ± 0.17	184.67±7.19
750	68.55 ± 0.68	73.84 ± 0.96	5.29 ± 0.50	31.50 ± 1.33	40.83 ± 3.64	5.17 ± 0.70	3.67 ± 0.33	5.92 ± 0.27	182.50±7.53
1000	70.45 ± 1.12	75.05 ± 0.66	4.63 ± 0.25	30.33 ± 2.14	30.33 ± 2.14	5.33 ± 0.33	3.17 ± 0.30	6.33 ± 0.30	174.57±5.27

Mean of six observations.
Means do not differ significantly

Table 3

Effect of different levels of enzyme supplementation on sensory evaluation of meat in broilers.

Enzyme g/ton of feed	Appearance	Flavour	Juiciness	Tenderness	Overall Acceptability
0	7.00 ± 0.33	7.25 ± 0.34	7.00 ± 0.41	7.11 ± 0.42	7.44 ± 0.34
250	6.56 ± 1.24	7.56 ± 0.37	7.33 ± 0.44	7.22 ± 0.40	7.62 ± 0.44
500	8.00 ± 0.44	7.67 ± 0.44	7.78 ± 0.36	7.78 ± 0.32	7.78 ± 0.28
750	7.00 ± 0.33	7.11 ± 0.31	6.89 ± 0.45	7.00 ± 0.28	7.44 ± 0.34
1000	7.22 ± 0.21	7.44 ± 0.15	7.22 ± 0.16	7.55 ± 0.25	7.56 ± 0.12

Mean of six observations.
Means do not differ significantly

From this study it was found that the enzyme supplementation reduced the intestinal viscosity, increased the DM content of excreta and tibial bone ash of broilers with dose dependent reduction of ME, CP, methionine+cystine and AP.

REFERENCES

AOAC.(1990). *Official Methods of Analysis*, Association of Official Analytical Chemists,15th edn.,Washington, D.C.

Table 4: Effect of different levels of enzyme supplementation on viscosity of intestinal digesta, dry matter content of excreta, tibial bone ash, calcium and phosphorus in broiler chicken.

Enzyme g / ton of feed	Viscosity of intestinal digesta* X 10^{-3} (NSm^{-2})	Dry matter content of excreta ** (%)	Tibial bone ash* (%)	Tibial bone ash*	
				Calcium (%)	Phosphorus (%)
0	$2.26^{c} \pm 0.11$	$20.54^{a} \pm 0.21$	$47.45^{a} \pm 0.69$	30.18 ± 0.78	$14..96^{a} \pm 0.32$
250	$1.85^{ab} \pm 0.11$	$22.18^{b} \pm 0.45$	$49.13^{ab} \pm 0.22$	30.47 ± 0.14	$14.98^{a} \pm 0.14$
500	$1.67^{a} \pm 0.06$	$22.83^{b} \pm 0.34$	$49.81^{bc} \pm 0.23$	30.59 ± 0.16	$15.13^{a} \pm 0.09$
750	$2.01^{bc} \pm 0.14$	$22.21^{b} \pm 0.09$	$49.87^{bc} \pm 0.14$	30.43 ± 0.15	$15.67^{ab} \pm 0.14$
1000	$2.00^{abc} \pm 0.14$	$22.03^{b} \pm 0.28$	$51.59^{c} \pm 1.10$	30.83 ± 0.17	$16.30^{b} \pm 0.21$

* Mean of six observations
** Mean of four observations
Means with atleast one common superscript in a column do not differ significantly (P<0.05).

Bedford, M.R and Classen, H. L. (1992). Reduction of intestinal viscosity through manipulation of dietary rye and pentosanase concentration is effected through changes in the carbohydrate composition of the intestinal aqueous phase and results in improved growth rate and food conversion efficiency of broiler chicks. *J. Nutr.*, 122: 560-569.

BIS. (1992).*Requirement for chicken feeds*.IS:1374-1992, Menak Bhavan, 9 Bahadurshah Zafar Marg, New Delhi-110001.

Brenes, A., Smith, M., Guenter, W and Marquardt, R.R. (1993a). Effect of enzyme supplementation on the performance and digestive tract size of broiler chicken fed wheat and barley based diets. *Poult. Sci.*, 2: 1731-1739.

Brenes, A., Marquardt, R.R., Guenter, W and Rotter, B.A. (1993b). Effect of enzyme supplementation on the nutritional value of raw, autoclaved and dehulled lupins (*Lupinus albus*) in chicken diets. *Poult. Sci*., 72: 2281-2293.

Brij Lal and Subramanyam, N.(1989). *Properties of Matter*, 5[th] edn., Eurasia publishing house (pvt) Ltd, pp: 254.

Carlos,A.B and Edwards, H.M.J.R.(1998).The effects of 1,25 dihydroxy cholecalciferol and phytase on the natural phytate phosphorus utilisation by laying hens. *Poult. Sci*., 77: 850-858.

Cheryan,M.(1980). Phytic acid interactions in food systems. CRC. *Critical Reviews in Food Sci. and Nutr.*,13 : 297-302.

Choct, M and Annison, G.(1992).The inhibition of nutrient digestion by wheat pentosans. *Br. J. Anim. Nutr*., 67 : 123-132.

Danicke, S., Simon, O.,Jeroch,H and Bedford, M.(1997a). Interactions between dietary fat type and xylanase supplementation when rye based diets are fed to broiler chickens. 1. Physicochemical chyme features. *Br. Poult. Sci*., 38: 537-545.

Danicke, S., Simon, O., Jeroch, H and Bedford, M.(1997b). Interactions between dietary fat type and xylanase supplementation when rye based diets are fed to broiler chicken. 2. Performance, nutrient digestibility and the fat soluble vitamin status of livers. Br. *Poult. Sci*., 38:546-556.

Denbow, D.M., Ravindran, V., Kornegay, E.T., Yi, Z and Hulet, R.M. (1995). Improving phosphorus availability in soyabean meal for broilers by supplemental phytase. *Poult. Sci.*, 74: 1831-1842.

Edwards, H.M.J.R.(1993). Dietary 1,25- Dihydroxy cholecalciferol supplementation increases natural phytate phosphorus utilization of chickens. *J.Nutr*., 123: 567-577.

Erdman, J.W.J.(1979). Oilseed phytates nutritional implications. *Journal of American Oil Chemists Society*., 56: 736-741.

Gracey, J.F.(1986). *Meat Hygiene*, 8 th edn., ELBS, pp.146.

Hessleman,H., Elwinger,K., Nilsson,M and Thomke,S.(1981). The effect of b-glucanase supplementation, stage of ripeness and storage treatments of barely in diets fed to broiler chickens. *Poult. Sci.*, 60: 2664-2671.

Hesselman, H., Elwinger, K and Thomke, S.(1982). Influence of increasing levels of b-glucanase on the productive value of barely diets for broiler chickens. *Anim. Feed Sci. and Tech.*, 7:351-358.

Nelson, T.S., Shieh, T.R., Wodzinski, R.J and Ware, J.H. (1971). Effect of supplemental phytase on the utilization of phytase phosphorus by chicks. *J. Nutr.,* 101: 1289-1294.

Perney, K.M., Cantor, A.H., Straw, M.L and Herkelman, K.L.(1993). The effect of dietary phytase on growth performance and phosphorus utilization of broiler chicks. *Poult. Sci.*, 72: 2106-2114.

Philip, J.S., Gilbert, H.J and Smithard, R.R. (1995). Growth, viscosity and b-glucanase activity of intestinal fluid in broiler chickens fed on barley based diets with or without exogenous b-glucanase. *Br. Poult. Sci*., 36: 599-603.

Short, F.J., Gorton, P., Wiseman and Boorman, K.N.(1996). Determination of titanium dioxide added as a inert marker in chicken digestibility studies. *Anim. Feed Sci. and Tech*., 59: 215-221.

Simons, P.C.M and Versteegh, H.A.J. (1990). Improvement of phosphorus availability by microbial phytase in broiler and pigs. *Br. J. Nutr*., 64: 525-540.

Snedecor, G.W and Cochran, W.C. (1989). *Statistical Methods* 8th edn. Iowa State University Press, Ames, Iowa.

White, W.B., Bird, H.R., Sunde, M.L., Prentice, N., Burger, W.C and Marlett, J.A.(1981). The viscosity interaction of barley b-glucan with *Trichoderma viridae* cellulase in the chick intestine. *Poult. Sci.*, 60: 1043-1048.