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Enzyme phytase supplementation on the production performance and cost effectiveness in layers

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ABSTRACT

A study was carried out to find out the effect of enzyme phytase (One g contained 2410 U of phytase activity) supplemented at 300, 600, 900 and 1200 U/kg in layer chicken diets containing available phosphorus (AP) at 0.20, 0.25, and 0.30 per cent from 21 to 52 weeks of age. A control group fed with diet containing 0.50 per cent AP alone was also maintained. The inclusion of phytase in layer chicken diets containing different levels of available phosphorus 0.2, 0.25 and 0.3 per cent has significantly ($P<0.01$) improved the body weight of layer chicken when compared to unsupplemented groups. During the laying period the data on hen housed and hen day egg production showed significant increase in egg production after 40 weeks of age by supplementation of phytase. The significant ($P<0.05$) difference in overall (21-52 weeks) mean feed consumption was observed. The higher feed consumption (g/bird/day) was recorded in 0.2 AP phosphorus without phytase. The feed efficiency (kg of feed per dozen of eggs) was improved by addition of phytase when compared to respective unsupplemented groups. The performance of layers fed diet with 0.30 per cent AP with 300 IU per kg phytase supplementation was comparable to the BIS recommendation

Contains 2 tables

Key words: Phytase, layer production performance, economics

Phytase incorporation in layer diet had a favorable effect on body weight and feed intake (Keshavarz, 2000) for the period of 0 to 18 weeks of age. Supplementation of phytase in layer diet significantly improved the feed conversion (Jalal and Scheideler, 2001) and egg production (Rama Rao *et al.*, 1999) as compared to reference diet. Supplementation of 500 U of microbial phytase in layer can reduce the non-phytase level to 0.12% in layer diet without affecting the laying performance (Um and Paik, 1999). Hence the present study was made to find out the level of phytase enzyme in layer diets based on growth and egg production perfrmance and to find out the relative economy of using phytase in layer diets.

MATERIALS AND METHODS

Three hundred and thirty six commercial White Leghorn pullets of sixteen weeks age from a single hatch were reared for adaptation up to 20 weeks of age. These pullets were weighed, leg banded and randomly allotted into sixteen treatment groups with three replicates of seven birds each. The layers were reared in cages during their entire experimental period adopting standard managmental practices and *ad libitum* feeding. Sixteen hours photo period was provided daily through out the experimental period.

Layer diets were formulated as per BIS (1992) except for the available phosphorus (AP) content, which was kept low at the levels of 0.20, 0.25 and 0.30 per cent. The experimental groups were 0.2%AP (T_1); 0.2% AP+ 300 U phytase (T_2) ; 0.2% AP + 600 U phytase (T_3); 0.2% AP + 900 U phytase (T_4); 0.2% AP + 1200 U phytase (T_5); 0.25% AP (T_6); 0.25% AP+ 300 U phytase (T_7); 0.25% AP + 600 U phytase (T_8); 0.25% AP + 900 U phytase (T_9); 0.25% AP + 120 U phytase (T_{10}); 0.3% AP (T_{11}); 0.3% AP + 300 U phytase (T_{12});

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0.3% AP + 600 U phytase (T_{13}); 0.3% AP + 900 U phytase (T_{14}); 0.3% AP + 1200 U phytase (T_{15}) and 0.5% AP, BIS, 1992 (control T_{16}). Calcite and shell grit were added as calcium sources. Dicalcium phosphate (DCP) was used to adjust three different levels of available phosphorus in different experimental diets. The ingredient and nutrient composition of layer diet are presented in Table 1.

Table 1. Ingredient and nutrient composition of experimental layer diets from 21 to 52 weeks of age (on DM basis)

Ingredients (per cent)	Available Phosphorus (per cent)			
	0.20	0.25	0.30	0.50
Maize	48.10	48.10	48.10	48.10
Deoiled rice bran	10.20	10.20	10.20	10.20
Sunflower meal	8.00	8.00	8.00	8.00
Soybean meal	20.90	20.90	20.90	20.90
Fishmeal	3.00	3.00	3.00	3.00
Calcite	5.00	5.00	5.00	5.00
Shell Grit	4.80	4.46	4.30	3.00
Dicalcium phosphate	0.00	0.34	0.50	1.80
Total	100.00	100.00	100.00	100.00
Supplements (g/100kg)				
AB_2D_3K[1]	10.00	10.00	10.00	10.00
B-complex[2]	20.00	20.00	20.00	20.00
Trace mineral[3]	100.00	100.00	100.00	100.00
Lysine	10.00	10.00	10.00	10.00
Methionine	40.00	40.00	40.00	40.00

Nutrients (per cent)	Available Phosphorus (per cent)			
	0.21	**0.26**	**0.31**	**0.49**
CP	18.04	18.03	18.03	18.03
Dry matter	90.09	90.09	90.09	90.05
Crude fibre	6.75	6.75	6.75	6.79
Ether extract	4.92	4.92	4.92	4.95
ME(Kcal/kg)*	2530	2530	2530	2530
Calcium	3.75	3.71	3.69	3.69
Total phosphorus	0.52	0.58	0.63	0.83
Phytate phosphorus	0.35	0.39	0.42	0.55
Methionine*	0.30	0.30	0.30	0.30
Lysine*	0.87	0.87	0.87	0.87
Total ash	12.46	12.51	12.55	12.67

*- Calculated values

[1]One gram of Vitamin AB_2D_3K supplement contained 82500 IU of Vitamin-A, 50 mg of Vitamin-B_2, 12000 IU of Vitamin-D_3 and 10 mg of Vitamin-K.

[2]One gram of B-Complex supplement contained 8 mg of Vitamin-B_1, 16 mg of Vitamin-B_6, 80 mcg of Vitamin B_{12}, 80 mg of Vitamin-E, 120 mg of Niacin, 8 mg of Folic acid, 80 mg of Calcium pantothenate, 120 mg of Calcium and 300 mg of Phosphate.

[3]One gram of Trace Minerals contained 54 mg of manganese, 52 mg of zinc, 20 mg of iron, 2 mg of iodine and 1 mg of cobalt.

Note- One gram of phytase enzyme contained 2410 U of phytase activity.

During the laying period, the individual layer bird weight and total feed consumption were recorded once in every twenty-eight days. Egg production was recorded daily. With the data collected, feed consumption per bird, hen-day egg production, hen-housed egg production, feed efficiency per dozen eggs and per kg of egg mass were calculated. The economics were calculated based on the actual prevailing cost of the feed and phytase during study period. All the parametric data obtained in this study were subjected to analysis of variance (CRD) for statistical significance as per the methods of Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

The analysis of data on enzyme phytase supplementation (One g contained 2410 U of phytase activity) on the mean body weight of layers 52 weeks of age showed a significant difference (Table 2) among treatment groups. The lowest body weight (1296 g) at 52nd week of age was observed in birds fed with 0.2 per cent AP without enzyme supplementation. The highest body weight (1373 g) was observed in 0.5 per cent available phosphorus group without phytase, followed by 0.3 per cent available phosphorus with 300 units phytase supplemented group (1372 g). The inclusion of phytase in layer chicken diets containing different levels of available phosphorus (0.2, 0.25 and 0.3 per cent) improved the body weight of layers when compared to unsupplemented groups. Similar findings were observed in layers (Gorden and Roland, 1997; Rama Rao *et al.*, 1999). The improvement in body weight observed in layers fed with phytase enzyme may possibly due to either the release of phosphorus from phytate-mineral complex (Qian *et al.*, 1996) and/or increased utilization of protein (Camovale *et al.*, 1988). The analysis of overall hen housed egg production from 21 - 52 weeks revealed significantly ($P<0.05$) higher in enzyme treated groups than 0.2 and 0.25, per cent AP without phytase supplemented groups (T_1 and T_6). The hen housed egg production in 0.3 and 0.5 per cent AP without phytase groups (T_{11} and T_{16}) is comparable to those of phytase supplemented groups.

The hen day egg production due to phytase enzyme supplementation (Table 2) showed a significant ($P<0.05$) difference during 41-44, and 45-48 ($P<0.01$) and 49-52 ($P<0.05$) weeks of age. However, there was no significant difference in overall hen day egg production from 21-52 weeks of age. Similar findings of increase in egg production due to enzyme supplementation were observed in layers by Kaminska *et al.* (1996), Gorden and Roland (1997), Punna and Roland (1999) and Rama Rao *et al.* (1999). Phytase supplementation after 40 weeks of age is more beneficial than that of early ages. This could be attributed that hens can mobilize calcium and phosphorus from bones to meet out their need for egg production in early stages of consuming low phosphorus diet. But during later stages (after 40 weeks of age) the depleted skeletal bones cannot satisfy the requirement and thus calcium and phosphorus requirement through feed by the way of releasing phytate phosphorus and phytate calcium by the action of phytase made improvement in egg production.

Different levels of phytase enzyme inclusion show significant difference ($P<0.05$) in overall (21-52 weeks) mean feed consumption (Table 2). Lowest overall mean feed consumption was noticed in 0.3 per cent AP with 1200 units of phytase groups (96.35 g) and highest feed consumption was noticed in 0.2 per cent available phosphorus without enzyme supplementation (99.67 g). It may be attributed to the increase in apparent metabolizable energy by adding enzyme phytase. Similar findings were noticed by Denbow *et al.* (1995), Ravindran *et al.* (1995), and Viveros *et al.* (2002). The feed efficiency in laying hens up to 40 weeks of age did not show significant difference but after 40 weeks of age significant difference in feed efficiency was noticed. The overall feed efficiency (Table 2) from 21st to 52nd week of age differed significantly ($P<0.05$) among treatment groups. Addition of phytase improved the feed efficiency when compared to their respective unsupplemented groups. Significantly ($P<0.05$) improved feed efficiency was observed in T_2, T_3, T_4 and T_5 (0.2 per cent available phosphorus with graded levels of phytase supplementation) as

Table 2. Effect of enzyme phytase supplementation on layer performance

Treatment	Body weight(g) 52 weeks**	Mean percent hen day egg production 31-52 weeks	Mean hen-housed egg prod.(eggs/hen) 21-52 weeks*	Feed consumption (g/bird/day) 21-52 weeks*	Feed efficiency (kg of feed/ dozen eggs)*	Feed cost/kg (Rs.)	Feed cost/egg produced(Rs.)	Cost of production/ egg (Rs.)	Net profit/ egg produced (Rs.)
T_1	1296.48±04.95^{e}	87.30±0.71	187.48±5.49^{c}	99.67±0.90^{a}	1.39±0.02^{e}	6.65	0.75	1.04	0.16
T_2	1317.40±01.15^{cde}	89.45±0.66	198.86±2.27^{ab}	98.07±0.58^{b}	1.32±0.01^{bcd}	6.69	0.73	0.97	0.23
T_3	1318.44±06.40^{cde}	90.17±1.13	201.00±2.40^{a}	97.61±0.54^{bc}	1.31±0.02^{a-d}	6.72	0.73	0.97	0.23
T_4	1315.00±08.41^{cde}	89.49±0.79	200.24±1.93^{a}	98.03±0.19^{b}	1.33±0.01^{cd}	6.76	0.75	0.98	0.22
T_5	1314.27±09.11^{cde}	90.13±0.40	201.67±0.67^{a}	97.31±0.26^{bc}	1.32±0.02^{bcd}	6.80	0.74	0.97	0.23
T_6	1314.06±04.55^{cde}	88.03±1.41	191.95±1.76^{bc}	97.69±0.22^{b}	1.35±0.02^{de}	6.69	0.75	1.01	0.19
T_7	1341.53±14.88^{abcd}	90.07±0.91	201.76±2.05^{a}	97.37±0.30^{bc}	1.31±0.02^{a-d}	6.72	0.71	0.96	0.24
T_8	1339.95±05.87^{abcd}	89.84±1.33	201.24±2.99^{a}	96.87±0.27^{bc}	1.30±0.02^{a-d}	6.76	0.72	0.96	0.24
T_9	1338.05±04.73^{abcd}	89.63±2.10	200.76±4.69^{a}	97.04±0.76^{bc}	1.31±0.04^{a-d}	6.80	0.72	0.97	0.23
T_{10}	1337.95±08.60^{bcd}	91.18±0.33	204.24±0.75^{a}	97.35±0.44^{bc}	1.30±0.01^{abc}	6.83	0.73	0.96	0.24
T_{11}	1347.43±02.76^{abc}	89.05±0.49	199.48±1.11^{a}	97.13±0.50^{bc}	1.33±0.01^{bcd}	6.72	0.73	0.97	0.23
T_{12}	1371.76±04.36^{a}	90.65±0.73	203.05±1.64^{a}	96.67±0.48^{bc}	1.30±0.01^{abc}	6.76	0.72	0.95	0.25
T_{13}	1353.44±17.18^{ab}	91.50±1.11	199.76±7.33^{a}	97.08±0.25^{bc}	1.29±0.02^{abc}	6.79	0.74	0.97	0.23
T_{14}	1360.95±14.32^{a}	90.56±1.22	202.86±2.73^{a}	96.98±0.44^{bc}	1.30±0.02^{abc}	6.83	0.72	0.96	0.24
T_{15}	1353.10±06.02^{ab}	91.35±0.39	204.62±0.88^{a}	96.35±0.77^{c}	1.27±0.01^{a}	6.87	0.72	0.95	0.25
T_{16}	1373.00±10.37^{a}	91.41±0.50	204.76±1.12^{a}	96.91±0.28^{bc}	1.28±0.01^{ab}	6.84	0.73	0.95	0.25

**Means within a column with no common superscript differ significantly ($P<0.01$)
*Means within a column with no common superscript differ significantly ($P<0.05$)

compared to unsupplemented group T_1 (0.2 per cent available phosphorus without phytase). Similar findings of non significant difference in feed efficiency up to 40 weeks of age were reported by Um and Paik, 1999. The improvement in feed intake and feed efficiency by phytase supplementation might be due to the possible release of minerals and protein from the phytate bound minerals and protein in phytase supplemented groups than unsupplemented groups.

Feed cost per kg layer diets, feed cost per egg produced, cost of production per egg and net profit per egg produced due to supplementation of different levels of phytase are presented in Table 2. Addition of enzyme phytase increased the feed cost proportionate to the level of inclusion. The beneficial effects of enzyme as increased egg production and body weight had curtailed the increase in feed cost by supplementing phytase. The supplementation of different levels of phytase enzyme on low available phosphorus diets did not increase the production cost and net profit per egg over that of 0.50 per cent available phosphorus group. Addition of phytase more than 300 units did not increase the production cost and net profit per egg. This is in accordance with the findings of Khose *et al.* (2003). Hence the BIS recommendation of 0.5 per cent available phosphorus may be very well reduced to 0.30 per cent available phosphorus when added with 300 units of phytase to get maximum profit in layer chicken

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