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EFFECT OF PHYTASE ENZYME SUPPLEMENTATION ON THE PERFORMANCE OF LAYING HENS FED LOW PHOSPHORUS DIETS.

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SUMMARY

A total of 150, forty- three – weeks old Norfa hens were used in this experiment. Layer diets were supplemented with microbial phytase enzyme at levels of 200, 500, and 800 FTU/kg diet as compared with negative and positive control. The experiment lasted 3 months. Performance parameters, feed conversion ratio and egg quality traits were determined. Results indicated that feed conversion was significantly ($P<0.05$) improved, while feed intake decreased when microbial phytase levels increased. Hen- day egg production percentage, egg weight, egg number and egg mass were improved by microbial phytase supplementation at the level of 800 FTU/kg diet compared with positive control. Pronounced effects on shell weight, percentage, strength and thickness were significantly noted. Albumen and yolk qualities and Haugh units were improved by adding microbial phytase at the levels of 200, 500 and 800 U/kg with low phosphorus (0.46% tP) laying hen diets. In general, it may be concluded that there are some beneficial effects of microbial phytase enzyme supplementation at levels 200, 500 and 800 FTU/kg in Norfa hens under our local environmental conditions . Pronounced effect was obtained with the level of 800 FTU/kg diet.

Keywords: microbial phytase, laying hens, performance, egg quality traits.

INTRODUCTION

Phosphorus (P) is an essential element required in a large quantity for poultry to perform efficiently. Poultry feedstuffs especially grains and oilseed meals have a relatively high content of P. However, up to 60 – 80% of this P is present as phytate P due to its combination with phytic acid (Lott *et al.*, 2000). Phytic acid not only reduces P availability but also negatively affects the utilization of other minerals such as Ca, Zn, Cu, Co, Mn, Fe and Mg (Yi *et al.*, 1996) as well as protein, energy, starch and digestive enzymes including pepsin, trypsin and amylase (Kornegay *et al.*, 1997 and Ravindran *et al.*, 1999). Layers have limited ability to utilize phytate P to meet the P requirement of poultry (Sebastian *et al.*, 1998 and Ceylon *et al.*, 2003). This is not only economically expensive, but also leads to potential environmental phosphorus pollution. As a result of these economic and environmental concerns, there has been interest in using phytase enzyme to: a) reduce the need for supplemented inorganic phosphorus, b) improve the utilization of phosphorus present in feedstuffs and c) reduce phosphorus excretion (Ravindran *et al.*, 1995; Sebastian *et al.*, 1998 and Abou El – Wafa *et al.*, 2005). In this respect, a number of studies have demonstrated that adding microbial phytase to laying hen diets improves phytate P utilization and layer performance (Jalal and Scheideler, 2001; Lim, *et al.*, 2003; Francesch *et al.*, 2005; Ciftci Mehmet *et al.*, 2005 and Metwally 2005). Keshavarz (2003) reported that a level of supplementary phytase (300 units phytase/kg diet) was more effective than a lower level (150 units) in restoring the performance of laying hens fed low – P diets (0.25, 0.20 or 0.15%) to that fed control level (0.45% P diet). Lim *et al.* (2003) found that supplementation of microbial phytase at level of 300 U/kg improved egg production and decreased the number of broken and soft eggs produced as well as P excretion. Ahmadi *et al.* (2007) showed an improvement in egg production, hen weight gain, feed consumption and feed conversion in hens fed a diet low in non phytate phosphorus (NPP) with supplementary phytase when compared to hens fed a low NPP diet without supplemental phytase. Hughes *et al.* (2008) studied the efficacy of quantum phytase in a forty-week production trial on White Leghorn laying hens fed corn-soybean meal-based diet. They noted that addition of phytase to the 0.15 % (NPP) diet, improved production characteristics to levels equal or better than the positive control (0.35% NPP) diet. El-deek *et al.* (2009) noted that hens fed dietary corn gluten feed (CGF) up to 20% with phytase (300 FTU/kg diet) showed no deleterious effects on egg production, egg weight, feed consumption, feed conversion ratio, egg mass and egg quality parameters. Musapuor *et al.* (2005); Metwally (2005); Silversids *et al.* (2006) and Liu *et al.* (2007) noted that phytase supplementation significantly increased egg quality parameters.

The objective of this investigation was to study the effect of different levels of supplemental phytase enzyme on the performance of Norfa laying hens. Performance parameters, feed efficiency, egg quality traits and economic efficiency were estimated.

MATERIALS AND METHODS

The present study was conducted at the Poultry Research Farm and the Poultry Nutrition Laboratory, Faculty of Agriculture, Minufiya University.

One hundred and fifty, 43 weeks old Norfa laying hens were used in this experiment. Birds were distributed at random into five treatment groups and each group was divided into 3 replicates of 10 layers each in a completely randomized design. Birds were housed in individual cages.

The composition of the basal diet is given in Table (1). The basal corn – soy bean meal diet used contained 16.54% crude protein (CP), ME of 2754 Kcal / kg diet and 0.46% total phosphorus (tP). Phytase (Natuphos 10,000; based on the guaranteed value of the phytase product) (BASF Crop, Mt. Olive, NJ) was added to the basal diet at 0 or (T_2: negative control), 200 (T_3), 500 (T_4) and 800 (T_5) U/kg diet. After the experiment was conducted, this product was assayed by BASF using their in-house procedure. The product was determined to have 6.054U/g, where1U is equivalent to one Phytase unit (FTU) and is the amount of enzyme that liberates 1μ mol of inorganic P per minute from 0.0051 mol/L sodium Phytate at 37°C and pH5.50 under the condition of the test.

Table (1). Composition and chemical analysis of the experimental laying diets.

Ingredients	Positive control (%)	Negative control (%)
Ground yellow corn (8.5%)	64.37	64.37
Soy bean meal (44%)	25.15	25.15
Cotton seed oil	0.42	0.42
Limestone,ground	7.41	8.15
Di-calcium phosphate	1.93	0.64
Vitamin and mineral mixture [1]	0.3	0.3
DL-methionine[2]	0.07	0.07
Sodium choloride	0.35	0.35
Sand	0	0.55
Total	100	100
Calculated value [3] :		
Crude protein, %	16.54	16.54
ME,Kcal/kg diet	2754	2754
C/P ratio	167	167
Lysine,%	0.85	0.85
Methionine,%	0.35	0.35
Met+Cys,%	0.64	0.64
Calcium,%	3.32	3.32
Total phosphorus,%	0.70	0.46
Determined values:-		
Dry matter,%	87.2	87.61
Crude protein,%	16.65	16.50
Ether extract,%	2.98	2.87
Crude fiber,%	3.28	3.66
Calcium,%	3.41	3.4
Total phosphours,%	0.71	0.46

[1]Vitamin and Mineral mixture at 0.30%of the diet supplies the following per kilogram of the diet : vit.A,1200 IU; Vit.D3, 2500 IU; Vit. E, 10 mg; Vit .K3, 3mg; Vit.B1, 1mg; Vit.B2, 4mg; pantothenic acid, 10 mg; Nicotinic acid, 20 mg; Folic acid, 1 mg; Biotin, 0.05 mg; Niacin , 40 mg; Vit.B6, 3 mg, Vit. B12, 20 mcg; ChalineChloride, 400 mg; Mn, 62 mg; Fe,44 mg; Zn, 56 mg; I, 1 mg; Cu, 5 mg and Se, 0.01mg.
[2]Dl-Methionine:98% feed grade (contains 98% methionine)
[3]Calculate according to NRC(1994)

In addition, dicalcium phosphate was added to the basal diet to create a positive control diet (T_1) that contained an analyzed value of 0.70% tP and no phytase. Feed and water were provided *ad libitum*. Performance measurements were recorded every 4-wk interval throughout the experimental period. Feed consumption and egg production were recorded. The following parameters were measured and obtained.

1. ***Body weight***: Individual body weights were recorded on the first day of the experiment and weekly, thereafter.
2. ***Egg number, egg weight and egg mass***: Daily egg production for each dietary treatment group and individual egg weight were recorded. Means of egg weight as well as egg mass of each treatment group were determined.
3. ***Feed intake and feed conversion for egg production***: Total feed intake / dietary treatment group / day was recorded and expressed as feed (g)/bird/day. Feed conversion was determined as feed (g) /egg mass (g).
4. ***Egg quality traits***: Fifteen eggs were randomly taken from each dietary treatment group for the determination of the following egg quality factors:-

   a. Egg shape index (%) according to Romanoff (1949) as follows :

   $$\text{Egg shape index} = \text{length (mm.)} / \text{width (mm.)} \times 100$$

   b. Egg shell strength and thickness (mm.) was determined according to Brant and Shrader (1952) by using micrometer (to the nearest 0.01 mm.) at the broad, narrow and the middle ends.

   c. Egg yolk index (%) according to Funk (1948) and Romanoff (1949):

   $$\text{Yolk index (YI)} = \text{yolk height (mm.)} / \text{yolk width (mm.)} \times 100.$$

   d. Egg yolk visual color was determined by matching the yolk color according to laroche Fan.

   e. Egg albumen index (%) was calculated from albumen height (mm.) and width (mm.).Albumen index (AI) = albumen height (mm.) / albumen weidth (mm.) × 100

   f. Haugh unit: was applied from a special chart using egg weight and albumen height which was measured using a tripod micro – meter according to Haugh (1937), Kotaiah and Mohapatra (1974) and Eisen *et al.* (1962) as follows:

   $$\text{Haugh units} = 100 \log (H + 7.57 - 1.7\, w^{0.37})$$

   Where: H = albumen height (mm.), W = egg weight (g)

5. ***Chemical analysis:*** Crude protein, calcium and phosphorus contents of feed samples were determined by the standard Kjeldahl method and atomic absorption spectrophotometer methods, respectively, A.O.A.C. (2003). Dry matter of feed samples was determined by drying at 135 C for 3 h. The metabolizable energy was calculated according to NRC (1994), from the proximate composition of the feed which was obtained from the feed manufactures.
6. ***Statistical Analysis:*** Experimental data obtained were statistically analyzed by the completely randomized design using SPSS 9.05 (1993) program and the

differences among means were determined using Duncan's multiple range test (Duncan 1955). Percentages were transformed to the corresponding arcsine values before statistical analysis.

The model applied was: $Y_{ij} = \mu + a_i + E_{ij}$, Where: Y_{ij} = an observation, μ = overall mean, a_i = effect of treatment (I = 1,2,..........5), and E_{ij} = Experimental random error.

RESULTS AND DISCUSSION

Effect of microbial Phytase enzyme on laying hens:

Body weight.

Results on the effect of supplemental microbial phytase on body weight of Norfa hens are presented in Table (2). Experimental data indicated that dietary treatments T_3, T_4 and T_5 (200, 500 and 800 FTU/ kg diet) showed overall average body weight of 1214.1, 1222.5 and 1244.2 g in a respective order. This indicated that increasing phytase level can liberate more phosphorus and perhaps other nutrients to be available and as a result layer hen's performance may be improved. Similar findings were obtained by Berry *et al.* (2003), Metwally (2005), Silversides *et al.* (2006), Hughes (2008). Mean while El-Deek (2009) noted that phytase supplementation had no significant effects on body weight and body weight gain. However, a slight increase was noted in this respect.

Table (2). Average live body weight of Norfa hens as affected by dietary phytase supplementation during periods from 43 to 54 weeks (Mean ± S. E) .

Age weeks	Dietary treatments[1]				
	T_1	T_2	T_3	T_4	T_5
43	1178.8±26.0	1176.1±2 9.6	1175.3±16.6	1175.5±26.0	1174.8±22.4
46	1230.8 ± 26.2	1196.4 ± 21.7	1196.5± 12.3	1204.4 ±10.6	1238.8±20.2
50	1256.6 ± 27.6	1215.3 ± 26.1	1212.1 ±19.1	1230.3±19.7	1273.1±25.5
54	1277.7 ± 23.4	1270.8 ± 25.8	1272.4 ±28.2	1279.8 27.7	1289.9 ± 9.9
Overall average	1236 ± 22.11^a	1214.5±27.1^c	1214.1±20.3^c	1222.5 ± 26.7^b	1244.2±24.7^a [2]

[1]T. Positive control; T_2, Negative control ; T_3, Negative control + 200 FTU phytase/kg diet ; T_4, Negative control +500 FTU phytase/kg diet ; and T_5, Negative control + 800 FTU phytase / kg diet.

[2] overall averages followed by different superscripts (a,b,......etc: for treatments; row and periods; column) are significantly different (P<0.05).

Egg production traits:

Effect of microbial phytase enzyme supplementation on egg production traits of Norfa hens are shown in Table (3). It is observed that percentage of egg production and egg number values were increased. Averages were 49.03, 50.88, and 53.80% for 200, 500 and 800 FTU/kg diet. Average of 47.47 % was obtained for the negative control diet (0.46%

tP) compared to 52.74 % for the positive control (0.70% tP). Averages of egg number were 13.76, 14.23, and 15.03 for the respective dietary treatments. The results of Abd – Elsamee (2002) indicated that phytase supplementation may influence utilization of not only phytate phosphorus (PP) but also other nutrients. The findings reported by different authors concerning egg production traits indicate wide variable significant effect of dietary microbial phytase(Lim *et al.*, 2003; Keshavarz 2003; Ciftci Mehmet *et al.*,2005; Liebert et al. 2005; Wu *et al.*, 2006 and Hughes et al. 2008). On the other hand, Metwally (2005) and Musapuor *et al.* (2005) noted that no significant difference was observed in percentage of egg production of hens fed phytase supplemented diets.

Table (3). Egg number and egg production of Norfa hens as affected by dietary microbial phytase levels.

Periods[2]	Dietary treatments[1]				
	T_1	T_2	T_3	T_4	T_5
			----------- Egg number (EN) / hen --------------		
P1	15.4 ± 0.2	13.6 ± 0.1	14.03 ± 0.19	14.67 ± 0.27	15.57 ± 0.12
P2	14.7 ± 0.2	13.2 ± 0.3	13.77 ± 0.11	14.23 ± 0.54	14.90 ± 0.22
P3	14.3 ± 0.1	13.0 ±.0.2	13.47 ±.0.18	13.80 ±.0.23	14.63 ±.0.11
Overall average	14.8 ± 1.8^{b}	13.3 ± 0.8^{c}	13.76 ± 0.1^{c}	14.23 ± 0.09^{b}	$15.03 \pm 0.64^{a3,4}$
			---------------------------Egg production(EP), % -------------------------		
p_1	54.9 ± 0.6	48.7 ± 0.4	50.02 ± 0.18	52.50± 0.18	55.46 ± 0.33
p_2	52.1 ± 0.2	47.3 ± 0.1	49.17 ± 0.43	50.85 ± 1.12	53.69 ± 0.72
p_3	51.2 ± 0.2	46.4 ± 0.2	47.89 ± 0.15	49.29 ± 0.16	52.26 ± 0.06
Overall average	52.7 ± 0.2^{b}	47.5 ± 0.6^{e}	49.03 ± 0.6^{d}	50.88 ± 0.21^{c}	$53.8 \pm 0.1^{a3.}$

[1] T_1, Positive control ; T_2, Negative control ; T_3, Negative control + 200 FTU phytase/kg diet ; T_4. Negative control +500 FTU phytase/kg diet ; and T_5. Negative control + 800 FTU phytase / kg diet.

[2] P_1, 43-46 wks ; P_2, 47-50 wks ; P_3, 51-54 wks.

[3] overall averages followed by different superscripts (a,b,......etc: for treatments; row and periods; column) are significantly different (P<0.05).

Experimental results indicated that egg weight was increased with microbial phytase supplementation. Means of egg weight were 47.68, 47.15, 47.10 and 49.32 g for positive control (0.70%tP), 200, 500 and 800 FTU/kg supplemented diets, respectively (Table 4). This agrees with findings of Um and Paik (1999) who reported that egg weight increased significantly with supplemental phytase to laying hen diets. Also Punna and Roland (1999) found that phytase supplementation (300 FTU/kg diet) increased egg weight when hens received a diet containing 0.1% available phosphorus, but no effect was noticed with 0.2, 0.3, and 0.4% available phosphorus diets. Yossef *et al.* (2001), Abd-Elsamee (2002), Metwally (2005) and Hughes et al. (2008) found that the effect of phytase on egg weight

Table (4). Egg weight (g) and egg mass (g/hen/day) of Norfa hens fed diets supplemented with different dietary microbial phytase levels.

periods[2]	Dietary treatments[1]				
	T_1	T_2	T_3	T_4	T_5
			Egg weight (EW), g		
P1	46.30 ± 0.36	44.47 ± 0.22	45.70 ± 0.16	46.03 ± 0.17	47.67 ± 0.76
P2	46.83 ± 0.26	44.80 ± 0.21	46.03 ± 1.13	45.73 ± 0.15	48.53 ± 0.06
P3	49.90 ± 0.05	48.57 ± 0.42	49.73 ± 0.05	49.53 ± 0.24	51.77 ± 0.15
Overall average	47.68 ± 0.3^{b}	45.9 ± 0.2^{d}	47.2 ± 0.77^{c}	47.1 ± 0.77^{c}	49.3 ± 0.17^{a3}
			Egg mass (EM), g / hen / day		
P1	25.46 ± 0.32	21.6 ± 0.2	22.94 ± 0.42	24.16 ± 0.21	26.38 ± 0.32
P2	24.91 ± 0.40	21.20 ± 0.88	22.66 ± 0.44	23.25 ± 0.07	26.02 ± 0.24
P3	25.56 ± 0.38	22.40 ± 0.44	23.95 ± 1.02	24.43 ± 0.18	26.10± 0.63
Overall average	25.31 ± 0.47^{b}	21.74 ± 0.38^{d}	23.18 ± 0.40^{c}	23.95 ± 0.58^{c}	26.17 ± 0.27^{a3}

[1]T_1, Positive control ; T_2, Negative control ; T_3, Negative control + 200 FTU phytase/kg diet ; T_4. Negative control +500 FTU phytase/kg diet ; and T_5, Negative control + 800 FTU phytase / kg diet.

[2]P_1, 43-46 wks ; P_2, 47-50 wks ; P_3, 51-54 wks.

[3]overall averages followed by different superscripts (a,b,……etc: for treatments; row and periods; column) are significantly different (P<0.05).

was not significant.

Diets supplemented with microbial phytase, generally, resulted in a higher egg mass (Table 4) during the different experimental periods. Egg mass was significantly increased (P<0.05) with increasing microbial phytase level (200, 500 and 800 FTU/kg diet) being 23.18, 23.95 and 26.17 g / hen, respectively compared to low phosphorus diets (21.74 g / hen). Hens fed the positive control diet (0.70% tP) had significantly higher value of egg mass (25.31 g / hen). The improved effect observed with layers fed diets supplemented with 800 units phytase /kg diet may be due to higher rate of laying and relatively larger egg weight. Results reported herein are in harmony with those obtained by Yossef *et al.* (2001), Keshavarz (2003) and Metwally (2005). Diets supplemented with microbial phytase, generally, resulted in a higher egg mass (Table 4) during the different experimental periods. Egg mass was significantly increased (P<0.05) with increasing microbial phytase level (200, 500 and 800 FTU/kg diet) being 23.18, 23.95 and 26.17 g / hen, respectively compared to low phosphorus diets (21.74 g / hen). Hens fed the positive control diet (0.70% tP) had significantly higher value of egg mass (25.31 g / hen). The improved effect observed with layers fed diets supplemented with 800 units phytase /kg diet may be due to higher rate of laying and relatively larger egg weight. Results reported herein are in harmony with those obtained by Yossef *et al.* (2001), Keshavarz (2003) and Metwally (2005).

Table (5). Feed intake (g/hen/day) and feed conversion (g feed/ g egg mass) of Norfa hens as affected by dietary microbial phytase levels.

periods[2]	Dietary treatments[1]				
	T_1	T_2	T_3	T_4	T_5
	Feed intake (FI), g / hen / day				
P1	111.50 ± 0.27	101.98 ± 0.03	102.13 ± 0.07	104.00 ± 0.13	102.70 ± 0.05
P2	107.77 ± 0.04	98.20 ± 0.14	97.81 ± 0.04	99.04 ± 0.23	96.26 ± 0.06
P3	110.04 ± 0.11	100.66 ± 0.05	100.76 ± 0.14	97.83 ± 0.14	95.67 ± 0.21
Overall average	109.77 ± 0.09^a	100.28 ± 0.04^b	100.23 ± 0.04^b	100.29 ± 0.04^b	98.21 ± 0.02^b
	Feed conversion (FC), g Feed / g egg mass				
P1	4.43 ± 0.06	4.74 ± 0.04	4.49 ± 0.06	4.31 ± 0.05	3.93 ± 0.06
P2	4.42 ± 0.07	4.65 ± 0.02	4.32 ± 0.07	4.27 ± 0.07	3.73 ± 0.07
P3	4.36 ± 0.06	4.51 ± 0.06	4.23 ± 0.06	4.02 ± 0.005	3.54 ± 0.007
Overall average	4.40 ± 0.03^b	4.63 ± 0.06^a	4.35 ± 0.06^b	4.20 ± 0.03^b	3.72 ± 0.06^c

[1]T_1, Positive control ; T_2, Negative control ; T_3, Negative control + 200 FTU phytase/kg diet ; T_4. Negative control +500 FTU phytase/kg diet ; and T_5, Negative control + 800 FTU phytase / kg diet.

[2]P_1, 43-46 wks ; P_2 , 47-50 wks ; P_3, 51-54 wks.

[3] overall averages followed by different superscripts (a,b,......etc: for treatments; row and periods; column) are significantly different (P<0.05).

Feed intake and feed conversion for egg production.

Results in Table (5), show the effect of dietary phytase supplementation on feed intake (FI). The average FI values were 100.23, 100.29 and 98.21 (g/hen/day) for 200, 500 and 800 FTU/kg diet, respectively. Feed intake for positive control (0.70tP) was 109.77 (g/hen/day). Similar findings on feed consumption were reported by Keshavarz (2003), Ciftci Mehmet *et al.* (2005) and Wu *et al.* (2006). On the other hand, Jalal and Scheideler (2001), Abd-Elsamee (2002) and Musapuor *et al.* (2005) found that feed intake was significantly increased when laying hens were fed diets supplemented with phytase.

Feed conversion ratio (FCR) was significantly (P<0.05) improved due to phytase supplementation at 800 FTU/kg diet; being 3.72 g/g. The improvement of feed conversion may be due to the increase in egg production with supplemental microbial phytase to laying hens (Abd – Elsamee (2002). Results reported in the present study are in agreement with those obtained by Jalal and Scheideler (2001), Abd-Elsamee (2002), Metwally (2005), Liebert (2005) and Musapuor *et al.* (2005). On the contrary, Um and Paik (1999) and Keshavarz (2000a and 2003) reported that microbial phytase had no significant effect on feed conversion ratio.

Egg quality traits:

Effect of supplementation of microbial phytase to layer diet on egg quality traits during different periods of production are summarized in Table (6). Microbial phytase supplementation improved egg shape index, egg shell weight and egg shell percent. Overall means for egg shape were 75.07, 75.38 and 75.37% for 200, 500 and 800 FTU/kg supplemented diets and egg shell weight were (7.28, 7.69 and 8.76 g) compared to the positive and negative control diets (8.46 and 6.91 g).Whereas, shell percentages were (10.82, 9.52, 9.90, 10.08 and 10.48 for T_1, T_2, T_3, T_4 and T_5, respectively. Shell thickness recorded 0.374, 0.337, 0.382, 0.376 and 0.400 mm for 0.70 % tP, 0.46 %tP, 200, 500 and 800 FTU/kg diet. The beneficial effect of microbial phytase appears to be due to phytase influence on utilization of calcium and phosphorus. Phytase supplementation, typically, the most sensitive and commonly used indicators of Ca metabolism in laying hens related to measurements of egg shell quality (Abd – Elsamee 2002 and Liu *et al.*, 2007). Several investigators reported a beneficial effect of dietary phytase supplementation on egg shell quality (Keshavarz 2000 b; Keshavarz 2003; Ceylen *et al.*, 2003 and Metwally 2005). Whereas, Van Der Klis *et al.* (1997), Lim *et al.* (2003) and Musapuor *et al.* (2005) noted no beneficial effect.

Insignificant differences were observed between microbial phytase supplementation with respect to yolk weight and yolk index. Values ranged from (12.53 to 13.14 g) and (42.41, 42.42 and 43.48%) for yolk weight and yolk index, respectively .Yossef *et al.* (2001) and Metwally (2005) reported similar findings.

The findings on albumen quality (albumen weight, index and Haugh units) are given in Table (6). Data showed that a slight increase in albumen weight, while a significant difference was noted in albumen index values between dietary treatments; being 10.57, 10.38 and 10.18 for 200, 500 and 800 FTU/kg diet, respectively..

Haugh units (albumen quality factor) was improved with dietary microbial phytase supplementation. The highest value was obtained for groups fed 200 and 800 units phytase/ kg diet. Experimental results obtained are in a harmony with those reported by Yossef *et al.* (2001)), Abd- Elsamee (2002), Lim *et al.* (2003) and Metwally (2005).

Economical efficiency:

In general, the results indicated that supplementation of microbial phytase to low – phosphorus layer diets (0.46% tP) had potential positive influence on economical and relative economical efficiency. Best values were obtained with 800 FTU microbial phytase /kg diet (Table 7).

CONCLUSION

It may be concluded that there are some beneficial effects of microbial phytase enzyme supplementation at level of 800 FTU/kg in Norfa hens diets containing low phosphorus (0.46 % tP) under our local environmental conditions in Egypt.

Table (6). Effect of dietary microbial phytase supplementation on some egg quality of Norfa hens during different experimental periods of production (Mean ± S. E).

Items	Dietary treatments[1]				
	T_1	T_2	T_3	T_4	T_5
Egg shape index, %	75.67 ± 0.59[a]	74.97 ± 0.19[ab]	75.1±0.1[abc]	75.4±0.2[ab]	75.4±0.2[ab3]
egg shell weight, g	8.46 ± 0.10[a]	6.91 ± 0.003[c]	7.28 ± 0.2[c]	7.69 ±0.19[b]	8.76±0.09[a]
egg shell percent, %	10.82 ± 0.07[a]	9.52 ± 0.1[d]	9.9± 0.2[c]	10.1±0.07[c]	10.48 ±0.1[b]
Egg shell strength	28.53 ± 0.23[b]	25.13 ± 0.40[d]	26.6 ± 0 .3[c]	26.4±0 .5[c]	31.7± 0.3[a]
Egg shell thickness, mm	0.34 ± 0.39[c]	0.34 ± 3.94[d]	0.38±0.50[b]	0.38±0.39[c]	0.40±0.42[a]
Yolk weight , g	15.28 ± 1.09[a]	12.43 ± 1.00[c]	12.5±1.5[c]	13.0 ±0.3[b]	13.1 ±1.1[b]
Yolk index , %	42.80 ± 0.32[b]	41.59 ± 0.52[c]	42.4±0.4[b]	42.4± 0.4[b]	43.5± 0.2[a]
Albumen weight, g	27.21± 0.14[b]	26.60 ± 0.24[c]	27.1±0.1[bc]	26.9±0.3[bc]	28.4± 0.2[a]
Albumen index, %	10.40 ± 0.27[a]	10.07 ± 0.29[b]	10.6±0.3[a]	10.4± 0.6[a]	10.12±0.1[b]
Haugh units	87.76 ± 1.00[a]	86.31 ± 0.75[b]	86.8±1.4[ab]	87.5±0.9[a]	87.7± 0.9[a]

[1] T_1, Positive control ; T_2, Negative control ; T_3. Negative control + 200 FTU phytase/kg diet ; T_4. Negative control +500 FTU phytase/kg diet ; and T_5. Negative control + 800 FTU phytase / kg diet.

[2] P_1. 43-46 wks; P_2, 47-50 wks; P_3, 51-54 wks.

[3] overall averages followed by different superscripts (a,b,......etc: for treatments; row and periods; column) are significantly different ($P<0.05$).

Table (7). The economic efficiency of the experimental diets.

Items	Dietary treatments[1]				
	T_1	T_2	T_3[2]	T_4	T_5
Price of Kg feed, (L.E.).	1.41	1.37	1.4	1.46	1.51
Total feed intake / hen, (Kg).	9.28	8.47	8.44	8.44	8.26
Total feed cost hen, (L.E.).	13.08	11.6	11.82	12.32	12.47
Total number of eggs/ hen, (L.E.).	44.43	39.83	41.27	42.7	45.1
Total price of eggs / hen, (L.E.)[3].	15.99	14.34	14.86	15.37	16.24
Net revenue / hen, (L.E.)[4]	2.91	2.74	3.04	3.05	3.77
Economic efficiency, (%)[5].	22.25	23.62	25.72	24.76	30.23
Relative Economic efficiency,[6]	100	106.16	115.6	111.28	135.87

[1] T_1, Positive control ; T_2, Negative control ; T_3. Negative control + 200 FTU phytase/kg diet ; T_4. Negative control +500 FTU phytase/kg diet ; and T_5. Negative control + 800 FTU phytase / kg diet.

[2] Assuming that price of one - egg was 36 P.T. (according to Egyptian market, 2008).

[3] Price of Kg Microbial phytase, was 170 (L.E.) according to Egyptian market, 2008).

[4] Net revenue / hen, (L.E.) = Total price of eggs - Total feed cost.

[5] Economic efficiency = (Net revenue ÷ Total feed cost) x100.

[6] Relative economic efficiency of control considered 100.

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تأثير إضافة إنزيم الفيتيز على أداء الدجاج البياض المغذى على علائق منخفضة فى الفوسفور

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تم إجراء هذه الدراسة فى محطة أبحاث الدواجن - قسم إنتاج الدواجن كلية الزراعة - جامعة المنوفية ، وذلك بهدف دراسة تأثير إضافة مستويات مُختلفة من إنزيم الفيتيز إلى علائق الدجاج البياض المربى فى أقفاص من سلالة النورفا Norfa.

وقد إستخدم فى هذه الدراسة عدد 150 دجاجة بياضة عمر 43 أسبوع حيث قسمت إلى خمس معاملات تجريبيه متماثلة. قسمت كل منها إلى 3 مكررات تحتوى على 10 دجاجات لكل منها. غذيت المعاملة الأولى على العليقة الأساسية (كنترول موجب تحتوى على 16,54 % بروتين خام ، 2754 كيلوكالورى طاقة ممثلة / كجم عليقة،0.70% فوسفوركلى) بينما المعاملات من الثانية إلى الخامسة تم تغذيتها على عليقة أساسية منخفضة فى محتواها من الفوسفور الكلى (0.46%) مضاف إليها إنزيم الفيتيز بمستويات صفر (كنترول سالب) ، 200 ، 500 ، 800 وحدة / كيلو جرام عليقة وقد إستمرت التجربة لمدة ثلاثة أشهر تحت الظروف المصرية . وقد تم تقدير الصفات الانتاجيه المختلفة وتقييم الأداء وكذلك صفات جودة البيض الناتج .

وفيما يلى أهم النتائج المتحصل عليها من الدراسة:-

1- أدى إضافة إنزيم الفيتيز الميكروبى إلى تحسن معنوى فى معدل تحويل الغذاء (الغذاء المأكول / كتلة البيض) حيث أظهرت الإضافة 800 وحدة / كجم عليقة أفضل كفاءة ، ولكن الغذاء المأكول إنخفض معنويا بزيادة مستويات إنزيم الفيتيز المضاف إلى العليقة.

2- تحسنت معنوياً كل من النسبة المئوية لإنتاج البيض و وزنه وعدد البيض الناتج وكذلك كتلة البيض بإضافة إنزيم الفيتيزبمستوى (800) وحدة/ كجم عليقة بالمقارنة بالكنترول الموجب.

3- أوضحت النتائج أيضاً أن إستخدام المستوى المنخفض من الفوسفورالكلى فى وجود إنزيم الفيتيز أدى إلى التحسن المعنوى لصفات جودة البيض والممثلة فى دليل البيضة، وجودة القشرة (وزن القشرة - % للقشرة – قوة الكسر وصلابة القشرة) وكذلك تحسنت كل من صفات جودة الألبيومين والصفار ووحدات هوف.

4- بصفة عامة وبناءً على النتائج المتحصل عليها فى هذه الدراسة فإنه يتضح من الناحيتين الغذائية والإقتصادية أن إضافة إنزيم الفيتيز الميكروبى إلى علائق دجاج النورفا Norfa البياضة المنخفضة فىمحتواها من الفوسفور الكلى بمعدل800 وحدة / كجم عليقة أدت إلى تحسين معدلات الأداء الإنتاجى وصفات جودة البيض وكذلك الكفاءة الإقتصادية تحت الظروف البيئية المصرية.