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EFFECT OF PHYTASE SUPPLEMENTATION ON UTILIZATION OF PHOSPHORUS IN LAYING HEN DIETS

Kassem, M . G.
Anim. Prod. Res. Institute, Agric. Res. Center, Ministry of Agric., Dokki, Giza.

ABSTRACT

An experiment was conducted to examine the effects of adding microbial phytase enzyme (E) [each gram contains 2500 FTU] at 0.05% of corn-soybean meal diets containing varying available phosphorus (AP) levels on the performance of Sinai laying hens. Six isocaloric-(2700 kcal/kg) isonitrogenous-(16% CP) with 3.3% Ca diets were formulated. Diet 1 contained 0.405% AP (a normal level) and served as a negative control (T1). Diet 2 had the same AP level plus E and designated as a positive control (T2). Whereas, diets 3, 4, 5 and 6 of T3, T4, T5 and T6 contained 0.334, 0.262, 0.190 and 0.119% AP, respectively, plus E. Each diet was fed to six replicates of 5 birds each from 32 to 52 weeks of age.

No significant differences were observed among dietary treatments in the performance of Sinai laying hens foe egg production, egg weight, egg mass, feed intake and feed conversion, with the exception of those of T6 which gave a significantly lower egg weight. As for reproductive performance; egg fertility, hatchability, and embryonic mortality were not affected by the dietary treatments. Neither exterior nor interior egg quality traits were influenced by the dietary treatments, as measured at 36, 40 or 44 weeks of age. No significant differences were detected among the dietary treatments in blood constituents of 52-wk-old Sinai laying hens; as assessed by the concentration of plasma total protein, total lipids, cholesterol, Ca and P. in addition, dietary treatments had no effect on carcass traits of these experimental birds. Economically, T2, T4, T5 and T6 exhibited a higher economic efficiency, but T6 had the advantage over all dietary treatments.

It would be concluded that Sinai laying hens can be fed on a layer diet containing as low available phosphorous level as 0.119% plus 0.05% Exogenous supplemental phytase without any adverse effect on their productive and reproductive performance.

INTRODUCTION

Phosphorus (P) is a mineral that is essential to growth and development structurally and metabolically. Cereal grains and oilseed meals both have a relatively high content of P; however, up to 80% of the P is present as phytic acid. This poses a problem to non-ruminant animals because they do not contain sufficient amounts of intrinsic phytases necessary to hydrolyze the phytic acid complexes (Nelson 1976; Schwarz, 1994). Non-ruminant diets primarily comprise feedstuffs that have a large portion of unavailable P (*e.g.*, corn and soybean meal), thereby making inorganic P supplementation necessary to support optimal animal performance (NRC, 1994). The low availability of P in plant ingredients poses problems both economically and environmentally. Economically, phosphorus is the third most expensive component in a nonruminant diet after energy and protein. Environmentally, a large amount of consumed P is excreted in the feces and urine because of its high unavailability. The animal wastes are then applied to soil, allowing P to wash into ground water, contaminating ponds,

streams, lakes, rivers, and oceans. Studies have demonstrated that exogenous dietary phytases improves phytate P utilization in broiler chickens (Simons *et al.*, 1990; Edwards,1993; Broz *et al.*, 1994; Biehl *et al.*, 1995; Denbow *et al.*,1995). Some studies have also shown that phytase improves phytate P utilization in laying hens (Gordon and Roland,1997; Van der Klis *et al.*, 1997; Carlos and Edwards, 1998). Sebastian *et al.* (1998) and Kies *et al.* (2001) reviewed the negative effect of phytate molecule on protein and energy utilization and its inhibitory effects on pepsin, trypsin and α–amylase. Phytate may form complexes with protein/amino acids as those inherited in feedstuffs (Ravindran *et al.*, 1995) or those *de novo* formed in the digestive tract (Jongbloed *et al.*, 1997) and with free amino acids in digestive tract (Rutherfurd *et al.*, 1997).

Supplemental phytase can improve the utilization of protein and energy of chicken diets (Biehl and Baker, 1997; Sebastian *et al.*, 1998; Ravindran *et al.*, 2001). Kornegay *et al.* (1998) evaluated the supplementation of phytase to a low protein amino acid diet on performance, ileal amino acid digestibility and carcass measurements of broilers and showed that supplementation of phytase at 300 to 400 FTU/kg diet restored the reduced performance, breast meat yield and improved ileal amino acid digestibility.

This study aimed to investigate the effect of dietary phytase supplementation on the performance, egg quality, fertility and hatchability, carcass yield, some blood constituents, and economic efficiency of Sinai laying hens fed different levels of dietary P.

MATERIALS AND METHODS

The present work was carried out at El-Serw Poultry Research Station, Animal Production Research Institute, Ministry of Agriculture.

Two hundred and ten (30 males and 180 females) 32-week-old Sinai laying hens (local strain) were used. The birds were randomly distributed into six equal experimental groups. Each treatment consisted of 6 replicates of 5 birds each, and housed in individual cages of wire-floored batteries in an open-sided house in which they were exposed to 16 hours light/day. Water and feed were offered *ad libtum*. The experiment elapsed from 32 to 52 weeks of age.

Six isocaloric (ME of about 2700 kcal/kg)-isonitrogenous (CP of about 16%)-diet were formulated and used. Diet 1 (served as control) contained 0.405% available phosphorous (AP) and was designated as a negative control diet. Diet 2 was the same as control but was supplemented with microbial phytase (at 0.05%of diet) and served as a positive control. Diets 3, 4, 5 and 6 contained 0.334, 0.262, 0.190 and 0.119% AP, respectively, with supplemental phytase of 0.05% of the diet. Each gram of microbial phytase used in the diets (T2 to T6) contained 2500 phytase units (FTU). All experimental diets were supplemented with DL-Methionine when needed to cover the recommended requirement (NRC, 1994).

The laying hen performance, expressed as feed intake, egg production rate, egg weight, total egg mass and feed conversion, was

determined during five 28–day periods. Means of change in body weight of birds were also computed during the entire experimental period. Three egg quality tests were carried out when birds were 36, 40 and 44 weeks of age. In each test, sixty freshly collected eggs (10 eggs/treatment) were broken out and used for egg quality measurements. Egg quality was measured in terms of some exterior and interior parameters as well as egg components. The exterior parameters of egg quality included egg shape index, egg specific gravity according to Harms *et al.* (1990), shell thickness (mm) and shell weight per unit surface area (SWUSA). Those of interior quality were albumen height (measured by a standard tripod micrometer, mm) Haugh unit score (using the equation adopted by Haugh, 1937). Yolk index was calculated as yolk height times 100 divided by yolk diameter. Egg components were determined, according to the procedure described by Keshavarz and Nakajima (1995). Shell thickness was measured by a special micrometer at two corresponding positions on the equator of the egg shell and the average was recorded to the nearest 0.001 mm. SWUSA was computed by dividing shell weight (including the adhering membranes) in mg by egg surface area (ESA) in cm^2. ESA was calculated according to the equation of Carter (1975) as follows:

$$ESA = [\ 3.9782 \times \text{egg weight [g]}\ ]^{0.7056}.$$

After 16 weeks from starting the experiment, 1600 settable eggs were collected from hens which had been artificially inseminated with fresh undiluted semen of Sinai cockerels, and incubated at three hatches when the birds were 48, 49 and 50 weeks of age. The eggs were examined two weeks after setting them into the incubator. Records of fertile eggs, infertile eggs, and eggs with dead embryos were maintained. Fertility was calculated as percentage of fertile eggs to total eggs in the incubator. Hatchability was calculated as percentage of healthy hatched chicks to total number of eggs set. Weights of healthy hatched chicks were also recorded.

At the end of the experiment (52 weeks of age) 3 females from each treatment, whose body weights were near the average value of the respective dietary treatments were selected for slaughter test. In addition, some blood constituents (serum glucose, total protein, total lipids, cholesterol, calcium and phosphorus) were measured using commercial kits according to the methods of Trinder (1969), Henry, (1964). Frings and Dunn (1970) and Allain *et al.* (1974), Moorhead and Biggs, (1974) and Goldenberg and Fernandez, (1966), respectively. Proximate analyses of experimental diets (Table 1) was carried out according to the official methods (AOAC, 1984). Economic efficiency (EE) was also determined according the following equation: EE=[sale price of one kg eggs – feeding cost per one kg eggs produced]/[feeding cost per one kg eggs produced] ×100. Data were processed using Quattro program software (Borland International, 1990). Statistical analyses of results were performed using Statgraphics Program software, Version 5.0, STSC (Rockville, 1991). One–way analysis of variance was used to estimate the significant differences among treatments. Differences were considered significant at ($P \leq 0.05$).

Table 1: **Composition of the experimental diets**

Ingredients %	T1	T2	T3	T4	T5	T6
Yellow corn	64.13	64.13	64.13	64.13	64.13	64.13
Soybean meal (44%)	22.99	22.99	22.99	22.99	22.99	22.99
Wheat b0000ran	3.00	2.95	3.00	3.00	3.00	3.00
Dicalcium phosphate	1.70	1.70	1.275	0.85	0.425	0.00
Limestone	7.50	7.50	7.75	8.00	8.25	8.50
Common salt	0.30	0.30	0.30	0.30	0.30	0.30
Vit&Min. Premix*	0.30	0.30	0.30	0.30	0.30	0.30
DL– methionine	0.08	0.08	0.08	0.08	0.08	0.08
Phytase (2500 FTU/g)	0.00	0.05	0.05	0.05	0.05	0.05
Sand	0.00	0.00	0.125	0.300	0.475	0.65
Total	100	100	100	100	100	100
Calculated analysis :**						
ME; kcal/kg	2703	2702	2703	2703	2703	2703
Crude protein; %	16.08	16.08	16.08	16.08	16.08	16.08
Ether extract; %	2.71	2.71	2.71	2.71	2.71	2.71
Crude Fiber; %	3.35	3.34	3.35	3.35	3.35	3.35
Ca; %	3.31	3.31	3.31	3.31	3.31	3.31
Total P; %	0.681	0.681	0.602	0.522	0.443	0.363
Available P (AP); %	0.405	0.405	0.334	0.262	0.190	0.119
Lysine; %	0.80	0.80	0.80	0.80	0.80	0.80
Methionine; %	0.34	0.34	0.34	0.34	0.34	0.34
Meth. & Cys.; %	0.62	0.62	0.62	0.62	0.62	0.62

*** Each 3 Kg of Vit. and Min Premix contains: 10,000,000 IU Vit. A; 2,000,000 IU Vit. D_3; 10,000mg Vit. E; 1000mg Vit. K_3; 1000 mg Vit. B_1; 5000 mg Vit. B_2; 10mg Vit B_{12}; 1500 mg Vit. B_6; 30000,mg Niacin; 10000 mg Pantothenic acid; 1000 mg Folic acid; 50 mg Biotin ; 300,000 mg Choline Chloride; 4000mg Copper; 300 mg Iodine; 30000 mg Iron; 50000 mg Zinc; 60000 mg Manganese; 100 mg Selenium and 100 mg Cobalt.**

**** According to NRC (1994).**

RESULTS AND DISCUSSION

Laying hen performance :

The results obtained from the feeding trial are shown in Table (2). Analysis of variance of the data revealed that feeding the experimental diets containing levels of available P (AP) from 0.119 to 0.405% with exogenous phytase supplementation had no significant ($P<0.05$) effects on egg production rate, average egg mass, feed intake or feed conversion during the entire experimental period with the exception of T6 (0.119% AP) which gave a significantly lower body weight and negative change in body weight, and a lower average egg weight as compared to the other treatments . This experiment has shown that the final live body and change in body weight were not significantly affected by phytase supplementation for hens either fed the diets containing a commercially recommended P (0.405%) or lower levels of AP (0.334, 0.262 and 0.190%) compared with the negative control. These results are in line with the finding reported by Yossef *et al.* (2001) who reported that body weight of laying hens was not significantly affected by phytase addition.

Table 2: Effect of supplemental phytase on productivity of Sinai laying hens fed experimental diets containing graded levels of available P with or without enzyme (E) supplementation from 32 to 52 wks of age

Criteria	Dietary treatments*					
	T 1	T 2	T 3	T 4	T 5	T 6
Initial body weight, g	1317±39	1305±31	1316±30	1238±14	1365±42	1329±38
Final body weight, g	1379±52[a]	1368±57[a]	1357±41[a]	1261±25[a]	1346±65[a]	1180±41[b]
Body weight change, g	62±24[a]	63±50[a]	41±42[a]	23±25[a]	-19±41[a]	-149±10[b]
Total egg production, eggs/bird	79.23 ±3.07	81.35 ±4.13	78.25 ±1.48	80.23 ±2.63	74.28 ±1.38	77.38 ±2.39
Egg production rate, %	56.29±1	58.10±2	55.83±1	58.41±4	53.0±2	52.64±2
Average egg weight, g	44.1±0.2[a]	44.4±0.5[a]	44.5±0.3[a]	43.8±0.2[a]	43.7±0.4[a]	42.0±0.2[b]
Average egg mass, kg/hen	3.494±136	3.612±184	3.482±57	3.514±112	3.246±67	3.250±103
Daily feed intake, g/ bird	93.39±1.6	95.59±1.3	95.26±1.2	94.71±1.6	89.54±1.7	86.35±1.8
Feed conversion	3.74±0.09	3.71±0.19	3.83±0.09	3.77±0.05	3.86±0.08	3.72±0.07

*: **T1=negative control (0.405% AP); T2=positive control (0.405% AP + enzyme); T3= 0.334% AP + enzyme; T4= 0.262% AP + Enzyme; T5= 0.190% AP + Enzyme and T6= 0.119% AP + Enzyme.**

[1]**a-b: Means within the same row with different superscripts are significantly different (P≤0.05).**

In the same respect. Keshavarz (1994) reported that birds fed a lower dietary P level had a significantly lower body weight than that of their control counterparts. Egg production of hens fed low AP-diets (0.334, 0.262, 0.190 or 0.119%) with phytase supplementation was not significantly different from that of the negative control which contained a commercially recommended level of AP (0.405%). These result are in agreement with the finding of Um and Paik (1999) who found that egg production of hens fed low AP (0.24 to 0.12%) with the supplementation of 500 FTU/kg diet was not significantly different from that of hens fed the control diet (0.37% AP). On the other hand, Vandepopuliere and Lyons (1992) reported that a diet containing 0.2% non-phytate P (NPP) depressed the performance of layers for feed intake, egg production, egg weight and egg mass compared to those fed 0.3 to 0.5% NPP-diets.

It is quite obvious from the present results that there were no significant differences among all treatments in average egg weight, with the exception of birds fed the lowest-P diet (0.119%) with phytase addition (T6) which exhibited significantly ($P<0.05$) the lowest average egg weight. This result is similar to that suggested by Gordon and Roland (1997) and Um and Paik (1999) who reported that egg weight was significantly increased due to adding supplemental phytase to low NPP-diets (0.1 to 0.2%) for laying hens. Results in Table 2 showed that there were no significant differences among all dietary treatments in egg mass, which is in partial agreement with that reported by Rama Rao and Reddy (1999) who found that phytase supplementation to layer diets improved egg production, feed per dozen eggs, egg weight and final body weight. During the entire experimental period elapsed between 32 and 52 weeks of age, there were no significant differences were observed among the experimental groups in feed intake and

feed conversion. These results are in partial agreement with the findings reported by Van der Klis *et al.* (1997), who found that feed intake, but not feed conversion, was no significantly affected by dietary supplementation with phytase. In contrast, Summers (1995), Gordon and Roland (1997), Um and Paik (1999) and Abd El Samee (2002) found that feed intake increased significantly when laying hens were fed on diet supplemented with phytase.

Regarding the feed conversion, the present data revealed that no significant differences were found in feed conversion values among the experimental groups. This result is confirmed by that of Um and Paik (1999) who found that feed conversion among their experimental groups was not significantly different when laying hens were fed diets containing AP levels of 0.37, 0.24 or 0.12% with supplementary phytase. Some studies have demonstrated that dietary phytase supplementation may improve not only phytate P utilization, but also that of the other nutrients.

Egg Components and egg quality:

Data on egg components and egg quality parameters of Sinai laying hens fed diets containing graded levels of AP with or without enzyme, at 36, 40 and 44 weeks of age, are presented in Tables 3, 4 and 5, respectively. In spite of the differences among the experimental diets; supplemented with phytase, in AP levels (0.405, 0.334, 0.262, 0.190 and 0.1119), eggs produced by hens fed on these diets did not differ significantly from those of the negative control diet (on the diet containing 0.405 AP%) in egg components or other egg quality traits. Eggshell quality measurements were not significantly affected by the dietary treatments.

Table 3: Means ± standard errors of egg components and egg quality parameters for 36 weeks old Sinai laying hens fed diets containing graded available phosphorus (AP) levels with or without phytase enzyme (E) supplementation.

Traits	Dietary treatments*					
	T1	T2	T3	T4	T5	T6
Egg components:						
Egg weight, g	42.07±1.60	42.08±0.80	41.70±0.98	39.76±1.12	40.94±0.99	41.71±0.41
Shell weight ,%	12.28±0.34	11.04±0.41	11.65±0.58	11.11±0.62	11.56±0.56	12.31±0.25
Yolk weight,%	30.41±0.95	30.93±0.51	31.42±0.55	31.72±0.38	31.39±0.30	30.51±0 80
Albumen weight, %	57.31±0.95	58.03±0.72	56.93±0.88	57.17±0.76	57.05±0.38	57.18±0 91
Exterior quality:						
Egg shape index, %	81.62±0.99	81.03±0.95	81.61±1.40	81.10±1.41	81.11±1.10	82.44±1.32
Egg specific gravity	1.10±0.002	1.09±0.002	1.10±0.003	1.09±0.004	1.10±0.001	1.10±0.001
Shell thickness, mm	0.35±0.01	0.35±0.01	0.34±0.01	0.34±0.01	0.34±0.01	0.33±0.01
SWUSA, mg/cm^2	92.58±2.42	83.34±2.90	87.56±3.94	82.29±4.18	86.56±1.62	92.75±1.82
Interior quality:						
Albumen height, mm	6.32±0.37	5.61±0.42	5.61±0.30	5.55±0.35	5.41±0.31	6.12±0.24
Haugh units	84.25±2.11	79.81±2.84	80.33±2.06	80.71±2.16	79.26±2.14	83.87±1.41
Yolk index, %	48.76±0.90	46.44±1.55	47.36±0.94	47.16±1.23	48.88±1.12	48.27±0.76

***: T1=negative control (0.405% AP); T2=positive control (0.405% AP + enzyme); T3= 0.334% AP + enzyme; T4= 0.262% AP + Enzyme; T5= 0.190% AP + Enzyme and T6= 0.119% AP + Enzyme.**

Table 4: Means ± standard errors of egg components and egg quality parameters for 40 weeks old Sinai laying hens fed diets containing graded available phosphorus (AP) levels with or without phytase enzyme (E) supplementation.

Traits	Dietary treatments*					
	T1	T2	T3	T4	T5	T6
Egg components:						
Egg weight, g	42.07±1.60	42.08±0.80	41.70±0.98	39.76±1.12	40.94±0.99	41.71±0.41
Shell weight ,%	12.28±0.34	11.04±0.41	11.65±0.58	11.11±0.62	11.56±0.56	12.31±0.25
Yolk weight,%	30.41±0.95	30.93±0.51	31.42±0.55	31.72±0.38	31.39±0.30	30.51±0.80
Albumen weight, %	57.31±0.95	58.03±0.72	56.93±0.88	57.17±0.76	57.05±0.38	57.18±0.91
Exterior quality:						
Egg shape index, %	81.71±0.82	81.61±1.09	81.04±1.66	80.46±1.32	80.21±1.01	80.40±0.99
Egg specific gravity	1.10±0.002	1.10±0.001	1.09±0.002	1.10±0.002	1.09±0.001	1.09±0.002
Shell thickness, mm	0.35±0.01	0.35±0.01	0.35±0.01	0.34±0.01	0.34±0.01	0.33±0.01
SWUSA, mg/cm^2	91.01±2.16	90.64±1.35	82.74±1.95	88.97±2.32	87.66±1.51	87.20±2.69
Interior quality:						
Albumen height, mm	5.61±0.27	7.07±0.47	6.34±0.42	5.80±0.49	6.42±0.48	5.82±0.46
Haugh units	77.91±1.86	87.35±3.02	83.13±2.95	80.09±2.98	84.21±3.29	80.20±3.60
Yolk index, %	41.66±2.06	41.53±0.66	41.14±1.05	42.10±0.88	43.17±1.02	40.40±0.84

*: T1=negative control (0.405% AP); T2=positive control (0.405% AP + enzyme); T3= 0.334% AP + enzyme; T4= 0.262% AP + Enzyme; T5= 0.190% AP + Enzyme and T6= 0.119% AP + Enzyme.

Table 5: Means ± standard errors of egg components and egg quality parameters for 44 weeks old Sinai laying hens fed diets containing graded available phosphorus (AP) levels with or without phytase enzyme (E) supplementation.

Traits	Dietary treatments*					
	T1	T2	T3	T4	T5	T6
Egg components:						
Egg weight, g	43.03±0.80	44.50±1.81	46.61±0.83	43.03±0.80	44.50±1.81	44.45±1.41
Shell weight ,%	12.63±0.26	11.78±0.54	11.85±0.25	12.63±0.26	11.78±0.54	12.22±0.38
Yolk weight,%	32.52±0.52	33.41±0.36	32.89±0.41	32.50±0.61	33.65±0.33	32.01±0.69
Albumen weight, %	54.85±0.53	54.81±0.74	55.26±0.35	54.87±0.65	54.57±0.65	55.77±0.58
Exterior quality:						
Egg shape index, %	78.49±0.65	77.44±1.52	80.74±0.97	78.49±0.65	77.44±1.52	81.28±0.88
Egg specific gravity	1.10±0.002	1.10±0.003	1.10±0.001	1.10±0.002	1.10±0.003	1.10±0.002
Shell thickness, mm	0.36±0.01	0.37±0.01	0.36±0.01	0.36±0.01	0.37±0.01	0.35±0.01
SWUSA, mg/cm^2	96.07±1.88	90.14±3.87	92.26±1.93	96.07±1.88	90.14±3.87	93.68±2.57
Interior quality:						
Albumen height, mm	7.66±0.31	7.09±0.25	7.54±0.20	7.66±0.31	7.09±0.25	7.25±0.36
Haugh units	92.17±1.49	88.66±1.59	90.54±1.18	92.17±1.49	88.66±1.59	89.46±1.84
Yolk index, %	45.40±1.06	43.98±1.17	44.58±0.82	45.40±1.06	43.98±1.17	44.42±0.58

*: T1=negative control (0.405% AP); T2=positive control (0.405% AP + enzyme); T3= 0.334% AP + enzyme; T4= 0.262% AP + Enzyme; T5= 0.190% AP + Enzyme and T6= 0.119% AP + Enzyme.

This result showed that incorporation of phytase in low-phosphorus diets may have a beneficial effect on eggshell quality, and this can be attributed to the releasing of inorganic P from the carbon skeleton of the phytate molecule. Nelson *et al.* (1968) reported that phytase from *Aspergillus ficuum* can hydrolyze 97% of the P from phytate in soybean meal, as determined by chemical analysis. Egg shape index, and egg specific gravity,

measured in the present study were not affected by any of the dietary treatments. Also, there were no significant differences among the current treatments in albumen height, Haugh units or yolk index. These results are in agreement with those reported by Yossef *et al.* (2001) who observed that interior egg quality was not affected by feeding Gimmizah laying hens on diets containing different available phosphorus from 0.25% (low level) to 0.40% (recommended level).

Egg fertility and hatchability:

Fertility and hatchability of eggs are the major parameters evaluating the reproductive performance of chickens and other poultry species. Nutrition is an important factor affecting egg fertility and hatchability. Means of three hatches for eggs of Sinai laying hens fed the experimental diets, of different AP levels with and without phytase enzyme, are shown in Table 6. Analysis of variance of these results showed that no significant differences were observed among the dietary treatments in egg fertility, hatchability (as a percent of the total or fertile eggs). The data of embryonic mortality and chick weight at hatch, in all hatches studied, exhibited no significant differences among the dietary treatments.

Table 6: Means ± standard errors of egg fertility, hatchability and embryonic mortality of eggs produced by Sinai laying hens fed diets containing graded available phosphorus (AP) levels with or without phytase enzyme (E) supplementation

Treatments / Criteria	Dietary treatments*					
	T1	T2	T3	T4	T5	T6
Total eggs set	270	266	262	285	259	258
Egg fertility, %	85.83 ±4.27	87.84.±1.80	91.34±3.94	86.15±3.69	89.43±3.24	89.27±2.60
Fertile hatchability, %	79.02±6.88	77.42±6.25	74.40±10.23	74.65±8.72	56.32±1.29	61.84±7.60
Total hatchability, %	68.39±8.90	68.20±6.64	68.70±11.71	64.11±6.88	50.42±2.70	55.39±7.46
Embryonic mortality, %	20.98±6.88	22.58±6.25	25.60±10.23	25.35±8.72	43.68±1.29	38.16±7.60
Mean chick weight,g	31.57±0.85	31.26±0.79	31.50±0.57	31.22±0.99	31.13±0.94	31.19±0.83

*: T1=negative control (0.405% AP); T2=positive control (0.405% AP + enzyme); T3= 0.334% AP + enzyme; T4= 0.262% AP + Enzyme; T5= 0.190% AP + Enzyme and T6= 0.119% AP + Enzyme.

Carcass yield and other slaughter traits:

Data of some criteria of carcass yield and other slaughter traits of 52-wk old Sinai laying hens, as affected by feeding experimental diets, containing graded AP levels with or without phytase supplementation, are shown in Table 7. Statistical analysis showed that there were no significant differences among the various experimental groups in all criteria of carcass traits.

Table 7: Means ± standard errors of carcass yield and some slaughter traits for 52 wks old Sinai laying hens fed diets containing graded available phosphorus (AP) levels with and without phytase enzyme (E) supplementation.

Criteria**	Dietary Treatments*					
	T1	T2	T3	T4	T5	T6
Live body weight, g	1363.33 ±30.18	1397.00 ±44.17	1377.67 ±20.18	1431.67 ±45.10	1430.67 ±26.03	1313.33 ±52.35
Liver %	2.40±0.03	2.64±0.39	3.22±0.38	2.51±0.44	2.94±0.44	2.42.±0.26
Gizzard %	1.33±0.01	1.47±0.110	1.40±0.12	1.24±0.08	1.14±0.13	1.39±0.02
Heart%	0.56±0.06	0.50±0.06	0.42±0.02	0.51±0.06	0.50±0.04	0.52.0.04
Abdominal fat %	4.32±0.16	3.52±0.83	2.57±0.49	3.88±0.22	2.97±1.35	3.56±0.60
Giblets, % (1)	4.29±0.07	4.61±0.55	5.04±0.52	4.26±0.42	4.58±0.35	4.33±0.22
Eviscerated wt, % (2)	62.42±0.46	62.18±0.50	62.80±0.25	63.31±0.38	62.43±0.35	62.78±0.14
Total edible parts (3)	66.71±0.52	66.80±0.97	67.84±0.35	67.57±0.41	67.01±0.60	67.12±0.25

*: T1=negative control (0.405% AP); T2=positive control (0.405% AP + enzyme); T3= 0.334% AP + enzyme; T4= 0.262% AP + Enzyme; T5= 0.190% AP + Enzyme and T6= 0.119% AP + Enzyme.

**% of body weight .

(1)Giblets = gizzard + heart + liver. (2) Eviscerated wt = carcass weight + neck. (3) Total edible parts = giblets + eviscerated weight .

Blood parameters:

Data on some blood constituents of 52-week-old Sinai laying hens, fed diets containing graded AP levels with and without phytase supplementation, are given in Table 8. Analysis of variance of these data showed that levels of plasma total protein ranged between 2.91 g/dl (T6) and 3.76 g/dl (T2) with no significant differences among dietary treatments. Also, levels of plasma total lipids, cholesterol, Ca and P were not significantly affected by the dietary treatments. It is interesting to not that the lowest cholesterol level was recorded by the negative control group (T1). This result is consistent with that of Yossef *et al.* (2001) who found that blood picture of Gimmizah laying hens fed low-P-, phytase- supplemented diets was almost similar to that of hens fed the normal recommended P level (0.4% AP) with no phytase addition.

Table 8: Means ± standard errors of blood constituents for 52-wk-old Sinai laying hens fed diets containing graded available phosphorus (AP) levels with and without phytase enzyme (E) supplementation.

Measurements	Dietary Treatments*					
	T1	T2	T3	T4	T5	T6
Total protein, g/dl	3.53±0.08	3.76±0.24	3.41±0.23	3.55±0.25	3.25±5.15	2 91±0.57
Total lipids, g/l	12.37±1.10	12.47±0.44	12.92±0.04	13.52±1.39	13.72±0.58	14.88±0.62
Cholesterol, mg/dl	111.51±2.15	115.67±3.30	119.83±2.84	120.12±4.44	121.74±4.06	122.28±1.93
Plasma calcium, mg/dl	13.67±0.18	17.63±0.13	17.33±0.38	16.53±0.32	16.17±0.17	16.07±0.07
Plasma phosphorus, mg/dl	4.50±0.08	6.41±0.18	6.30±0.18	5.97±0.28	5.95±0.03	5.92±0.15

*: T1=negative control (0.405% AP); T2=positive control (0.405% AP + enzyme); T3= 0.334% AP + enzyme; T4= 0.262% AP + Enzyme; T5= 0.190% AP + Enzyme and T6= 0.119% AP + Enzyme.

Comparing plasma Ca and P levels between the negative (T1) and positive (T2) control groups, phytase supplementation led to significantly higher levels of plasma Ca and P. the lack of significant differences in plasma P concentration of laying hens fed the low-P diets with supplemental phytase (T3 to T6); as compared to that of the negative control group (T1), may suggest a further evidence for the efficacy of phytase to correct the negative relationship between dietary P and plasma P levels; as reported by several authors (Keshavarz, 1986; Frost *et al.*, 1991 and Triyuwanta *et al.*, 1992).

Frost *et al.* (1991) reported that feeding low-P-diets (0.3, 0.6 or 0.9% total P) to laying hens resulted in an increase in plasma Ca, but noted that higher levels of total P actually suppressed this response. Furthermore, other studies had indicated that plasma P is positively correlated with the dietary P level (Zumbado and Britton,1983; Keshavarz, 1986; Triyuwanta *et al.*, 1992). On the other hand, the present results disagree with those reported by Abdallah *et al.* (1993), and Pan *et al.* (1998); in which they indicated that serum Ca or P were significantly affected by dietary inorganic P supplementation.

Economic efficiency:

Economic efficiency of feeding the different experimental diets throughout the entire period are shown in Table 9. Means of economic efficiency (EE) expressed as money output/money input were found to be 0.499, 0.482, 0.471, 0.424, 0.418 and 0.392 for T6, T2, T4, T5, T1 and T3, respectively. Analysis of variance showed that no significant differences were noted in EE values among the experimental diets.

It would be concluded that when the economic aspect and performance of laying hens are put into consideration, it appeared that reducing dietary AP from 0.405 to 0.119% with phytase supplementation for Sinai laying hens is practically effective and seams to be more economic. This is of great benefit to enhance the utilization of organic phosphorus and reduce the addition of inorganic phosphorus in laying hen diets.

Table 9: Economic efficiency of Sinai laying hens fed the experimental diets containing graded available phosphorus (AP) levels with or without phytase enzyme (E) supplementation from 32 to 52 weeks of age (Means ± SE)

Items	Dietary Treatments*					
	T1	T2	T3	T4	T5	T6
Economic efficiency (EE)**	0.418±0.03	0.482±0.03	0.392±0.03	0.471±0.02	0.424±0.02	0.499±0.02
Relative EE***	100	115.13	93.74	112.68	101.44	119.38

*: T1=negative control (0.405% AP); T2=positive control (0.405% AP + enzyme); T3= 0.334% AP + enzyme; T4= 0.262% AP + Enzyme; T5= 0.190% AP + Enzyme and T6= 0.119% AP + Enzyme.

; EE = Money output/money input. *; Assuming that the relative EE of control diet (T1) equals 100.

Conclusion

Based on the results of this study, practically and economically, it can be concluded that local Sinai laying hens could efficiently utilize diets containing low level of AP (0.119%) with exogenous phytase supplementation without any adverse effects on their productive and reproductive performance.

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تأثير أضافه إنزيم الفيتيز على الاستفادة من الفوسفور فى علائق الدجاج البياض

محمد جاد الحق قاسم

معهد بحوث الإنتاج الحيواني – مركز البحوث الزراعية – وزاره الزراعة – الدقى – الجيزة.

أجريت الدراسة لمعرفة تأثير إضافة أنزيم الفيتيز الميكروبي (يحتوي الجرام علي ٢٥٠٠ وحدة) بمستوي ٠,٠٥% من العليقة المحتوية علي مستويات متدرجة من الفسفور المتاح علي الأداء الإنتاجي لدجاج السينا البياض. تم تكوين ٦ علائق تجريبية متساوية الطاقة (٢٧٠٠ك كالوري/ كجم) والبروتين الخام (١٦%) ومستوي كالسيوم ٣,٣ %، احتوت والعليقة الأولي علي ٠,٤٠٥% فسفور متاح و استخدمت عليقة كنترول سالبة والعليقة الثانية كانت مثل الأولي في مستوي الفسفور المتاح مع إضافة أنزيم الفيتيز لها واستخدمت كنترول موجب بينما العلائق ٣، ٤، ٥، ٦ احتوت علي المستويات ٠,٣٣٤ % ، ٠,٢٦٢%، ٠,١٩٠%، ٠,١١٩% فسفور متاح علي الترتيب مع إضافة الأنزيم. غذيت كل عليقة تجريبية لعدد ٣٠ طائر موزعة علي ستة مكررات متساوية في الفترة من ٣٢ إلي ٥٢ أسبوع من العمر.

من تحليل النتائج لم يلاحظ فروق معنوية في الأداء الإنتاجي لدجاج السينا بين المعاملات الغذائية متمثلة في قياسات إنتاج البيض ووزن البيضة وكتلة إنتاج البيض والعلف المستهلك وكفاءة تحويل الغذاء باستثناء أن المعاملة السادسة أعطت متوسط وزن بيضة أقل معنويا مقارنة بالمعاملات الأخرى. بالنسبة لخصوبة البيض الناتج ونسبة التفريخ ونسبة النفوق الجنيني لم تتأثر معنويا بالمعاملات الغذائية. لوحظ أيضا أن مواصفات الجودة الخارجية والداخلية للبيض لم تتأثر معنويا بالمعاملات الغذائية عند الأعمار المدروسة وهى ٣٦، ٤٠، ٤٤ أسبوع. لم تلاحظ فروق معنوية بين المعاملات الغذائية في مكونات الدم المدروسة عند ٥٢ أسبوع من العمر والمتمثلة في تركيز البلازما من البروتين الكلي، الدهون الكلية، الكلسترول، الكالسيوم والفسفور. علاوة علي ذلك لم تؤثر المعاملات الغذائية علي مواصفات الذبيحة. من الناحية الاقتصادية لوحظ أن المعاملات ٢، ٤، ٥، ٦ حققت كفاءة اقتصادية عالية ولكن المعاملة السادسة تفوقت علي كل المعاملات الغذائية في الكفاءة الاقتصادية النسبية.

من النتائج المتحصل عليها يمكن استنتاج أن دجاج السينا البياض يمكن تغذيته علي عليقة الدجاج البياض بمستوي منخفض من الفسفور المتاح (٠,١١٩%) مع إضافة ٠,٠٥% من أنزيم الفيتيز دون أن يؤثر ذلك علي الأداء الإنتاجي أو نتائج التفريخ.