THE EFFECT OF PHOSPHORUS LEVELS AND PHYTASE SUPPLEMENTATION ON GROWTH PERFORMANCE, BONE QUALITY AND CARCASS TRAITS IN BROILER CHICKENS

Y.S. Shabban[1], F. Abdel Azeem[1], H.A. Thabet[1], A.I. El. Faham[2], Nematallah G.M. Ali[1] and Ebtehag I. Abou Elenin[2]

[1]Poultry Production Department, Faculty of Agriculture, Ain shams University, Egypt

[2]Animal Nutrition Department, Animal Production Research Institute, Dokki, Giza Egypt

SUMMARY

The aim of this study was to evaluate the effect of adding phytase enzyme in broiler diet with optimized nutrients content (standard) or with calcium and phosphorus deficiency on growth performance, bone quality, Carcass traits and economic efficiency. Total numbers of 180 one-day old broiler chicks of Cobb 500 were randomly distributed into 6 treatments with 10 chicks per replicate and 3 replicate per treatment. Chicks fed on 3 starter (0-21 d) and 3 grower diets (100, 75 and 50%) of calcium and phosphorus requirements according to the guidebook off Cobb 500 broilers. All the diets were without or with adding commercial and enzymatic product (phytase, 550 FTU) per kg diet. The main results obtained can be summarized as follows: There were insignificant difference in body weight, body weight gain, feed consumption and feed conversion between chicks fed different levels of calcium and phosphate with or without enzyme supplementation.Carcass traits (dressing percentage and ready to cook) were non-significantly different for all treatment groups except giblets percentage, liver percentage, gizzard percentage and heart percentage were significantly affected by calcium and phosphorus levels. In the same manner, tibia length tibia width and tibia seedor index weren't significantly affected by treatments. Whereas, tibia-brokering stress was significantly reduced only with chicks 100/50% diet and chicks fed (100/100%) diet give the significantly higher figure. Results of economic evaluation showed that supplementation phytase enzyme (100/75) calcium and phosphorus in broiler diet support and enhance economic efficiency.

In conclusion, it could be recommended that using of (100/75) as a level of calcium and phosphorus according to the guidebook of Cobb 500 broiler diet with phytase enzyme could keep better utilization of both calcium and phosphorus to maintain performance, carcass and tibia as well as enhance economic efficiency.

Keywords: *Phosphorus, Phytase, performance, bone quality, broilers*

INTRODUCTION

During the last decades, researchers have been investigated ways which may reduce the environmental pollution by N and phosphorus that utilized for poultry productions. The accurate is important to calculate the nutritional allowance of birds to be having nutrient needs. The second approach to enhance the utilization of poultry's nutrients has to be investigated. Levels of N, Ca, P, Cu, Mn, and Zn that found in poultry excreta were significant which led to environmental pollution (Han *et al.,* 2001; Payne, 1998; Paterson, 2002).

However, the level of nutrients specially Ca and P can be decreased in poultry diets when adding phytase to enhance broiler performance. Total P was reduced in the manure of broilers fed the low phosphorus diets ($P<0.01$) in broilers fed phytase (Powell *et al.*, 2008). Gautier *et al.* (2018) Found that broilers body weight gain was enhanced by the addition of phytase enzyme regardless of the mineral matrix, however, enhanced the ratio of Ca: P from 2.00:1 to 2.65:1 via depression of mineral concentrations in diets caused an overall decrease in body weight gain (BWG) and with the supplementation of phytase, the reduction was minimum level.

Supplementation of phytase enzyme enhanced ($P<0.05$) broilers feed intake that fed a deficient of phosphorus diets. Furthermore, the results illustrated that adding phytase with level 1000 PU/kg and higher released phytate P that was maximized the utilization of phosphorus for growth in the same manner as would phosphorus supplied by dicalcium phosphate (Abo Omar and Sabha, 2009).

While, Li *et al.* (2016) found that feed intake was not influenced by diet components at 9 days of bird age, but was lowest in broilers fed that diet with 0.2% NPP level at 19 d of age ($P<0.05$). Lin *et al.* (2017) illustrated that broilers feed: gain ratio in the 0.18% dietary NPP group was higher ($P<0.01$) than those broilers in other groups. Birds fed P diets with sufficient amounts of P requirements and those fed diets with P reduced by 50%. The feed conversion ratio was not affected by diet (P>0.10). (Kahindi *et al.,* 2017)

Furthermore, Pieniazek *et al.* (2017) found that supplementation of phytase at 2,000 U/kg improved ($P<0.05$) feed conversion ratio in both grower and finisher phase compared to the control diet. Sousa *et al.* (2015) found that gizzard relative weight was not affected by treatments. However, supplementation of phytase with reducing Ca and P in diets, the results showed that liver (p<0.10) and heart (P<0.01) relative weights enhanced by about 9.06 and 13.33%; respectively, in birds the fed diet with no adding phytase.

Also, supplementation of phytase was evaluated on dressing percentage of broilers where there weren't any effect (Abo Omar and Sabha 2009). Srikanthithasan *et al.* (2020) illustrated that the tibia length of birds fed high or low levels of phytase were higher than those of broilers fed control (without phytase). Also, the tibia was taller for birds fed high phytase than those of birds fed low level phytase on day 35. Fernandes *et al.* (2019) showed that linear effect with inclusion of phytase was observed. The highest values of both Ca and P deposited in tibia were revealed by phytase high level, which reflected on tibia resistance and great breaking strength values.

Also, the results of many previous studies demonstrated that the use of phytase enzyme has beneficial influence on bone quality and some carcass traits. However, there are numbers inconsistent and conflicting finding surrounding the effect of using phytase enzyme as feed additives in low calcium and phosphor diets on broiler productive performance. Therefore, the current study investigated the Impact of phytase enzyme inclusion in broiler diets with optimized nutrients content (standard) or with calcium and phosphorus deficiency on growth performance, bone quality and carcass traits.

MATERIALS AND METHODS

This study was conducted at poultry experimental unit and laboratories faculty of Agricultural, Ain shams University, Egypt. A total number of 180 one-day old Cobb 500 broiler chicks were randomly divided into 6 equal groups ,each was subdivided into 3 replicates with (10 chicks/each). All checks weird vaccine against the common viral disease (NDV, IBDV) at the recommended period.

Two feeding phases were applied starter from 1-21 days and grower from 22-24 days of age. The chicks where feed 1 starters the diet formulated according the guidebook of Cobb 500 and 3 diets (100, 75 and 50) calcium and phosphorus requirements which are present in table (1). All the diets were with or without commercial enzymatic product (natphos) 50 g/ ton diet. Each one gram of this product contain fight is phytase enzyme 10000 FTU. Feed and water were provided ad-libtum. All chicks were kept under the same managerial, hygienic and environmental conditions. Chicks were individually weight at the beginning of the experimental, then at weekly intervals unit the end of experimental, live body weight, body weight gain, feed consumption and feed conversion ratio were recorded during these periods. At the end of experiment 6 birds from each experimental group were weighted and slaughtered. Carcass, liver, gizzard and heart weighted. Tibia bones were removed clean off all soft tissues and weighted. Tibia length, tibia widths were determined using digital micrometer according to the method described by Samejima *et al.* (1990). The Seeder index was determined according to Seeder (1991), breaking strength was determined using the method of Fleming *et al.* (1998). Economic efficiency was calculated according to North (1981) in relation to prices of local market at time of the study.

Statistical analysis

Data were analyzed statistically using two-way classification of SAS,(2005) and Duncan (1955) as blow:

$$Y_{ijkl} = \mu + D_i + P_j + (D*P)_k + e_{ijkl}$$

Where:

Y_{ijkl}= observation of the parameter measured.
μ = overall mean
D_i =effect of dietary treatments,
P_j= phytase effect,
$(D*P)_k$= the interaction between dietary treatments and phytase effect.
e_{ijkl} = random error effect.

RESULTS AND DISCUSSION

Productive performance

Live body weight (g) and daily weight gain (g/day)

The live body weight (g) at 3 and 6 weeks of age and daily weight gain (g/day) of broilers as affected by dietary treatment are illustrated in Table (2). It is worth to note that, the chicks fed T2 (100/75) and T3 (100/50) diets during overall (0-6 weeks) reflect the highest insignificant results in both live body weight and daily body weight gain compared with T1 (100/100) treatment. Moreover, chicks fed T2(100/75) diets showed increasing in body weight and daily body weight gain (6.6 and 6.8 %) respectively compared to the fed T1 (100/100) diets(1968.59 VS 1847.57 g) and (48.11 VS 45.04 g/day) respectively, the differences were statistically non-significantly.

In addition, adding phytase had positive effect on live body weight. So, it was noticed that daily live body weight of chick according to dietary treatments effect was no significant effect but numerically, during 0-3 wks, during 3-6wks and overall of 0-6 wks,. These results confirmed by those obtained by Rousseau *et al.* (2016) who reported that during 10 to 35 days of birds 'age, decreasing level of NPP in diets affected on daily gain. However, Kahindi et al. (2017) found that birds fed diets containing sufficient amountsof inorganic phosphorus to meet P requirements had higher ($P<0.001$) daily gain than those fed diets with inorganic phosphorus reduced by 50%. Also, results by Shang *et al.* (2015) showed no significant effects of reduced levels of Ca and available P on birds' growth was observed for all treatments during 5 to 14 d of age.

Daily feed consumption

It showed at Table (3) the records of daily feed consumption of broiler chicks. During 0-3wks, T1 was the highest significant record of feed consumption and T3 was the lowest. Then, during 3-6wks, using level of 100-50 (T3) lead to improve feed consumption with no significant differ. Consequently, overall 0-6wks, it noticed that feed consumption was the highest value for T2 than those others; numerically. That may be due to low levels Calcium and Phosphorus lead chicks to feed more to cover its requirements. Adding phytase decreased daily feed intake with no significant effects. These results are in agreement with results of Shang *et al.* (2015) they indicated that reduce levels of available P did not significantly affected on birds' growth and feed consumption at an early age. While, during 10 to 35 days at all, birds feed intake was 1ower especially with lowest NPP (%) diets and with the high Ca (Rousseau *et al.*, 2016).

Feed conversion ratio

Concerning of feed conversion values in Table (3), there was the highest insignificant values for T1 compare with other dietary treatments (T_{2-3}) during the first period, second period and during overall periods (0-6wks), the same trend was observed. Rousseau *et al.* (2016) who reported that broilers from 10 to 21 d, which fed the 0.3% NPP diet was lower feed conversion than birds fed the 0.45% NPP diet, but this difference was clear noticed at the lowest Ca level diets.

There weren't phytase effect on feed conversion was observed. These results may be due to data of feed consumption and daily live body weight gain which calculated from it. While, the result of the experiment of Shang *et al.* (2015) during 5 to 21 days reported that supplemented diets with phytase decreased feed conversion ratio ($P<0.05$). In addition to, the birds receiving the diet with supplemented phytase linearly increased all the growth performance impact (Olukosi *et al.*, 2013). Furthermore, phytase supplementation at different percent improved ($P<0.05$) feed conversion ratio of broilers at weight of marketing compared to low P diets (Abo Omar and Sabha, 2009)

Carcass traits

Table 4 shows the effect of different dietary treatment with or without phytase enzyme on carcass traits. Experimental treatment with or without phytase enzyme had insignificant effects on the dressing % or ready to cook %. Corresponding values for the dressing % range between 73.08 and 72.41%, while ready to cook between 78.75 and 78.13. Moreover, chicks fed T1 (100/100) diets showed the highest liver and giblets %, being (4.04 and 6.51%) respectively and lowest significant gizzard and heart% being (1.74 and 0.61%) respectively compared with those fed T2 or T3. On the other hand, there were not any effect for adding phytase on dressing% or ready to cook%. these results in harmony with the result obtained by (Abo omra and Sobha 2009; Soysq et al., 2015 and Emmenes et al., 2018) who observed no differences in carcass yield among broilers had different levels of P in dietary or phytase supplemented diets. Furthermore, Freitas *et al.* (2019) reported that carcass characteristics weren't affected by phytase addition in the diets.

Bone quality

Table (5) illustrated the effect of different treatments and phytase on bone measurements (Tibia Length (cm), Tibia Width (cm), Tibia breaking strength and, Tibia Seedor Index (SI). All measurements hadn't significant different except tibia breaking strength the different treatments , even T1 and T2 recorded the highest tibia breaking strength records compared with those T3 treatment, so there was an improvement of tibia strength. These results are in agreement with Rousseau *et al.* (2016) who found tibia breaking strength at 35 days was higher for broilers fed Ca with 0.6 percent and NPP 0.30 percent diets. In addition to, broilers fed diet with low concentration of Ca and NPP resulting in depression of tibia breaking strengths compared to the other diets. These results are in agreement with Liu *et al.* (2017) who found that diets with low NPP level affected ($P<0.0001$) tibia bone strength. Furthermore, birds fed the diets with decreasing phosphorus intake content from 100 to 0% linearly reducing ($P<0.05$) tibia length in chicks. In addition to, the diets with 50% low P or no supplemented P resulted in decreasing available P content which led to decrease tibia length (Kahindi *et al.,* 2017). Furthermore, adding phytase had positive response on tibia breaking strength. These results are confirmed by results of Zeller *et al.* (2015) who found that bone breaking strength were increased significantly by phytase supplementation.

Economic efficiency

The final body weight, length of the growing period and feeding cost are generally among the most important factors involved in achievement of maximum net return of meat production. The effect of the different treatments diets on the economic efficiency of meat production is presented in Table (6). The economic efficiency values were calculated according to the prevailing market price of feed ingredients as well as the price of one kilogram live body weight at the end of the experimental period which was 27 L.E. The results of relative economic efficiencies of the diets containing lower levels of NPP without or with phytase relatively to control (T1) were higher than those other groups. **Anjum *et al.* (2018)** broilers fed diets with 50% less di-calcium phosphate (DCP) with adding phytase, the total feed cost per unit weight gain was numerically 14% and 9% less than the broilers fed contained 50% less di-calcium phosphate (DCP) without phytase and positive control diet.

So generally, according to data of this study, it is recommended that using 100/50% from requirements of phosphorus for broilers during both starter and grower periods was the best treatment.

CONCLUSION

The results indicated that birds fed on lower levels of Ca and AP below the requirements had positive effects without adverse effects especially with adding phytase on productive performance and carcass traits with improving economic efficiency in addition to deficient of environmental pollution.

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تاثير مستوي الفوسفور واضافة انزيم الفيتيز على الاداء الانتاجي وصفات الذبيحة والعظم لدجاج اللحم

ياسر سعد شعبان[1]، فتحي عبد العظيم[1]، هانى على ثابت[1]، أحمد ابراهيم الفحام[1]، نعمة الله جمال الدين[1] و ابتهاج إبراهيم ابوالعنين[2]

[1]قسم انتاج الدواجن – كلية الزراعة – جامعة عين شمس – مصر

[2]قسم تغذية الحيوان – معهد بحوث الانتاج الحيوانى – دقى – جيزة - مصر

180 كتكوت غير مجنس سلالة (كب 500) وزعت على 6 معاملات غذائية (3 مكررات × 10 كتكوت) استخدمت فى تجربة عاملية (3×2) كالاتى: غذيت الكتاكيت على عليقة بادى (0 – 21 يوم) ونامي (22 – 42 يوم) احتوت على 3 مستويات من الكالسيوم والفوسفور (50 – 75 – 100) من الاحتياجات لسلالة كب 500 مع او بدون اضافة انزيم الفيتيز (FTU 550) لكل كيلو جرام علف.

اوضحت النتائج ان المعاملات الغذئية المختلفة:

- لم توثر على وزن الجسم الحي والمكتسب واستهلاك العلف ومعامل التحويل الغذائي
- لم توثر على % للذبيحة وال % للاجزاء الكلية الماكولة بينما % للحوائج و% للكبد و% للقانصة و% للقلب تاثير معنويات بمستوي الكالسيوم والفوسفور في العليقة
- لم توثر على صفات عظمة الساق بينما اثرت معنويا على قوة كسر العظمة حيث معاملة 50/100 و100/100 اعطت اعلى القيم معنويا
- اضافة انزيم الفيتيز لعليقة (75/100) كالسيوم وفوسفور ادى الى تحسين العائد الاقتصادى لدجاج اللحم

الخلاصة :- نتائج التجربة توضح ان اضافة انزيم الفيتيز لعليقة بداري التسمين المحتوي على 100% كالسيوم / 75% فوسفور تحسن العائد الاقتصادى بدون تاثيرات سيئة على الاداء الانتاجى وصفات الذبيحة والعظم

Table(1): Composition and calculated analysis of the starter and grower experimental diets.

Ingredients%	Starter			Grower		
	100%	75%	50%	100%	75%	50%
Yellow corn	56.68	57.14	58.52	63.95	64.31	65.10
Soybean meal (44 % CP)	31.15	33.35	34.00	25.18	27.70	29.15
Corn gluten meal(60%CP)	5.60	4.00	3.35	4.10	2.20	1.05
Vegetable Oil	2.00	2.00	1.65	2.50	2.50	2.35
Ca Carbonate	1.60	1.17	0.77	1.47	1.08	0.70
Mono Ca Ph	1.85	1.25	0.64	1.65	1.10	0.56
Salt (NaCl)	0.30	0.30	0.30	0.30	0.30	0.30
Premix*	0.30	0.30	0.30	0.30	0.30	0.30
HCl-Lysine	0.28	0.24	0.22	0.31	0.26	0.23
DL- Methionine	0.24	0.25	0.25	0.24	0.25	0.26
Total	100	100	100	100	100	100
Price L.E /Ton	5680	5550	5410	5420	5280	5150
Calculated analysis:-						
CP %	22	22.01	22.01	19.06	19.02	19.01
ME (Kcal/Kg)	2999	3004	3006	3103	3101	3102
Calcium %	1.01	0.75	0.51	0.91	0.68	0.45
Available phosphorous %	0.51	0.38	0.25	0.46	0.34	0.23
Lysine%	1.32	1.32	1.32	1.2	1.19	1.19
Methionine %	0.62	0.62	0.62	0.57	0.57	0.57
Meth. + Cys. %	0.985	0.984	0.980	0.896	0.891	0.892

** The premix contains: Vitamins: A: 12000000 IU; Vit. D3 2000000 IU; E: 10000 mg; K_3: 2000 mg; B_1:1000 mg; B_2: 5000 mg; B_6:1500 mg; B_{12}: 10 mg; Biotin: 50 mg; Coline chloride: 250000 mg; Pantothenic acid: 10000 mg; Nicotinic acid: 30000 mg; Folic acid: 1000 mg; Minerals: Mn: 60000 mg; Zn: 50000 mg; Fe: 30000 mg; Cu: 10000 mg; I: 1000 mg; Se: 100 mg and Co: 100 mg.*

Table (2): Effects of Phytase and successive levels of calcium and phosphorus on live body weight and daily live body weight gain of broiler chicks.

Item		Dietary treatments							Prob.			
		T1 (100-100)	T2 (100-75)	T3 (100-50)	T4 (75-75)	T5 (75-50)	T6 (50-50)	Overall	SEM	D	P	D*P
		Live body weight g.										
Initial weight	Without phytase	45.60	44.80	44.90	44.07	44.83	42.90	44.52	0.43			
	With phytase	46.20	43.80	43.67	44.17	46.77	44.03	44.77	0.43	NS	NS	NS
	Overall	45.90	44.30	44.28	44.12	45.80	43.47		1.06			
3 wks	Without phytase	654.9	690.20	630.07	672.70	666.9	659.4	662.36	8.12			
	With phytase	646.7	646.4	669.1	673.8	665.53	696.03	666.26	8.12	NS	NS	NS
	Overall	650.80	668.30	649.85	673.25	666.22	677.72		19.89			
6 wks	Without phytase	1816.12	1905.15	1941.65	1896.02	1909.41	1880.00	1891.3	27.79			
	With phytase	1879.03	2032.03	1941.79	1941.10	1799.73	1984.08	1929.6	27.79	NS	NS	NS
	Overall	1847.57	1968.59	1941.72	1918.56	1854.57	1932.04		68.08			
		Daily live body weight gain g/day.										
0-3 wks	Without phytase	29.01	30.73	27.87	29.93	29.62	29.36	29.42	0.38			
	With phytase	28.60	28.70	29.78	29.98	29.47	31.05	29.59	0.38	NS	NS	NS
	Overall	28.80	29.71	28.82	29.96	29.54	30.20		0.66			
3-6 wks	Without phytase	55.30	57.85	62.46	58.25	59.17	58.12	58.53	1.25			
	With phytase	58.68	65.98	60.60	60.35	54.01	61.34	60.16	1.25	NS	NS	NS
	Overall	56.99	61.92	61.53	59.30	56.59	59.73		2.17			
0-6 wks	Without phytase	44.26	46.51	47.42	46.30	46.61	45.93	46.17	0.69			
	With phytase	45.82	49.71	47.45	47.42	43.82	48.50	47.12	0.69	NS	NS	NS
	Overall	45.04	48.11	47.44	46.86	45.22	47.21		1.20			

[a,b,c]*Means in the same row or column with the same letters are not significantly different.*
SEM = Standard error of means. NS: Non-significant.
*D = dietary treatments, P= phytase effect, D*P= the interaction between dietary treatments and phytase effect*

Table (3): Effects of Phytase and successive levels of calcium and phosphorus on daily feed consumption and feed conversion ratio of broiler chicks.

Item		Dietary treatments								Prob.		
		T1 (100-100)	T2 (100-75)	T3 (100-50)	T4 (75-75)	T5 (75-50)	T6 (50-50)	Overall	SEM	D	P	D*P
Daily feed consumption												
0-3 wks	Without phytase	41.35	41.27	37.27	40.52	40.08	41.14	40.27	0.54			
	With phytase	38.94	38.73	38.21	40.00	39.49	41.14	39.42	0.54	*	NS	NS
	Overall	40.14[ab]	40.00[ab]	37.74[b]	40.26[ab]	39.79[ab]	41.14[a]		0.95			
3-6 wks	Without phytase	118.52	123.10	131.27	117.38	118.84	125.09	122.37	2.32			
	With phytase	121.43	126.25	119.61	120.17	116.41	124.55	121.40	2.32	NS	NS	NS
	Overall	119.97	124.68	125.44	118.77	117.63	124.82		4.02			
0-6 wks	Without phytase	79.93	82.19	84.27	78.95	79.46	83.11	81.32	1.23			
	With phytase	80.18	82.49	78.91	80.08	77.95	82.85	80.41	1.23	NS	NS	NS
	Overall	80.06	82.34	81.59	79.52	78.71	82.98		2.13			
Feed conversion ratio												
0-3 wks	Without phytase	1.43	1.34	1.34	1.36	1.36	1.40	1.37	0.02			
	With phytase	1.36	1.35	1.29	1.34	1.34	1.33	1.33	0.02	NS	NS	NS
	Overall	1.39	1.35	1.31	1.35	1.35	1.36		0.03			
3-6 wks	Without phytase	2.15	2.17	2.10	2.03	2.07	2.16	2.12	0.05			
	With phytase	2.06	1.92	1.98	2.00	2.17	2.03	2.03	0.05	NS	NS	NS
	Overall	2.11	2.04	2.04	2.02	2.12	2.10		0.09			
0-6 wks	Without phytase	1.90	1.87	1.86	1.80	1.79	1.90	1.85	0.03			
	With phytase	1.83	1.75	1.75	1.78	1.88	1.79	1.80	0.03	NS	NS	NS
	Overall	1.87	1.81	1.81	1.79	1.83	1.85		0.06			

[a,b,c]Means in the same row or column with the same letters are not significantly different.
*SEM = Standard error of means. NS: Non-significant. *: ($P \leq 0.05$)*
*D = dietary treatments, P= phytase effect, D*P= the interaction between dietary treatments and phytase effect*

Table (4): Effects of Phytase and successive levels of calcium and phosphorus on carcass characteristics of broiler chicks.

Item		Dietary treatments								Prob.		
		T1 (100-100)	T2 (100-75)	T3 (100-50)	T4 (75-75)	T5 (75-50)	T6 (50-50)	Overall	SEM	D	P	D*P
Dressing %	Without phytase	73.03	72.55	72.24	72.75	73.35	72.86	72.80	0.21			
	With phytase	72.18	73.60	72.58	72.53	72.50	73.40	72.80	0.21	*	NS	NS
	Overall	72.61^{ab}	73.08^{ab}	72.41^{b}	72.64^{ab}	72.93^{ab}	73.13^{a}		0.12			
Liver %	Without phytase	3.37	3.46	3.10	3.12	3.03	3.02	3.18	0.10			
	With phytase	4.71	2.82	3.04	2.66	2.62	2.77	3.10	0.10	*	NS	NS
	Overall	4.04^{a}	3.14^{b}	3.07^{b}	2.89^{b}	2.82^{b}	2.89^{b}		0.06			
Gizzard %	Without phytase	1.61	1.85	2.04	1.75	1.89	1.79	1.82	0.07			
	With phytase	1.88	1.83	2.11	1.77	2.05	1.59	1.87	0.07	**	NS	NS
	Overall	1.74^{c}	1.84^{abc}	2.08^{a}	1.76^{bc}	1.97^{ab}	1.69^{c}		0.04			
Heart %	Without phytase	0.61	0.61	0.62	0.66	0.58	0.55	0.61^{b}	0.02			
	With phytase	0.62	0.62	0.82	0.68	0.61	0.68	0.67^{a}	0.02	*	*	NS
	Overall	0.61^{b}	0.62^{b}	0.72^{a}	0.67^{ab}	0.60^{b}	0.61^{b}		0.01			
Giblets %	Without phytase	5.72	6.04	5.89	5.65	5.65	5.49	5.74	0.13			
	With phytase	7.31	5.40	6.11	5.23	5.45	5.17	5.78	0.13	**	NS	NS
	Overall	6.51^{a}	5.72^{ab}	6.00^{b}	5.44^{c}	5.55^{c}	5.33^{c}		0.07			
Tibia %	Without phytase	0.64	0.66	0.65	0.67	0.63	0.62	0.64^{b}	0.01			
	With phytase	0.65	0.67	0.72	0.67	0.68	0.67	0.67^{a}	0.01	*	*	NS
	Overall	0.64^{b}	0.66^{ab}	0.68^{a}	0.67^{ab}	0.66^{ab}	0.64^{b}		0.01			

a,b,c: Means in the same row or column with the same letters are not significantly different.
*SEM = Standard error of means. NS: Non-significant. *: ($P \leq 0.05$)*
*D = dietary treatments, P= phytase effect, D*P= the interaction between dietary treatments and phytase effect*

Table (5): Effects of Phytase and successive levels of calcium and phosphorus on bone measurements of broiler chicks.

Item		Dietary treatments								Prob.		
		T1 (100-100)	T2 (100-75)	T3 (100-50)	T4 (75-75)	T5 (75-50)	T6 (50-50)	Overall	SEM	D	P	D*P
Tibia Length (cm)	Without phytase	9.33	9.35	9.29	9.33	9.05	9.24	9.27	0.34			
	With phytase	9.40	9.35	9.09	9.15	9.30	9.19	9.25	0.34	NS	NS	NS
	Overall	9.36	9.35	9.19	9.24	9.18	9.21		0.60			
Tibia Width (cm)	Without phytase	0.69	0.77	0.71	0.74	0.71	0.71	0.72	0.16			
	With phytase	0.81	0.75	0.72	0.72	0.73	0.78	0.75	0.16	NS	NS	NS
	Overall	0.75	0.76	0.72	0.73	0.72	0.75		0.28			
Tibia breaking strength	Without phytase	31.63	30.42	28.34	28.47	29.35	28.15	29.39	0.31			
	With phytase	31.18	30.08	29.80	30.13	29.50	29.98	30.11	0.31	*	N.S	N.S.
	Overall	31.41[a]	30.25[ab]	29.07[b]	29.30[b]	29.43[b]	29.06[b]		0.54			
Tibia Seedor Index (SI)[1]	Without phytase	1.08	1.12	1.07	1.10	1.16	1.04	1.10	0.02			
	With phytase	1.03	1.17	0.98	1.03	1.13	1.25	1.10	0.02	N.S	N.S	N.S
	Overall	1.06	1.15	1.03	1.07	1.14	1.15		0.03			
Tibia Robusticity Index (RI)[2]	Without phytase	3.31	3.42	3.25	3.41	3.49	3.16	3.34	0.07			
	With phytase	3.17	3.59	2.77	3.11	3.44	3.81	3.31	0.07	*	N.S	N.S
	Overall	3.24[ab]	3.50[a]	3.01[b]	3.26[ab]	3.46[a]	3.49[a]		0.13			

a,b,c: Means in the same row or column with the same letters are not significantly different.
SEM = Standard error of means.NS: Non-significant.
*D = dietary treatments, P= phytase effect, D*P= the interaction between dietary treatments and phytase effect*
1 : Seedoret al. (1991); 2 :Reisenfeld(1972)

Table (6): Effects of Phytase and successive levels of calcium and phosphorus on economic efficiency of broiler chicks.

	Dietary Treatments						
	Adding phytase	**T1 (100-100)**	**T2 (100-75)**	**T3 (100-50)**	**T4 (75-75)**	**T5 (75-50)**	**T6 (50-50)**
Feed Cost / Bird (LE)	without	18.42	18.57	18.65	17.74	17.53	18.20
	with	18.48	18.63	17.51	18.00	17.20	18.16
Total Cost[1] / Bird (LE)	without	30.42	30.57	30.65	29.74	29.53	30.20
	with	30.48	30.63	29.51	30.00	29.20	30.16
Total Return[2] Bird (LE)	without	49.04	51.44	52.43	51.19	51.55	50.76
	with	50.73	54.86	52.43	52.41	48.59	53.57
Net Return / Bird (LE)	without	18.61	20.86	21.79	21.45	22.03	20.56
	with	20.26	24.23	22.93	22.41	19.39	23.41
Economic Efficiency[3]	without	61.18	68.23	71.10	72.13	74.60	68.05
	with	66.47	79.11	77.71	74.70	66.38	77.63
Relative Economic Efficiency[4]	without	100	111.52	116.21	117.90	121.93	111.23
	with	100	119.02	116.91	112.38	99.87	116.78

[1]*Total cost = (feed cost + price of one-day live chicks + incidental costs); L.E.: Egyptian Pound*
[2]*According to the local price of Kg sold live birds was 27.00 L.E.*
[3]*Economic efficiency = net return/total feed cost*100. Whereas net revenue= total return - total feed cost.*
[4]*Assuming that the relative economic efficiency of control group equals 100*