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EFFECT OF PHYTASE ENZYME ON LAYERS FED PLANT PROTEIN DIETS CONTAINING LOW LEVELS OF AVAILABLE PHOSPHORUS
1- BONE CHARACTERISTICS, MINERAL RETENTION AND NUTRIENTS DIGESTIBILITY

By

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Abstract: *A trial was performed to study the effect of two levels of available phosphorus (0.23 and 0.13%), and four levels of phytase enzyme (0, 100, 300 and 500 FTU/Kg) on mineral retention, nutrients digestibility and bone characteristics of 40 wks old laying hens fed diets based on corn-soybean meal compared to control diet containing 0.32% available phosphorus (AP) without phytase addition. Reducing AP without phytase addition depressed tibia breaking strength by 22.4%. Supplemental phytase by 100, 300, and 500 FTU /kg diet improved tibia breaking strength by 17.9, 6.0, and 15.8% respectively. Adding phytase improved tibial and femoral wall thickness, but still behind those of control group. Reducing AP without phytase addition showed decreases in tibial wet weight, dry weight, free fat dry weight (FFDW), and ash weight by 10.79, 10.80, 10.12 and 12.37% respectively. Adding phytase up to 500 FTU/kg diet showed insignificant improvement. Phytase addition significantly ($P<0.05$) increased percentage of tibial and femoral fat free DM and total ash, and insignificantly increased percentage of tibial total P and calcium by 10.79 and 10.54%, respectively. Phytase level of 100 FTU/kg diet had attained the highest values of ME, and PE. This level attained also the highest digestibility of CP, NFE. The highest value of EE digestibility was attained by phytase level of 300 FTU/kg diet (81.87%), whereas control group attained lowest value (72.15%) that was not different ($P>0.05$) from zero phytase group. On the other hand, phytase addition had no effect ($P>0.05$) on digestibilities of NFE, OM, and DM. Decreasing AP without phytase addition significantly ($P<0.05$) decreased ME and PE. Phytase addition increased ME and PE to the level of positive control group. Decreasing AP without phytase addition reduced phosphorus retention ($P<0.05$) by 30.86%. Phytase addition (300 FTU/kg diet) improved this value significantly ($P<0.05$) by 32.89%. Phytase addition (100 FTU/kg diet) attained highest value (65.27%) of Ca retention. Phytase addition by 500 FTU/kg diet decreased fecal phosphorus by 27.15%.*

INTRODUCTION

Chickens are lacking or limited in phytase, the enzyme that is necessary for breakdown of phytate molecule and subsequent release of phosphorus for absorption. The addition of phytase enzyme to the layer diets will decrease the amount of phosphorus needed from other sources. The expected increase in phosphorus digestibility will in turn reduce the amount of phosphorus being excreted. Phosphorus is the nutrient that of concern because it poses the potential problem of environmental contamination.

Keshavarz (2000), Boling *et al.* (2000a), and **Keshavarz (2003)** found that tibia ash was significantly reduced due to decreasing available phosphorus (AP) in the diet. Adding phytase to such diets improved tibia ash but still lower than control group **(Keshavarz 2003).** On the other hand, **Keshavarz (2000)** showed that tibia ash was not influenced by dietary AP or phytase during the early stage of production. **Usayran and Balnave (1995)** reported that phytase addition increased tibia ash at 18 ºC but reduced it at 30 ºC. Phytase also increased tibia P on the 0.46% P/kg diet but reduced it on the 0.32% P/kg diet. **Raquel *et al.* (2001)** found that Ca level in tibia increased linearly as phytase level increased.

Keshavarz (2000) showed that tibia weights were not influenced by dietary AP or phytase regimens. **Gordon and Roland (1997)** reported that tibia breaking strength increased (P=0.09) 9% when the 0.1% AP was supplemented with phytase. **Lim *et al.* (2003)** reported that phytase significantly increased digestibility of DM, P, and fiber, while other nutrients were not affected. **Abd-Elsamee (2002)** found that phytase significantly improved minerals retention and digestion coefficients of nutrients, except for crude fiber. Also **Um and Paik (1999)** reported that retention of DM, fat, ash, Ca, Mg, Fe, and Zn were significantly greater in phytase-supplemented group than control. On the other hand, **Keshavarz (2000)** showed that the effect of phytase in retention of total P was inconsistent and varied with AP levels.

Boling *et al.* (2000a), Boling *et al.* (2000b), Lim *et al.* (2003), and **Keshavarz (2003)** found that adding phytase to low AP-diet decreased P excretion. In addition, **Um and Paik (1999)** illustrated that excretion of ash, P, and Cu was less in phytase supplemented group than the control.

The objective of this study was to determine the effects of phytase supplementation on bone quality, digestion coefficient of nutrients, mineral retention, and fecal phosphorus in laying hens fed low-AP diets.

MATERIAS AND METHODS

This trial was conducted in Ras Sedr Experimental Station South-Sini. A total of 153, 44 weeks old, ISA brown hens were randomly assigned to nine dietary treatments (T1 to T9) and housed in six cages per treatment until 60 wks of age. Birds of control group (T1) were fed 0.32% AP without phytase addition. Available phosphorus (AP) level was reduced by an interval of 0.1% in diets of T2 to T5, while it was reduced by an interval of 0.2% in diets of T6 to T9. Birds at groups T2, T3, T4 and T5 received 0, 100, 300 and 500 FTU phytase per kg diet respectively with 0.23% AP. Birds of groups T6, T7, T8 and T9 received the same levels of phytase, respectively with 0.13% AP. Nine corn-soybean diets were isonitrogenous (17% crude protein) and isoenergetic (2900 Kcal, ME/kg diet) as shown in Table 1.

At the end of the trail, three birds from each treatment were randomly chosen, and slaughtered. Both the right and left tibiae and femurs were excised and frozen for subsequent analysis. The bones were later thawed and stripped of all soft tissues. After record the weight and dimensions, left tibiae and femurs were cut at midshafts using coping saw. Diameters at midshaft and wall thickness were measured by calipers. After that, left tibiae and femurs were dried (100 C° for 10 hour), weighed, extracted with ether using soxhlet procedure, dried again and weighed. The ground dry fat-free bones were ashed in muffle furnace at 600 °C. Ash weight was calculated as a percentage of dry fat-free bone weight. Right tibiae and femurs were tested for breaking strength using an Instron Universal Testing Machine.

A digestibility trial was carried out to study the effect of adding phytase enzyme on nutrients digestibility and mineral retention. At the end of the experiment, 3 birds of each group were housed individually in digestion cages. The birds were fed the test diets for 4 days for adaptation. Through the successive 4 days excreta collection trays were used and the feed intake was calculated. Dry excreta for each bird was ground and kept for analysis. Chemical analysis was carried out as described in **Association of Official Analytical Chemists (1980)**. Urinary Nitrogen was determined according to **Jakobsen *et al.* (1960).** Urinary Organic Matter was evaluated according to **Abou-Raya and Galal (1971)**. Productive energy (PE) and metabolizable energy (ME) were calculated according to **Titus and Fritz (1971)**.

Data were subjected to analysis of variance using the General Linear Model of SAS software (**SAS Institute, 1990**). Means were compared (P<0.05) using Duncan's multiple range test (**Duncan, 1955**).

RESULTS AND DISCUSSION

The tibial breaking strength and dimensions of tibia and femur are present in Table 2. Tibia breaking strength showed significant (P<0.05) interaction between AP and phytase, where control birds (T1) recorded highest value (23.7 kg) followed by birds fed 0.23% AP+500 FTU phytase/kg, T5, (22.6 kg). The main effects showed that reduced dietary AP to 0.23 and 0.13% resulted in decrease tibia breaking strength by 13.5 and 15.6%, respectively. Birds fed low AP-diet without phytase gave tibia breaking strength lower by 22.4% (Fig. 1). Supplemental phytase by 100, 300, and 500 FTU/kg diet did improve tibia breaking strength by 17.9, 6.0, and 15.8%, respectively. On the other hand, AP and phytase regimens had no significant (P>0.05) effect on femoral breaking strength. The results are in agreement with those of **Gordon and Roland (1997)** who reported that bone breaking strength was increased (P=0.09) 9% when 0.1% AP diet was supplemented with phytase.

Length of tibia and femur bones were not affected (P>0.05) by AP or phytase treatments because bone usually reaches complete development at the end of growing stage. Phytase by AP interaction showed significant (P<0.056) differences among wall thickness and width at epiphysis and at midshaft of tibia and femur. Reducing dietary AP decreased wall thickness of tibia and femur. The main effects showed that reducing dietary AP without phytase addition decreased tibial and femoral wall thickness by 21.3 and 53.6%, respectively. Adding phytase alleviated this depression, but still less than those of the control group. This result confirmed those of **Orban *et al.* (1999)** who reported that, tibial wall thickness at midshaft exhibited a quadratic response to phytase level.

Data present in Table 3 show physical characters of tibia and femur bones. The interaction between AP and phytase exhibited significant (P<0.05) differences among wet weight, dry weight, fat free dry weight (FFDW), and ash weight. The main effects indicated that reducing AP levels significantly (P<0.05) decreased all of these traits. Hens fed the lowest AP-diet without phytase showed decrease in tibia wet weight, dry weight, FFDW, and ash weight by 10.79, 10.80, 10.12 and 12.37%, respectively. Adding phytase up to 500 FTU/kg diet showed insignificant (P>0.05) improvement. The femur bone responds to phytase by the same manner. Unresponsive of these bone traits to phytase may be related to egg production, where phytase addition by 100, 300, and 500 FTU /kg diet resulted in egg production which surpassed those of the control group. It is well known that the increase of egg production releases minerals from bone to deposit eggshell. Our results of tibial weight disagreed with those of

Keshavarz (2000) who found that dietary AP level or phytase had no effect on tibia weight. However, our results of bone ash content agreed with those of **Keshavarz (2003), Boling *et al.* (2000a),** and **Usayran and Balnave (1995).**

Table 4 shows percentage of fat free DM, total ash, total P, and calcium contents in tibia and femur bones. The main effects indicated that the decrease in dietary AP insignificantly (P>0.05) decreased percentage of tibial ash, phosphorus and calcium by 1.95, 6.46, and 13.03%, respectively. In addition, femoral percentage of ash and phosphorus significantly (P<0.05) decreased by 2.07 and 11.40%, respectively. Femoral calcium also insignificantly decreased by 15.12%. Birds fed low-AP diets without phytase addition significantly (P<0.05) increased percentage of tibial and femoral total ash. Phytase addition significantly (P<0.05) increased percentage of tibial and femoral fat free DM and total ash, In addition, phytase supplementation (500 FTU/kg) insignificantly increased percentage of tibial total P (Fig. 2) and calcium by 10.79 and 10.54%, respectively. Percentage of femoral total P significantly (P<0.05) increased by 19.27% while, percentage of femoral calcium insignificantly (P>0.05) increased by 16.67%. These results are in agreement with those of **Raquel *et al.* (2001)** who found that the level of calcium in tibia increased as the phytase level increased. However, our results of total P disagreed with those of **Usayran and Balnave (1995)** who found that phytase supplementation increased tibia P on the 0.46% P diet but reduced it on the 0.32% P diet.

The digestion coefficients and energy values are present in Table 5. Digestibilities of CP, EE, CF, OM, and DM showed significant (P<0.05) differences for the interaction between AP and phytase. AP levels had no significant effect on digestibility of all nutrients. Irrespective of AP levels, 100 FTU phytase/kg diet attained the highest value of CP digestibility (90.75%) which was not different (P>0.05) from that of the control (90.08%). While 500 FTU/kg diet gave the lowest value (88.91%). In fact, positively charged proteins can form insoluble complexes with negatively charged phytase at low pH **(Cheryan 1980)**, so protein and phytate complex has low digestibility and phytase addition may improve protein digestibility.

The highest value of EE and CF digestibility was attained by phytase level of 500 FTU /kg diet (81.87 and 9.88%, respectively), whereas birds fed low-AP diets without phytase addition attained the lowest value (68.19 and 4.01%, respectively) that was not different from of control group. On the other hand, phytase addition had no effect (P>0.05) on digestibility of NFE, OM, and DM.

Data present in Table 5 show that the interaction between AP and phytase was significant ($P<0.05$) for ME, PE values. Irrespective of phytase levels, AP had no effect on ME and PE values, birds received low AP with no supplemental phytase gave ME and PE values less ($P<0.05$) than the control birds by 5.69 and 5.13%, respectively. Phytase addition by 100, 300, and 500 FTU /kg diet increased ME and PE by 8.38 and 9.40%; 6.82 and 8.43%; and 7.89 and 8.70%, respectively. So the 100 FTU phytase/kg diet attained the highest value of energy and the highest digestibility values of CP, NFE, OM, and DM. It is well known that phosphorus is Important for energy metabolism and energy transfer in most metabolic systems. **Lim *et al.* (2003)** reported that high AP increased fiber availability, and phytase increased availability of fiber and dry matter.

Data summarized in Table 6 indicated that the interaction between AP and phytase was significant ($P<0.05$) for apparent retention of DM, Ash, P, and Ca. The main effects showed that phosphorus retention significantly ($P<0.05$) decreased by 8.68 and 21.20% at dietary AP levels of 0.23 and 0.13%, respectively, while calcium retention was not affected by AP levels. Birds fed low-AP diets without phytase reduced phosphorus (Fig. 3) and calcium retention ($P<0.05$) by 30.86 and 4.00% respectively. Phytase addition (100 FTU /kg diet) significantly ($P<0.05$) improved these retention by 31.79 and 14.73%, respectively.

Table 6 shows fecal phosphorus values. The main effects indicated that lowering dietary AP levels decreased fecal phosphorus by 15.61 and 19.60% for groups fed 0.23 and 0.13% AP, respectively. Regardless of dietary AP levels, phytase supplementation by 500 FTU /kg diet decreased fecal phosphorus by about 27.15%.

It could be concluded that dietary phytase supplementation to low-AP diets decreased fecal phosphorus; however, improved bone strength, phosphorus and calcium levels in the bone, metabolizable energy, ether extract digestibility and phosphorus retention.

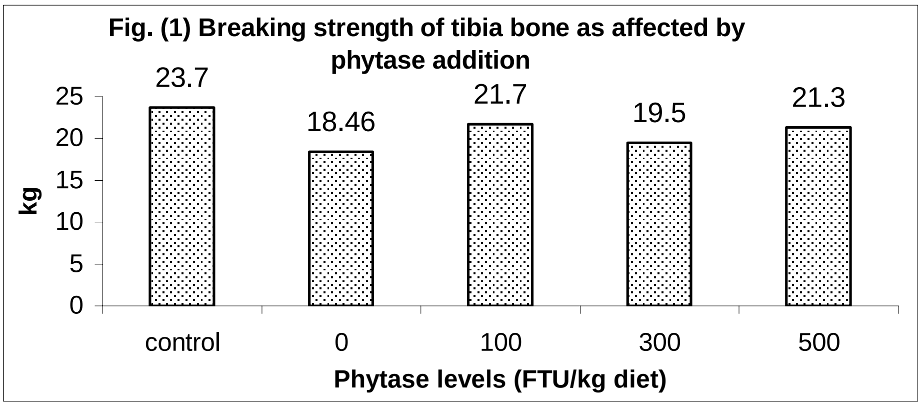

Fig. (1) Breaking strength of tibia bone as affected by phytase addition

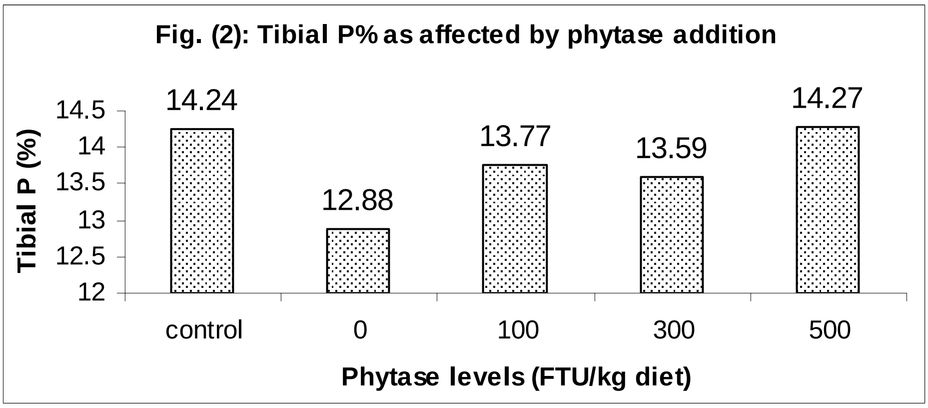

Fig. (2): Tibial P% as affected by phytase addition

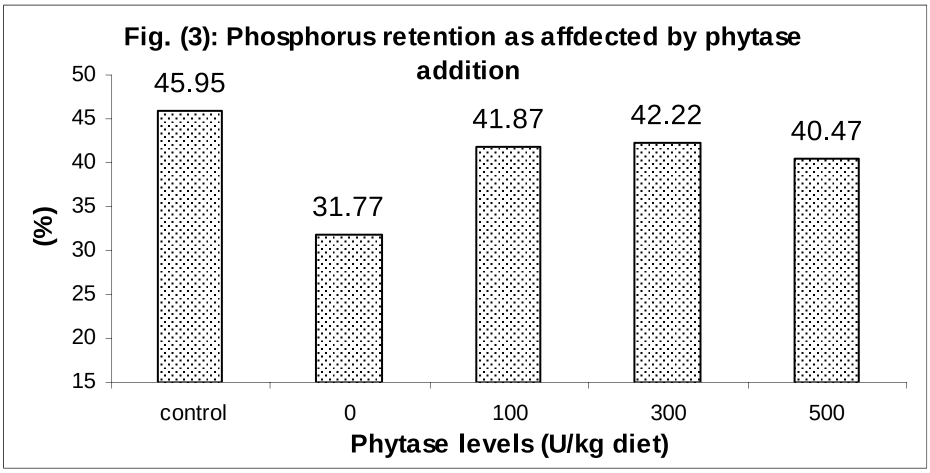

Fig. (3): Phosphorus retention as affdected by phytase addition

Table (1): Composition and calculated analysis of experimental diets

AP, (%)	0.32	0.23				0.13			
Phytase, *FTU/Kg*	-	0	100	300	500	0	100	300	500
	T1	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**
a. Ingredients									
Corn yellow	60.2	60.2	60.2	60.2	60.2	60.7	60.7	60.7	60.7
Soybean meal (44%)	26.7	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.5
Vegetable oi*l*	3.3	3.3	3.3	3.3	3.3	3.15	3.15	3.15	3.15
Sawdust	-	0.38	0.38	0.38	0.38	0.3	0.30	0.30	0.30
Calcium carbonate	8.3	8.6	8.6	8.6	8.6	8.85	8.85	8.85	8.85
Dicalcium phosphate	1	0.52	0.52	0.52	0.52	-	-	-	-
Vit.-Mineral mix.*	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100	100	100
b. Calculated values									
Crude protein %	17.04	17.02	17.02	17.02	17.02	17.04	17.04	17.04	17.04
ME (Kcal /kg)	2905	2903	2903	2903	2903	2905	2905	2905	2905
Calcium %	3.45	3.46	3.46	3.46	3.46	3.45	3.45	3.45	3.45
Av. Phosphorus %	0.32	0.23	0.23	0.23	0.23	0.133	0.133	0.133	0.133
Met + Cys %	0.56	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
Lysine %	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92

** To supply Kg diet by: vit. A 9600 IU; cholecalciferol,* *3120 IU; vit. E, 36 IU; menadione, 24 mg; vit. B12, 0.02 mg; riboflavi n, 7.2 mg; pantothenic acid, 14.4 mg; niacin, 60 mg; thiamine, 1.2 mg; choline, 500 mg; pyridoxine, 2.4 mg; folic acid, 0.72 mg; biotin, 0.06 mg; zinc, 100 mg; iron, 80 mg; manganese, 100 mg; copper, 12 mg; iodine, 1 mg; and selenium, 0.3 mg*

Table (2): Some bone parameters as affected by dietary AP and phytase levels.

	Tibia					Femur				
Phytase	Breaking Strength	Length	Width at proximal epiphysis	Width at midshaft	mean Thickness	Breaking Strength	Length	Width at proximal epiphysis	Width at midshaft	mean Thickness
U/Kg	Kg	cm	cm	cm	cm	Kg	cm	cm	cm	cm
0	23.7 ^{a}	12.055	2.475 ^{a}	0.822 ^{a}	0.080 ^{ab}	19.9	8.618	1.860 ^{ab}	0.900 ^{a}	0.125 ^{a}
0	17.1 ^{b}	12.223	2.370 ^{bc}	0.828 ^{a}	0.071 ^{abcd}	16.8	8.742	1.710 ^{b}	0.855 ^{ab}	0.058 ^{b}
100	22.0 ^{ab}	12.043	2.390 ^{abc}	0.813 ^{ab}	0.084 ^{a}	20.7	8.658	1.820 ^{ab}	0.803 ^{bcd}	0.058 ^{b}
300	20.1 ^{ab}	11.877	2.350 ^{bc}	0.777 ^{c}	0.068 ^{bcd}	19.1	8.518	1.817 ^{ab}	0.818 ^{bcd}	0.065 ^{b}
500	22.6 ^{a}	11.808	2.307 ^{c}	0.785 ^{bc}	0.063 ^{cd}	19.3	8.487	1.707 ^{b}	0.782 ^{cd}	0.048 ^{b}
0	19.6 ^{ab}	12.015	2.368 ^{bc}	0.797 ^{abc}	0.056 ^{d}	17.6	8.520	1.822 ^{ab}	0.840 ^{bc}	0.057 ^{b}
100	21.5 ^{ab}	11.818	2.360 ^{bc}	0.770 ^{c}	0.064 ^{cd}	17.3	8.458	1.770 ^{b}	0.770 ^{d}	0.069 ^{b}
300	18.9 ^{ab}	11.903	2.413 ^{ab}	0.820 ^{a}	0.075 ^{abc}	16.2	8.585	1.795 ^{ab}	0.837 ^{bc}	0.065 ^{b}
500	20.0 ^{ab}	11.997	2.352 ^{bc}	0.825 ^{a}	0.077 ^{abc}	20.7	8.642	1.942 ^{a}	0.832 ^{bc}	0.065 ^{b}
P level:										
'ontrol)	23.7 ^{a}	12.055	2.475 ^{a}	0.822	0.080 ^{a}	19.9	8.618	1.860	0.900 ^{a}	0.125 ^{a}
	20.5 ^{b}	11.988	2.354 ^{b}	0.801	0.072 ^{ab}	19.0	8.601	1.763	0.815 ^{b}	0.058 ^{b}
	20.0 ^{b}	11.933	2.373 ^{b}	0.803	0.068 ^{b}	18.0	8.546	1.832	0.820 ^{b}	0.064 ^{b}
vel:										
trol)	23.7 ^{a}	12.055	2.475 ^{a}	0.822 ^{a}	0.080 ^{a}	19.9	8.618	1.860	0.900 ^{a}	0.125 ^{a}
	18.4 ^{b}	12.119	2.369 ^{b}	0.813 ^{ab}	0.063 ^{b}	17.2	8.631	1.766	0.848 ^{b}	0.058 ^{b}
	21.7 ^{ab}	11.931	2.375 ^{b}	0.792 ^{b}	0.074 ^{ab}	19.0	8.558	1.795	0.787 ^{c}	0.064 ^{b}
	19.5 ^{b}	11.890	2.382 ^{b}	0.798 ^{ab}	0.072 ^{ab}	17.7	8.542	1.806	0.828 ^{bc}	0.065 ^{b}
	21.3 ^{ab}	11.903	2.330 ^{b}	0.805 ^{ab}	0.070 ^{ab}	20.0	8.564	1.824	0.807 ^{bc}	0.057 ^{b}

Means in the column with the same superscript are not significantly different ($P<0.05$).

AP = Available Phosphorous

Table (3): Wet weight, dry weight, fat free dry weight and ash weight of layers bones as affected by AP and phytase levels.

Treat.	AP	Phytase	Tibia				Femur			
			Wet Weight	Dry Weight	Free Fat Dry Weight	Ash Weight	Wet Weight	Dry Weight	Free Fat Dry Weight	Ash Weight
	(%)	U/Kg	g	g	g	g	g	g	g	g
T1	0.32	0	8.536 ^{a}	8.118 ^{a}	5.881 ^{a}	3.580 ^{a}	6.354 ^{a}	5.993 ^{a}	5.039 ^{a}	3.583 ^{a}
T2	0.23	0	7.942 ^{ab}	7.551 ^{abc}	5.611 ^{ab}	3.337 ^{ab}	5.667 ^{ab}	5.275 ^{ab}	4.537 ^{ab}	3.097 ^{ab}
T3	0.23	100	7.857 ^{ab}	7.467 ^{abc}	5.285 ^{ab}	3.283 ^{ab}	5.835 ^{ab}	5.160 ^{ab}	4.518 ^{ab}	3.057 ^{ab}
T4	0.23	300	7.135 ^{ab}	6.417 ^{c}	4.898 ^{b}	2.993 ^{b}	5.207 ^{b}	4.902 ^{ab}	4.061 ^{b}	2.917 ^{b}
T5	0.23	500	7.319 ^{ab}	6.987 ^{abc}	4.989 ^{b}	3.020 ^{ab}	5.334 ^{ab}	5.025 ^{ab}	4.179 ^{b}	2.973 ^{ab}
T6	0.13	0	7.289 ^{ab}	6.930 ^{abc}	4.600 ^{b}	2.937 ^{b}	5.189 ^{b}	4.866 ^{ab}	4.110 ^{b}	2.790 ^{b}
T7	0.13	100	6.924 ^{b}	6.548 ^{bc}	4.882 ^{b}	2.853 ^{b}	5.074 ^{b}	4.813 ^{b}	3.986 ^{b}	2.727 ^{b}
T8	0.13	300	8.153 ^{ab}	7.783 ^{ab}	5.431 ^{ab}	3.273 ^{ab}	5.845 ^{ab}	5.505 ^{ab}	4.454 ^{ab}	3.260 ^{ab}
T9	0.13	500	7.923 ^{ab}	7.514 ^{abc}	5.456 ^{ab}	3.357 ^{ab}	5.823 ^{ab}	5.450 ^{ab}	4.565 ^{ab}	3.327 ^{ab}
Main effects										
Dietary AP level:										
0.32 (Control)			8.536 ^{a}	8.118 ^{a}	5.881 ^{a}	3.580 ^{a}	6.354 ^{a}	5.993 ^{a}	5.039 ^{a}	3.583 ^{a}
0.23			7.563 ^{b}	7.106 ^{b}	5.196 ^{b}	3.158 ^{b}	5.511 ^{b}	5.091 ^{b}	4.324 ^{b}	3.011 ^{b}
0.13			7.572 ^{b}	7.194 ^{b}	5.182 ^{b}	3.105 ^{b}	5.483 ^{b}	5.159 ^{b}	4.279 ^{b}	3.026 ^{b}
Phytase level:										
0 (Control)			8.536 ^{a}	8.118 ^{a}	5.881 ^{a}	3.580 ^{a}	6.354 ^{a}	5.993 ^{a}	5.039 ^{a}	3.583 ^{a}
0			7.615 ^{ab}	7.241 ^{ab}	5.286 ^{b}	3.137 ^{b}	5.428 ^{b}	5.071 ^{b}	4.323 ^{b}	2.943 ^{b}
100			7.391 ^{b}	7.007 ^{b}	5.083 ^{b}	3.068 ^{b}	5.454 ^{b}	4.987 ^{b}	4.252 ^{b}	2.892 ^{b}
300			7.644 ^{ab}	7.100 ^{b}	5.164 ^{b}	3.133 ^{b}	5.526 ^{b}	5.203 ^{ab}	4.258 ^{b}	3.088 ^{b}
500			7.621 ^{ab}	7.250 ^{ab}	5.223 ^{b}	3.188 ^{ab}	5.579 ^{b}	5.238 ^{ab}	4.372 ^{b}	3.150 ^{ab}

Means in the column with the same superscript are not significantly different ($P<0.05$).
AP = Available Phosphorous.

Table (4): Minerals content in layers tibia and femur bones as affected by available phosphorus and phytase levels.

Treat.	AP	Phytase	Tibia				Femur			
	(%)	U/Kg	Fat Free Dry Matter %	Total Ash %	Total Phosphorus %	Total Calcium %	Fat Free Dry Matter %	Total Ash %	Total Phosphorus %	Total Calcium %
T1	0.32	0	93.75 ^{c}	60.93 ^{abc}	14.24 ^{a}	42.12	93.56 ^{ab}	59.79 ^{ab}	13.86 ^{b}	37.57
T2	0.23	0	93.76 ^{c}	59.50 ^{bcd}	13.99 ^{a}	35.76	92.84 ^{c}	58.73 ^{bc}	12.03 ^{bc}	30.91
T3	0.23	100	93.76 ^{c}	62.12 ^{a}	13.74 ^{a}	38.75	93.34 ^{bc}	59.37 ^{ab}	12.81 ^{bc}	35.27
T4	0.23	300	94.00 ^{bc}	61.16 ^{ab}	14.40 ^{a}	40.91	93.75 ^{ab}	59.62 ^{ab}	13.01 ^{bc}	33.94
T5	0.23	500	94.02 ^{bc}	60.51 ^{abcd}	14.01 ^{a}	37.27	93.85 ^{ab}	59.24 ^{b}	16.27 ^{a}	38.48
T6	0.13	0	93.65 ^{c}	58.89 ^{cd}	11.77 ^{b}	33.33	93.66 ^{ab}	57.24 ^{cd}	11.43 ^{c}	27.27
T7	0.13	100	94.01 ^{bc}	58.40 ^{d}	14.21 ^{a}	37.73	94.06 ^{a}	56.64 ^{d}	13.20 ^{b}	33.63
T8	0.13	300	94.33 ^{ab}	60.22 ^{abcd}	12.77 ^{ab}	36.37	93.86 ^{ab}	59.26 ^{b}	12.76 ^{bc}	37.27
T9	0.13	500	94.61 ^{a}	61.45 ^{ab}	14.54 ^{a}	39.09	94.18 ^{a}	61.07 ^{a}	11.71 ^{c}	29.27
Main effects										
Dietary AP level:										
0.32 (Control)			93.75	60.93	14.24	42.12	93.56	59.79 ^{a}	13.86 ^{a}	37.57
0.23			93.89	60.82	14.04	38.17	93.45	59.24 ^{ab}	13.53 ^{a}	34.65
0.13			94.15	59.74	13.32	36.63	93.94	58.55 ^{b}	12.28 ^{b}	31.89
Phytase level:										
0 (Control)			93.75 ^{c}	60.93 ^{a}	14.24	42.12	93.56 ^{ab}	59.79 ^{a}	13.86 ^{a}	37.57
0			93.70 ^{c}	59.20 ^{b}	12.88	34.54	93.25 ^{b}	57.99 ^{b}	11.73 ^{b}	29.09
100			93.89 ^{bc}	60.26 ^{ab}	13.97	38.24	93.70 ^{ab}	58.01 ^{b}	13.01 ^{ab}	34.45
300			94.17 ^{ab}	60.69 ^{ab}	13.59	38.64	93.80 ^{a}	59.44 ^{a}	12.89 ^{ab}	35.60
500			94.32 ^{a}	60.98 ^{a}	14.27	38.18	94.02 ^{a}	60.16 ^{a}	13.99 ^{a}	33.94

Means in the column with the same superscript are not significantly different ($P<0.05$).
AP = Available Phosphorous.

Table (5): Digestion coefficients of nutrients and energy values of laying diets as affected by dietary AP and phytase levels.

Treat.	AP (%)	Phytase U/Kg	Digestion coefficients (%) CP	EE	CF	NFE	OM	DM	Energy Values Kcal /kg ME	PE
T1	0.32	0	90.07 ^{b}	72.15 ^{ab}	4.60 ^{cde}	80.99	79.41 ^{ab}	74.45 ^{a}	2795 ^{abc}	1985 ^{ab}
T2	0.23	0	89.95 ^{bcd}	64.46 ^{b}	2.57 ^{e}	79.95	78.47 ^{abc}	72.37 ^{ab}	2672 ^{cd}	1891 ^{bc}
T3	0.23	100	91.98 ^{a}	75.52 ^{ab}	10.16 ^{ab}	81.42	80.89 ^{a}	75.25 ^{a}	2935 ^{a}	2080 ^{a}
T4	0.23	300	89.96 ^{bcd}	73.99 ^{ab}	9.19 ^{abc}	75.83	75.56 ^{c}	70.13 ^{b}	2725 ^{bcd}	1947 ^{ab}
T5	0.23	500	89.06 ^{cd}	82.23 ^{a}	8.75 ^{abcd}	79.30	78.23 ^{abc}	73.04 ^{ab}	2822 ^{abc}	2000 ^{ab}
T6	0.13	0	89.65 ^{bcd}	71.91 ^{ab}	5.44 ^{bcde}	77.45	76.71 ^{bc}	73.36 ^{ab}	2600 ^{d}	1810 ^{c}
T7	0.13	100	89.51 ^{bcd}	75.17 ^{ab}	3.56 ^{de}	80.89	77.08 ^{bc}	72.46 ^{ab}	2778 ^{abc}	1970 ^{ab}
T8	0.13	300	90.45 ^{b}	80.94 ^{a}	5.66 ^{abcde}	80.91	79.81 ^{ab}	74.64 ^{ab}	2906 ^{a}	2067 ^{a}
T9	0.13	500	88.77 ^{d}	81.52 ^{a}	11.00 ^{a}	77.91	77.25 ^{bc}	73.22 ^{ab}	2866 ^{ab}	2024 ^{ab}
Main effects										
Dietary AP level:										
0.32 (Control)			90.08	72.15	4.60	80.99	79.41	75.45	2759	1985
0.23			90.24	74.05	7.67	79.29	78.29	72.70	2789	1980
0.13			89.60	77.39	6.42	79.29	77.71	75.42	2787	1968
Phytase levels:										
0 (Control)			90.08 ^{ab}	72.15 ^{ab}	4.60 ^{b}	80.99	79.41	75.45	2795 ^{a}	1951 ^{a}
0			89.80 ^{b}	68.19 ^{b}	4.01 ^{b}	78.70	77.59	72.87	2636 ^{b}	1851 ^{b}
100			90.75 ^{a}	75.34 ^{ab}	6.86 ^{ab}	81.16	78.99	73.85	2857 ^{a}	2025 ^{a}
300			90.21 ^{ab}	77.47 ^{ab}	7.42 ^{ab}	78.37	77.69	72.38	2816 ^{a}	2007 ^{a}
500			88.91 ^{c}	81.87 ^{a}	9.88 ^{a}	78.61	77.74	73.13	2844 ^{a}	2012 ^{a}

Means in the column with the same superscript are not significantly different ($P<0.05$).

AP = Available Phosphorous.

Table (6): Apparent retention and fecal phosphorus as affected by available phosphorus and phytase levels.

Treat.	AP (%)	Phytase U/Kg	Apparent retention (%) DM	Ash	P	Ca	Fecal phosh. (%)
T1	0.32	0	74.02 [abc]	48.08 [ab]	45.95 [ab]	59.26 [bc]	1.153
T2	0.23	0	71.94 [bc]	41.49 [ab]	31.35 [d]	55.35 [c]	0.957
T3	0.23	100	77.36 [a]	49.42 [ab]	48.79 [a]	66.77 [a]	0.983
T4	0.23	300	69.96 [c]	36.17 [b]	43.86 [abc]	58.01 [bc]	1.010
T5	0.23	500	73.04 [abc]	44.54 [ab]	43.81 [abc]	57.98 [bc]	0.943
T6	0.13	0	73.32 [abc]	57.21 [a]	32.19 [d]	58.43 [bc]	0.953
T7	0.13	100	72.35 [bc]	49.23 [ab]	34.94 [cd]	63.77 [ab]	1.083
T8	0.13	300	74.92 [ab]	52.74 [ab]	40.57 [abcd]	61.23 [abc]	0.933
T9	0.13	500	73.41 [abc]	46.41 [ab]	37.12 [bcd]	58.97 [bc]	0.737
Main effects							
Dietary AP levels:							
0.32 (Control)			74.02	48.08	45.95 [a]	59.26	1.153
0.23			73.08	43.16	41.96 [ab]	59.53	0.973
0.13			73.50	51.40	36.21 [b]	60.60	0.927
Phytase levels:							
Control			74.02	48.08	45.95 [a]	59.26 [b]	1.153
0			72.63	49.35	31.77 [b]	56.89 [b]	0.955
100			74.85	49.32	41.87 [a]	65.27 [a]	1.033
300			72.44	45.51	42.22 [a]	59.62 [b]	0.972
500			73.23	45.48	40.47 [a]	58.48 [b]	0.840

Means in column with the same letter are not significantly different (P>0.05).
AP = Available Phosphorous.

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الملخص العربي

تأثير إنزيم الفيتيز على الدجاج البياض المغذى على علائق بروتين نباتي منخفضة الفوسفور المتاح
١- صفات العظام, إحتجاز المعادن, معاملات هضم العناصر الغذائية

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أجريت هذه التجربة في محطة بحوث رأس سدر –جنوب سيناء لدراسة تأثير مستويان من الفوسفور المتاح (٠,٢٣ ، ٠,١٣%) وأربعة مستويات من إنزيم الفيتيز (صفر ، ١٠٠ ، ٣٠٠ ، ٥٠٠ وحدة /كجم عليقة) على احتجاز المعادن ومعاملات هضم العناصر الغذائية وجودة عظام الدجاج البياض المغذى على عليقة ذرة-كسب صويا مقارنة بعليقة التحكم (ذرة-كسب صويا) المحتوية على ٠,٣٢% فوسفور متاح دون إضافة إنزيم فيتيز.

انخفض تحمل عظام الساق للكسر في الطيور المغذاة على عليقة منخفضة الفوسفور المتاح دون إضافة فيتيز بمقدار ٢٢,٤%. أدت اضافة الفيتيز بمعدل ١٠٠ ، ٣٠٠ ، ٥٠٠ وحدة إنزيم/كجم عليقة إلى تحسين تحمل عظام الساق للكسر بمقدار ١٧,٩ ، ٦ ، ١٥,٨ % على الترتيب. أدت إضافة الفيتيز إلى تحسن سمك جدر عظام الساق والفخذ ولكنه ظل أقل مما في مجموعة التحكم. أدى نقص الفوسفور المتاح دون إضافة فيتيز إلى انخفاض الوزن الرطب والوزن الجاف والوزن الجاف خالي الدهن ووزن الرماد لعظم الساق بمقدار ١٠,٧٩ ، ١٠,٨٠ ، ١٠,١٢ ، ١٢,٣٧ % على الترتيب. إضافة الفيتيز حتى مستوى ٥٠٠ وحدة إنزيم /كجم عليقة لم يحسن هذه الأوزان معنويا. أدت إضافة الفيتيز إلى زيادة المادة الجافة خالية الدهن والرماد الكلى في كل من عظم الساق والفخذ معنويا (بمستوى معنوية أقل من ٠,٠٥), وزيادة نسبة الفوسفور والكالسيوم في عظم الساق زيادة غير معنوية.

سجل مستوى ١٠٠ وحدة إنزيم فيتيز /كجم عليقة أعلى قيمة للطاقة الممثلة والطاقة الإنتاجية وأعلى معامل هضم لكل من البروتين الخام والمستخلص خالي النتروجين. سجل مستوى ٣٠٠ وحدة فيتيز /كجم عليقة أعلى معامل هضم لمستخلص الأثير (٨١,٨٧%) بينما سجلت مجموعة التحكم أقل قيمة (٧٢,١٥%), والتي لم تكن تختلف معنويا عن مجموعة صفر فيتيز /كجم عليقة. لم يؤثر إنزيم الفيتيز معنويا على معامل هضم المستخلص خالي الأزوت، المادة العضوية والمادة الجافة. أدى نقص الفوسفور دون إضافة فيتيز إلى انخفاض الطاقة الممثلة والطاقة الإنتاجية معنويا (بمستوى معنوية أقل من ٠,٠٥), إضافة الفيتيز يزيد هذه القيم إلى مستوى مجموعة التحكم. أدى نقص فوسفور الغذاء دون إضافة فيتيز إلى انخفاض احتجاز الفوسفور معنويا (بمستوى معنوية أقل من ٠,٠٥) بمقدار ٣٠,٨٦%. أدت إضافة الفيتيز (٣٠٠ وحدة إنزيم فيتيز /كجم عليقة) إلى تحسين هذه القيمة معنويا (بمستوى معنوية أقل من ٠,٠٥) بمقدار ٣٢,٨٩%. أدت إضافة الفيتيز بمقدار ٥٠٠ وحدة إنزيم فيتيز /كجم عليقة إلى انخفاض فوسفور الزرق بمقدار ٢٧,١٥%.