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PERFORMANCE, BONE MINERALIZATION AND CARCASS CHARACTERISTICS OF BROILERS FED LOW PHOSPHORUS DIETS SUPPLEMENTED WITH PHYTASE

By

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Abstract: *Broiler growth experiment was conducted to further study the effect of dietary nonphytate-P (NPP) level and phytase supplementation on performance, bone mineralization and carcass characteristics. Four diets were formulated to contain 0.14, 0.25, 0.35 and 0.45% NPP for feeding from 1 to 21 days of age, and 0.13, 0.20, 0.30 and 0.35% NPP for feeding from 21 to 35 days of age, correspondingly. Phytase enzyme was added to all diets at two levels being, 0 and 500 U/Kg. Every dietary treatment was fed to 3 replicates (12 chicks each) of one day old Ross broiler chicks for 35 days experimental period.*

The results showed that weight gain and feed intake increased with increasing level of dietary NPP. Also feed conversion ratio significantly (P<0.001) improved with increasing dietary NPP level. Addition of phytase improved body weight, feed intake and feed / gain equal to that occurred when the dietary NPP increased by 0.1%.

Length of tibia and weights of tibia and toe significantly (P<0.001) increased with increasing of dietary NPP level. The addition of phytase enzyme increased (P<0.01) length of tibia and improved weights of tibia (P>0.05) and toe (P>0.05). Phytase supplementation significantly (P<0.001) increased ash percentages in tibia and toe and increased concentration of P%, Ca % and Zn (mg/kg) in tibia bone ash.

Dressing percentage, liver, heart and gizzard (% of body weight) were significantly (P<0.05) affected as dietary NPP increased, while addition of phytase enzyme had no significant effect.

It could be concluded that the addition of 500 U phytase/Kg to corn-soybean meal broiler diets containing low levels of NPP improved growth performance, bone mineralization and carcass characteristics.

INTRODUCTION

Poultry diets are based largely on cereal grains and oilseed meals. These ingredients have a relatively high content of phosphorus (P); however, up to 80% of the P is bound to phytic acid to form phytate-P. The availability of phytate (p) is low in monogasteric animals, because of very low or no phytase activity in their digestive tracts (Pallouf *et al*.,1992). Denbow *et al*. (1995) indicated that the inability of poultry to utilize phytate P necessitates the dietary addition of inorganic P, which increases feed costs, phosphorus excretion and environmental contamination.

Nutritional approaches are currently being evaluated to deal with the poor availability of phytate P and the resultant potential for P pollution. These approaches include:-1) formulating diets at the requirements of birds to avoid excess P excretion, 2) adding microbial phytase to poultry diets to increase phytate P availability, and 3) genetically lowering the phytic acid content of cereals grains and oilseeds, thereby improving plant P availability.

Dietary supplementation with phytase is well established as an effective and practical method of improving phytate digestibility in poultry (Sebastian *et al.,* 1996; Qian *et al.,* 1997; Mohana and Nys, 1999; and Ravindran *et al.,* 2000).

In this concern recent studies have indicated that phytase supplementation in phosphorus deficient broiler diets improves phytate P utilization and broiler performance (Mohamed *et al.,* 2001; El-Medany and El-Afifi, 2002; Salem *et al.,* 2003 and Rutherfurd *et al.,* 2002).

The objective of this study was to evaluate the influence of added phytase to diets containing different levels of nonphytate P on performance, bone mineralization and carcass characteristics of broiler chicks.

MATERIALS AND METHODS

A starter (23% CP and 3200 Kcal ME/Kg) and a grower (20% CP and 3200 Kcal ME/Kg) basal diet (diet A) were formulated with no inorganic phosphorus supplements. The starting period lasted from 1 to 21 days of age while the growing period lasted from 21 to 35 days of age. The nutrients content of such basal diets were adequate to cover the recommended chick requirements (NRC, 1994) except that of P. The calculated total P (tP) and NPP contents were 0.39 and 0.14% for the starter diet and 0.37 and 0.13% for the grower diet, respectively. Commercial dicalcium phosphate (18.7% P and 22% Ca) was added to formulate diets of treatments B, C, and D containing 0.50, 0.60 and 0.70% tP and 0.25, 0.35 and 0.45 % NPP, respectively in starter period, and 0.44, 0.54 and 0.60% tP and 0.20, 0.30 and 0.35% NPP, respectively in grower period. Limestone and vegetable oil were used to adjust dietary Ca and calories content, respectively. Vitamin and mineral mixture was added in enough quantities to cover the chick requirements (NRC, 1994).

Tables 1 and 2 show the formulation and nutrient composition of the different starter and grower diets, respectively. Phytase enzyme (Ronozyme 2500) was added (500 FTU/Kg) to diets A, B, C and D and these diets were fed with or without phytase supplementation. Thus a number of 8 diets were formulated.

A number of 288 one-day old Ross broiler chicks were used. Every dietary treatment was fed to 3 replicates of 12 chicks each. The average initial live body weights of all replicates were nearly similar. Replicates were randomly allocated in batteries of three-tier system divided into 24 compartments (3 replicates X 8 dietary treatments). Gas heaters were used to keep the required temperature for the brooding period while light was provided 23 hr daily throughout the experimental period. Feed and water were allowed for *ad libitum* consumption. After fasting overnight, birds were individually weighed and feed consumption was recorded per replicate at 35 days of age. Gain in body weight and feed conversion ratio were calculated. At 35 days of age, 6 representative chicks with body weight close to the group average were selected from each group and slaughtered for carcass characteristics and bone measurements (as described by Mohamed *et al.,* 2001).

Determination of phosphorus and calcium in tibia ash was carried out based on the Official Methods of Analysis (AOAC, 1990). Zinc content of tibia ash was determined using flame atomic absorption spectrophotometer after ashing with 15 ml HNO_3 and 10 ml $HClO_4$.as described by Scancar *et al*. (2000) based on the described method of Berg *et al.*(2000).

Data were statistically analyzed for analysis of variance as 4 X 2 factorial arrangement using the General Liner Model of **SAS (1990).** Significant differences among treatment means were separated by Duncan's new multiple rang test **(Duncan, 1955)** at a 5% level of probability**.**

RESULTS AND DISCUSSION

Performance at 35 days of Age.

Performance (weight gain, feed intake and feed /gain) at 35 days of age of broiler chicks fed the 8 dietary treatments is summarized in Table 3. Phytase supplementation significantly ($P<0.05$) improved weight gain among birds fed diets containing different NPP levels. Birds fed 0.14/0.13% NPP diet (0.14% on the starter and 0.13% on the grower diet) with no added phytase gave the lowest ($P<0.05$) weight gain compared to the other treatments.

Increasing the dietary NPP content resulted in pronounced increases in weight gain. Birds fed 0.35/0.30% NPP diet with phytase supplementation recorded the highest weight gain, which was higher than those recorded by birds fed diets containing 0.14/0.13 or 0.25/0.20% NPP with or without phytase addition or birds fed diets containing 0.35/0.30 or 0.45/0.35% NPP without phytase addition. No significant differences were detected between birds fed diets of 0.35/0.30 or 0.45/0.35% NPP with phytase addition.

The main effect of adding phytase enzyme showed significant ($P<0.001$) improvement in weight gain, which increased from 1118 to 1272 g (14% increase). Birds fed 0.14/0.13% NPP diet without phytase supplementation, consumed significantly ($P<0.05$) less feed than the other treatments. While birds fed diet containing 0.45/0.35% NPP with phytase addition recorded the highest feed intake. Addition of phytase to all dietary NPP levels significantly ($P<0.05$) improved feed intake.

The statistical main effects of dietary NPP level and phytase supplementation on feed intake indicated that dietary NPP level significantly ($P<0.001$) affected feed intake. Increasing dietary NPP level from 0.14/0.13 up to 0.35/0.30% gave significant increases ($P<0.001$) in feed intake. No significant difference was detected in feed intake between birds fed diets of 0.35/0.30 and 0.45/0.35% NPP. Addition of phytase enzyme significantly ($P<0.001$) improved feed intake.

Values of feed conversion ratio (feed/gain) showed that adding phytase enzyme to diet containing 0.35/0.30% NPP caused a significant ($P<0.05$) improvement in feed utilization compared to birds fed diets of 0.14/0.13 or 0.25/0.20% NPP with or without phytase and 0.35/0.30% NPP without phytase addition. No significant differences were detected among birds fed the different dietary NPP levels supplemented with phytase enzyme and those fed 0.45/0.35% NPP diet without phytase supplementation.

The best feed conversion ratio was recorded for birds fed 0.35/0.30% NPP diet with phytase addition (1.58) while the worst ratio was recorded for birds fed 0.14/0.13% NPP diet without phytase supplementation (1.77). These results indicated that dietary NPP level significantly ($P<0.001$) affected feed/gain ratio. Addition of phytase enzyme significantly ($P<0.001$) improved feed/gain ratio.

The performance results of this experiment showed that addition of phytase enzyme to broiler diets of low NPP content significantly ($P<0.001$) improved weight gain, feed intake and feed/gain ratio. No significant interactions between dietary NPP level and added phytase enzyme on weight gain, feed intake and feed/gain ratio of birds were observed. Addition of 500 U phytase/Kg diet resulted in improvements in body weight, feed intake and feed/gain equal to that occurred when the dietary NPP increased by 0.1%. It could be concluded that phytase supplementation of the diet containing 0.35/0.30% NPP resulted in the best performance.

These results are in agreement with the previous findings of Cabahug *et al.* (1999), Mohamed *et al.* (2001), Yan *et al.* (2001), Lan *et al.* (2002), Attia (2003), Wu *et al.* (2003), Augspurger and Baker (2004), and Onyango *et al.* (2004) who obtained increases in body weight gain and feed intake when microbial phytase was added to low phosphorus broiler diets. Lan *et al.* (2002) obtained appreciable improvements in gain/feed with supplemental phytase. However, Denbow *et al.* (1995) and Viveros *et al.* (2002). found that gain/feed of broilers was unaffected by phytase supplementation.

On the other hand, Sohail and Roland (1999) observed significant decreases in feed intake, body weight and feed efficiency when available P was reduced from 0.325% to 0.225%. Phytase addition significantly increased body weight at the lower available P level but not at the higher available P level. Mohamed *et al.* (2001) reported that addition of phytase or increasing the dietary phosphorus level resulted in pronounced increases in weight gain and feed intake. Feed/gain ratio showed that addition of phytase to the lowest P diet caused a significant improvement in feed utilization. Viveros *et al.* (2002) demonstrated that low-P diets caused a negative effect on performance compared to the normal NPP (0.45%) diet. Addition of phytase gave favorable effects on weight gain at 3 and 6 wk of age. Feed efficiency was not affected by addition of phytase. Herms and Al-Homidan (2003) reported that addition of phytase enzyme at 500 U/Kg significantly ($P<0.01$) improved weight gain and feed/gain ratio compared to the chicks fed diet containing 0.35 and 0.45% NPP with no phytase supplement. Shirley and Edwards (2003) indicated that supplementing phytase significantly ($P<0.05$) improved body weight gain, feed intake and gain to feed of broiler chicks fed a total P deficient (0.46%) corn-soybean meal diet. Wu *et al*. (2003) found that phytase addition (500 U/Kg) to broiler diets based on maize caused improvements in weight gain and feed intake in the low-P (0.30% NPP) diet but had little effect in the adequate P diet. Also, Onyango *et al*. (2004) found that added phytase to a corn-soybean meal diet improved body weight gain and feed intake of broiler chicks fed low P diet (0.24% NPP).

The improvements in growth observed in chickens fed on a low phosphorus diet with phytase may be due to one or more of the following: (1) an increase in absorbed phosphorus (2) the release of other minerals from the phytate mineral complex, (3) the utilization of inositol, (4) an increase in digestibility, and/or (5) increased availability of amino acids (Simons *et al*., 1990).

In conclusion, the results demonstrated that increasing dietary NPP level has appreciable effects in improving the chick body weight gain and feed conversion ratio. Also, phytase supplementation to low P diet increased body weight gain and improved feed/gain ratio.

Bone Measurements at 35-Days of Age.

The effects of dietary NPP level and phytase supplementation on bone measurements of 35-day old chicks fed the different dietary treatments are shown in Table 4.

Increasing dietary NPP level from 0.14/0.13 to 0.35/0.30% without or with added phytase enzyme significantly ($P<0.05$) increased length of tibia. No significant differences in tibia length were detected among birds fed 0.35/0.30% NPP with phytase and birds fed 0.45/0.35% NPP with or without phytase supplementation.

The main effect of NPP level and phytase supplementation on tibia length showed that length of tibia significantly ($P<0.001$) increased either as dietary NPP increased or by the addition of phytase enzyme. Regarding weights of tibia and toe, bone weights were significantly increased for tibia and toe ($P<0.001$) with increasing dietary NPP level up to 0.35/0.30%. No significant differences on bone weights were recorded between birds fed 0.35/0.30 or 0.45/0.35% NPP. Supplementation of phytase significantly ($P<0.05$) increased toe weight, while the observed increase in tibia weight was not significant.

Birds fed the lowest dietary NPP level recorded the minimum ash percentage of tibia and toe. The maximum ash percentages were recorded for birds fed diet containing 0.45/0.35% NPP with phytase.

The main effects showed that increasing dietary NPP level and phytase supplementation significantly (P<0.001) increased bone ash percentages. No significant difference in bone ash percentages was detected between birds fed 0.35/0.30 or 0.45/0.35% NPP. Significant interaction between NPP level and phytase supplementation was detected in tibia length (P<0.01). While no significant interaction was observed on weight and ash of either tibia or toe.

It could be concluded, therefore, that increasing dietary non-phytate P or added phytase enzyme to low P diets increased percentages of bone ash of broilers.

Tibia Mineral Concentrations

The effects of dietary NPP level and phytase supplementation on concentrations of Ca, P% and Zn mg/Kg in tibia ash are shown in Table 5. Increasing dietary NPP level significantly (P<0.05) increased P and Ca (%) and significantly (P<0.05) decreased Zn (mg/Kg) in tibia ash. The main effects of NPP level and phytase addition on concentration of Ca, P and Zn of tibia ash showed that increasing NPP up to 0.35/0.30% significantly (P<0.001) increased Ca and P%. Concentration of Zn in tibia ash decreased significantly (P<0.001) by increasing dietary NPP level. However, phytase supplementation significantly (P<0.001) increased Ca, P and Zn (P<0.01) concentrations.

These data clearly indicated that increasing dietary NPP level or added phytase enzyme to broiler diets from 1 to 35 days of age improved bone mineralization. The improvement in tibia ash percentage could be considered as a good indication of increased bone mineralization (Sebastian *et al.*, 1996).

The results of bone measurements are in agreement with the previous studies of Qian *et al.* (1996), Sebastian *et al.* (1996), Carlos and Edwards (1997), Mohamed *et al.* (2001), Lan *et al.* (2002), Viveros *et al.* (2002), Wu *et al.* (2003) and Augspurger and Baker (2004).

Qian *et al.* (1996) found that supplemental phytase and inorganic phosphorus increased tibia length, shear force and bone ash content of broiler chicks. The results of Sebastian *et al.* (1996) showed that phytase supplementation to a low-P corn-soybean broiler diet improved percentages of tibia ash and apparent availability of Ca, P, Cu and Zn. The authors postulated the importance of re-evaluating mineral requirements, particularly Zn, of broiler chicks when fed phytase supplemented diets. Phytase not only reduces the need for inorganic P but also serves to reduce the need for some other minerals. Mohamed *et al.* (2001) found that increasing dietary NPP level or adding phytase resulted in increasing length of both femur and tibia and bone ash percentages. Onyango *et al*. (2004) found that supplementation of low P diet (0.24% NPP) with any of the 3-phytase preparations equally improved the tibia ash and bone mineral content similar to those obtained in chicks fed the adequate-P diet.

Carcass Characteristics at 35 Days of Age.

Carcass characteristics included carcass weight, percentages of dressing, abdominal fat, liver, heart and gizzard (% of body weight) at 35 days of age are shown in Table 6.

The results indicated that increasing dietary NPP level increased carcass weights. Addition of phytase to low NPP diet significantly ($P<0.05$) increased carcass weight. Such addition did not significantly affect carcass weight of birds fed higher dietary NPP level.

Increasing dietary NPP level significantly ($P<0.05$) increased dressing percentage. Addition of phytase significantly ($P<0.05$) affected dressing percentage only with birds fed 0.14/0.13% NPP diet. Abdominal fat (% of body weight) was not affected by either dietary NPP level or phytase supplementation. Liver weight (% of body weight) of birds fed the lowest NPP diet with or without phytase addition recorded significantly ($P<0.05$) higher values than other treatments. No significant effects were observed among other treatments fed diets with or without phytase addition. The effects of dietary NPP level and phytase supplementation on liver weight (% BW) indicated that increasing NPP from 0.14/0.13 to 0.25/0.20% NPP significantly ($P<0.001$) decreased liver weight. With higher dietary NPP level no significant effect on liver weight was detected. Phytase supplementation was of no significant effect upon liver weight. Heart weight was significantly ($P<0.05$) affected by dietary NPP level. Birds fed the lowest NPP diet showed the highest heart weight but those fed on higher level of NPP showed no significant effect on heart weight. Phytase addition did not affect heart weight (% of BW). Gizzard weight (% of BW) did not show consistent trend. However, increasing dietary NPP or added phytase slightly increased gizzard weight. The interactions between NPP and phytase were not significant for any of the measured organs.

It could be concluded therefore, that the dressing percentage, liver, heart and gizzard weights were significantly ($P<0.05$) affected as dietary

NPP increased, while, addition of phytase enzyme was of no significant effect on weights of such organs.

These results agreed with those of Kornegay *et al*. (1998), Attia *et al.* (2001), EL-Medany and Afifi (2002), Abd-Elsamee (2002) and Salem *et al*. (2003) who found that phytase addition did not affect carcass characteristics. Kornegay *et al*. (1997) showed that carcass measurements were not affected by adding phytase of broiler fed diets containing low P. Viveros *et al.* (2002) found that decreasing NPP content of broiler diet caused an increase in relative liver weight. Phytase supplementation to low P diets reduced the relative liver weight by 6.3%. Spleen was not affected by phytase supplementation. The interaction between NPP and phytase was not significant for any relative organ weight measured. Abd-Elsamee (2002) reported that there were no significant differences in both carcass characteristics (dressing percentage and giblets) and meat analysis value due to phytase supplementation of broiler chicks. Salem *et al*. (2003) found that increasing dietary NPP level significantly ($P<0.05$) increased carcass percentage of broiler chicks.

It could be concluded that, supplementing phytase enzyme to corn-soybean meal diet renders the dietary phosphorus contents more available to the birds. Therefore, the amount of supplemental phosphorus could be remarkably reduced. Thus, it seems that phytase supplementation could have an appreciable sparing effect on the inorganic P content of broiler diets.

Table 1: Formulation and nutrient composition of the starter diets.

Item	Diet A 0.14% NPP	Diet B 0.25% NPP	Diet C 0.35% NPP	Diet D 0.45% NPP
Ingredients %				
Yellow corn	51.55	51.14	50.75	50.43
Soybean meal (44%)	32.00	32.00	32.00	32.00
Corn gluten meal (60%)	8.00	8.00	8.00	8.00
Vegetable oil	5.21	5.37	5.52	5.63
Limestone	2.36	2.02	1.72	1.40
Dicalcium phosphate	-----	0.59	1.13	1.66
Vitamin and Mineral mix. (1)	0.40	0.40	0.40	0.40
Salt	0.35	0.35	0.35	0.35
L-Lysine HCl	0.03	0.03	0.03	0.03
DL-Methionine	0.10	0.10	0.10	0.10
Total	**100**	**100**	**100**	**100**
Calculated Composition (2)				
%	23.08	23.06	23.02	23.00
Crude protein	3199	3200	3200	3199
ME (Kcal/Kg)	1.10	1.10	1.10	1.10
Lysine	0.54	0.54	0.54	0.54
Methionine	0.90	0.90	0.90	0.90
Methionine + Cystine	1.00	1.00	1.00	1.00
Calcium	0.39	0.50	0.60	0.70
Total phosphorus	0.14	0.25	0.35	0.45
Nonphytate P				

(1) Vitamin - mineral mixture supplied per Kg of diet: Vit A, 12000 I.U; Vit D_3, 2200 I.U; Vit E, 10 mg; Vit K_3, 2 mg; Vit B_1, 1mg; Vit B_2, 4mg; Vit B_6, 1.5mg; Vit B_{12}, 10µg; Niacin, 20 mg; Pantothenic acid, 10 mg; Folic acid, 1 mg; Biotin, 50 µg; Choline chloride, 500mg; Copper, 10 mg; Iodine, 1mg; Iron, 30 mg; Manganese, 55 mg; Zinc, 50 mg, Selenium, 0.1 mg and cobalt, 0.25 mg.

(2) Calculated values based on feed composition Tables of NRC (1994)

Table 2: Formulation and nutrient composition of the grower diets.

Item	Diet A 0.13% NPP	Diet B 0.20% NPP	Diet C 0.30% NPP	Diet D 0.35% NPP
Ingredients %				
Yellow corn	61.01	60.77	60.41	60.22
Soybean meal (44%)	26.00	26.00	26.00	26.00
Corn gluten meal (60%)	6.00	6.00	6.00	6.00
Vegetable oil	4.00	4.08	4.22	4.29
Limestone	2.13	1.92	1.61	1.45
Dicalcium phosphate	-----	0.37	0.90	1.18
Vitamin and Mineral mix. (1)	0.35	0.35	0.35	0.35
Salt	0.35	0.35	0.35	0.35
L-Lysine HCl	0.11	0.11	0.11	0.11
DL-Methionine	0.05	0.05	0.05	0.05
Total	**100**	**100**	**100**	**100**
Calculated Composition (2)				
%	20.02	20.01	19.90	19.90
Crude protein	3199	3198	3198	3198
ME (Kcal/Kg)	1.00	1.00	1.00	1.00
Lysine	0.38	0.38	0.38	0.38
Methionine	0.72	0.72	0.72	0.72
Methionine + Cystine	0.90	0.90	0.90	0.90
Calcium	0.37	0.44	0.54	0.60
Total phosphorus	0.13	0.20	0.30	0.35
Nonphytate P				

(1) Vitamin - mineral mixture supplied per Kg of diet: Vit A, 12000 I.U; Vit D_3, 2200 I.U; Vit E, 10 mg; Vit K_3, 2 mg; Vit B_1, 1mg; Vit B_2, 4mg; Vit B_6, 1.5mg; Vit B_{12}, 10µg; Niacin, 20 mg; Pantothenic acid, 10 mg; Folic acid, 1 mg; Biotin, 50 µg; Choline chloride, 500mg; Copper, 10 mg; Iodine, 1mg; Iron, 30 mg; Manganese, 55 mg; Zinc, 50 mg, Selenium, 0.1 mg and cobalt, 0.25 mg.
(2) Calculated values based on feed composition Tables of NRC (1994

Table 3: Effect of dietary nonphytate-P level and phytase supplementation on performance of broiler chicks at 35 days of age

Item		Body weight gain (g)	Feed intake (g)	Feed/gain
Dietary treatments				
NPP[#] %	**Phytase U/Kg**			
0.14/0.13	0	819 [e]	1451 [d]	1.77 [a]
0.14/0.13	500	932 [d]	1631 [c]	1.75 [a]
0.25/0.20	0	1037 [c]	1729 [c]	1.67 [b]
0.25/0.20	500	1232 [b]	1999 [b]	1.62 [bcd]
0.35/0.30	0	1285 [b]	2132 [b]	1.66 [bc]
0.35/0.30	500	1465 [a]	2313 [a]	1.58 [d]
0.45/0.35	0	1329 [b]	2144 [b]	1.61 [cd]
0.45/0.35	500	1459 [a]	2331 [a]	1.60 [d]
SE of means		48.04	65.29	0.01
Main effects				
NPP [#] %				
0.14/0.13		876 [c]	1541 [c]	1.76 [a]
0.25/0.20		1135 [b]	1864 [b]	1.65 [b]
0.35/0.30		1375 [a]	2223 [a]	1.62 [bc]
0.45/0.35		1394 [a]	2238 [a]	1.61 [c]
Phytase U/Kg				
0		1118 [b]	1864 [b]	1.68 [a]
500		1272 [a]	2069 [a]	1.64 [b]
Significances				
Source of variation				
NPP effect		***	***	***
Phytase effect		***	***	***
NPP X Phytase		NS	NS	NS

[a-e] Means within each column for each effect with no common superscript are significantly different (P< 0.05).

*** P< 0.001 NS: not significant (P>0.05)

[#] NPP (starter/grower)

Table 4: Effect of dietary nonphytate-P level and phytase supplementation on bone measurements at 35-days of age.

Item		Tibia length (cm)	Weight (g)		Ash %	
			Tibia [(1)]	Toe [(2)]	Tibia	Toe
Dietary treatments						
NPP%	**Phytase U/Kg**					
0.14/0.13	0	6.33 [e]	1.70 [d]	0.89 [e]	37.22 [e]	6.56 [e]
0.14/0.13	500	7.23 [d]	2.20 [cd]	1.00 [de]	40.59 [d]	7.47 [d]
0.25/0.20	0	7.33 [cd]	2.21 [cd]	1.09 [cde]	40.83 [cd]	7.44 [d]
0.25/0.20	500	7.53 [c]	2.48 [bc]	1.19 [bcd]	43.08 [c]	8.09 [c]
0.35/0.30	0	7.87 [b]	3.04 [ab]	1.29 [bc]	46.36 [b]	8.39 [bc]
0.35/0.30	500	7.87 [ab]	3.16 [ab]	1.33 [b]	47.86 [ab]	8.81 [ab]
0.45/0.35	0	7.97 [ab]	3.15 [ab]	1.32 [b]	46.86 [b]	8.43 [abc]
0.45/0.35	500	8.17 [a]	3.38 [a]	1.53 [a]	49.35 [a]	8.97 [a]
SE of means		0.12	0.13	0.05	0.86	0.17
Main effects						
NPP %						
0.14/0.13		6.78 [d]	1.95 [b]	0.95 [c]	38.91 [c]	7.02 [c]
0.25/0.20		7.43 [c]	2.34 [b]	1.14 [b]	41.96 [b]	7.77 [b]
0.35/0.30		7.87 [b]	3.10 [a]	1.31 [a]	47.11 [a]	8.60 [a]
0.450.35		8.07 [a]	3.26 [a]	1.43 [a]	48.11 [a]	8.70 [a]
Phytase U/Kg						
0		7.38 [b]	2.52	1.15 [b]	42.82 [b]	7.71 [b]
500		7.70 [a]	2.81	1.26 [a]	45.22 [a]	8.34 [a]
Significances						
Source of variation						
NPP effect		***	***	***	***	***
Phytase effect		***	NS	*	***	***
NPP X Phytase		**	NS	NS	NS	NS

[a-e] Means within each column for each effect with no common superscript are significantly different (P< 0.05).
*P<0.05 **P<0.01 *** P< 0.001 NS: not significant (P>0.05)
[(1)] Fat free dry weight [(2)] Dry weight

Table 5: Effect of dietary nonphytate-P level and phytase supplementation on tibia mineral concentration at 35-days of age.

Item		Tibia mineral		
		P %	Ca %	Zn mg/Kg
Dietary treatments				
NPP[#] %	**Phytase U/Kg**			
0.14/0.13	0	18.42 [d]	37.96 [e]	431[ab]
0.14/0.13	500	18.80 [c]	38.37 [d]	446 [a]
0.25/0.20	0	18.52 [d]	38.23 [d]	406 [bc]
0.25/0.20	500	19.44 [b]	38.95 [c]	417 [abc]
0.35/0.30	0	19.77 [a]	39.02 [bc]	364 [d]
0.35/0.30	500	19.82 [a]	39.25 [a]	395 [c]
0.45/0.35	0	19.74 [a]	39.18 [ab]	340 [d]
0.45/0.35	500	19.82 [a]	39.32 [a]	360 [d]
SE of means		0.12	0.10	7.68
Main effects				
NPP %				
0.14/0.13		18.61 [c]	38.17 [c]	438 [a]
0.25/0.20		18.98 [b]	38.59 [b]	412 [b]
0.35/0.30		19.80 [a]	39.14 [a]	380 [c]
0.45/0.35		19.78 [a]	39.25 [a]	350 [d]
Phytase U/Kg				
0		19.11 [b]	38.60 [b]	385 [b]
500		19.47 [a]	38.97 [a]	405 [a]
Significances				
Source of variation				
NPP effect		***	***	***
Phytase effect		***	***	**
NPP X Phytase		***	**	NS

[a-e] Means within each column for each effect with no common superscript are significantly different (P< 0.05).
**P<0.01 *** P< 0.001 NS: not significant (P>0.05)
[#] NPP (starter/grower)

Table 6: Effect of dietary nonphytate-P level and phytase supplementation on carcass characteristics at 35-days of age.

Item		Carcass weight (g)	Dress-ing %	Abdo-minal fat %	Giblets		
					Liver %	Heart %	Gizz-ard %
Dietary treatments							
NPP# %	**Phyt-ase** U/Kg						
0.14/0.13	0	590 [e]	70 [d]	1.81	3.74 [a]	0.63	1.97 [b]
0.14/0.13	500	702 [d]	72 [c]	1.80	3.74 [a]	0.62	2.04 [ab]
0.25/0.20	0	810 [c]	73 [bc]	1.81	3.16 [b]	0.60	2.11 [ab]
0.25/0.20	500	894 [c]	73 [bc]	1.79	3.37 [b]	0.61	2.20 [a]
0.35/0.30	0	1005 [b]	74 [ab]	1.79	3.30 [b]	0.57	2.19 [a]
0.35/0.30	500	1093 [ab]	74 [ab]	1.75	3.35 [b]	0.57	2.19 [a]
0.45/0.35	0	1061 [ab]	75 [a]	1.76	3.28 [b]	0.58	2.08 [ab]
0.45/0.35	500	1158 [a]	75 [a]	1.75	3.22 [b]	0.57	2.12 [ab]
SE of means		40.52	0.03	0.01	0.06	0.01	0.01
Main effects							
NPP # %							
0.14/0.13		646 [c]	71 [d]	1.81	3.74 [a]	0.63 [a]	2.01 [b]
0.25/0.20		852 [b]	73 [c]	1.80	3.27 [b]	0.61 [ab]	2.16 [a]
0.35/0.30		1049 [a]	74 [b]	1.77	3.33 [b]	0.57 [b]	2.19 [a]
0.45/0.35		1110 [a]	75 [a]	1.76	3.25 [b]	0.57 [b]	2.10 [ab]
Phytase U/Kg							
0		867 [b]	73	1.79	3.37	0.59	2.09
500		962 [a]	73	1.77	3.42	0.59	2.14
Significances							
Source of variation							
NPP effect		***	***	NS	***	*	*
Phytase effect		**	NS	NS	NS	NS	NS
NPP X Phytase		NS	NS	NS	NS	NS	NS

[a-e] Means within each column for each effect with no common superscript are significantly different (P< 0.05).

*P<0.05 **P<0.01 *** P< 0.001 NS: not significant (P>0.05)

[#] NPP (starter/grower)

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Phytase, Phosphorus, Broiler, Bone, Carcass.

الملخص العربى

الأداء الإنتاجى ،المحتوى المعدني للعظام وصفات الذبيحة لكتاكيت اللحم المغذاة على علائق منخفضة من الفسفور والمضاف إليها أنزيم الفيتيز.

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تهدف هذه التجربة إلى دراسة تأثير إضافة إنزيم الفيتيز إلى علائق كتاكيت اللحم (ROSS) المحتوية على مستويات مختلفة من الفوسفور المتاح على الأداء وبعض صفات العظام والذبيحة. تم تكوين أربعة علائق احتوت على (٠,١٤، ٠,٢٥، ٠,٣٥، ٠,٤٥%) و(٠,١٣، ٠,٢٠، ٠,٣٠، ٠,٣٥%) فوسفور متاح خلال الفترة من ١-٢١ يوم ومن ٢١-٣٥ يوم من عمر الكتاكيت على الترتيب. أضيف إنزيم الفيتيز إلى كل العلائق بمعدل (صفر، ٥٠٠ وحدة /كجم علف). قدمت هذه المعاملات لعدد ٢٨٨كتكوت (٨ معاملات X ٣ مكررات X ١٢ كتكوت) و تم دراسة تأثير هذه المعاملات على ألأداء الإنتاجى للكتاكيت وبعض صفات العظام (طول عظمة الساق ووزن عظمة الساق والإصبع ونسبة الرماد فى عظمة الساق والإصبع) وتركيز كل من الكالسيوم والفوسفور والزنك فى رماد عظمة الساق وبعض صفات الذبيحة (نسبة التصافي ووزن الكبد والقلب والقونصة ونسبة دهن البطن % من وزن الجسم).

أظهرت النتائج أن زيادة محتوى العلائق من الفوسفور المتاح أو إضافة إنزيم الفيتيز بمعدل ٥٠٠ وحدة/كجم يؤدى إلى زيادة معنوية فى وزن الكتاكيت وكمية الغذاء المأكول.وكذا تحسن كفاءة التحويل الغذائي.

زيادة مستوى الفوسفور أو إضافة إنزيم الفيتيز أدت إلى تحسن معنوي فى طول ووزن عظمة الساق. سجلت اقل نسبة للرماد فى عظمة الساق والإصبع مع الكتاكيت التي غذيت على المستوى الاقل من الفوسفور المتاح بدون إضافة إنزيم الفيتيز.بينما سجلت أعلى نسبة لرماد العظام مع الكتاكيت التي غذيت على المستوى الأعلى مع إضافة إنزيم الفيتيز. زيادة مستوى الفوسفور المتاح أدت إلى زيادة محتوى عظمة الساق من الكالسيوم والفوسفور بينما انخفض معنويا محتوى العظمة من الزنك. بينما أدت إضافة إنزيم الفيتيز إلى زيادة محتوى عظمة الساق من الكالسيوم والفوسفور والزنك.

أظهرت الكتاكيت التي غذيت على المستوى المنخفض من الفوسفور المتاح بدون إضافة الفيتيز اقل وزن للذبيحة واقل نسبة تصافى مقارنة بباقي المعاملات. زيادة مستوى الفوسفور أدت إلى زيادة فى وزن الذبيحة ونسبة التصافي. لم تتأثر نسبة التصافي ووزن الذبيحة معنويا بإضافة إنزيم الفيتيز إلى المستوى الأعلى من الفوسفور المتاح. لم يتأثر وزن دهن البطن بمستويات الفوسفور أو إضافة إنزيم الفيتيز.

نستخلص من هذه الدراسة أن إنزيم الفيتيز يعطى نتائج جيدة عندما يضاف إلى علائق كتاكيت اللحم المكونة من الذرة وكسب فول الصويا حيث تحسن أداء الكتاكيت ومحتوى العظام من العناصر المعدنية عندما أضيف هذا الإنزيم إلى العلائق المنخفضة فى محتواها من الفوسفور المتاح٠