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RESPONSE OF BROILER CHICKS TO MICROBIAL PHYTASE SUPPLEMENTATION IN DIETS DIFFER IN AVAILABLE PHOSPHORUS SOURCES AND LEVELS.

BY

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Abstract: *A total number of 840 unsexed one week old Arbor Acres broiler chicks were used in this study to determine the effect of feeding diets low in available phosphorus (AP) and supplemented with different levels of microbial phytase on broiler performance, nutrients digestibility, minerals retention, bone characteristics, and economic efficiency. Two sources of phosphorus (di – calcium phosphate being inorganic and bone meal as organic source), two levels of AP (0.35 and 0.25 %) and three levels of microbial phytase (500 , 750 and 1000 FTU / kg) were used , in addition to the control diets containing 0.45 % AP. Accordingly , chicks were randomly distributed into 14 treatments , each contained 60 birds in 3 replicates , and fed the experimental diets under similar conditions during the experimental period from 1 to 7 weeks of age .*

The best values of body weight gain and feed conversion ratio as well as bone characteristics were obtained from feeding broiler chicks diets based on bone meal at 0.35 % AP compared to those obtained from feeding di – calcium phosphate diets . Also , the addition of microbial phytase at either 750 or 1000 FTU / kg gave the best values of the studied parameters .Results showed that when dietary AP was lowered to 0.25 %, it has a negative effect on either chick performance or bone characteristics. While, the addition of 500 FTU phytase / kg failed to improve these determinations.

However, supplementing the diet with 1000 FTU phytase restore the performance to the level of the control treatment. Moreover, feeding broiler chicks on diets containing 0.35 % AP and supplemented with either 750 or 1000 FTU phytase / kg gave the highest values of economic efficiency.

In conclusion, it is possible to feed broiler chicks on low – AP diets supplemented with adding microbial phytase at 750 or 1000 FTU / kg to obtain the best values of broiler performance and bone characteristics.

INTRODUCTION

Phosphorus (P) is an essential element required in a large quantity for poultry to perform efficiently . Poultry feedstuffs especially grains and oilseed meals have a relatively high content of P ; however , up to 60 – 80 % of this P is present as phytate P due to its combination with phytic acid ***(Lott et al ., 2000)***. Phytic acid not only reduce P availability but also negatively affect the utilization of other minerals such as Ca , Zn , Cu , Co, Mn, Fe and Mg ***(Yi et al ., 1996)*** as well as protein, energy, starch and digestive enzymes including pepsin, trypsin and amylase ***(Kornegay et al ., 1997 ; Ravindran et al ., 1999)***. Poultry have limited ability to utilize phytate P which leads to the use of inorganic P sources to meet the P requirement of poultry ***(Sebastian et al ., 1998 ; Ceylon et al ., 2003)*** . This is not only economically expensive, but also leading to potential environmental phosphorus pollution. As a result of these economic and environmental concerns , there has been interest in using phytase enzyme to : a) reduce the need for inorganic phosphorus supplementation , b) improve the utilization of the phosphorus present in feedstuffs and c) reduce phosphorus excretion ***(Ravindran et al ., 1995 ; Sebastian et al ., 1998 ; Abou El – Wafa et al ., 2005)*** . In this respect, a number of studies have demonstrated that adding microbial phytase to broiler chick diets improves phytate P utilization and broiler performance ***(Ravindran et al ., 2000 ; Shirely and Edwards , 2003 ; Ibrahem , 2006*** and ***Watson et al ., 2006)*** .

The main target of this study was to evaluate the influence of phosphorus sources and levels with or without supplemental microbial phytase on broiler chick performance, bone characteristics, blood parameters, digestibility coefficients, minerals retention and economic efficiency.

MATERIALS AND METHODS

The present work was carried out at the Poultry Nutrition Research Unit, Experimental Station and Laboratories of Animal Production Department, Faculty of Agriculture, Cairo University, Giza, Egypt.

The objective of this study was to examine the response of broiler chicks to diets low in available phosphorus (AP) and supplemented with different levels of microbial phytase.

Experimental design:

Two sources of phosphorus were used in this study. These sources were di – calcium phosphate (as inorganic) and bone meal (as organic). Each one of the tested phosphorus sources was applied at three levels of dietary AP being 0.45 % (optimum level), 0.35 % (medium level) and 0.25 % (low level). A microbial phytase (Natuphos) was added only to medium and low dietary AP levels at three levels (500, 750 and 1000 FTU / kg of the diet). Accordingly, 12 (2 x 2 x 3) experimental diets were formulated. In addition, two control diets containing optimum level of AP (0.45 %) were used but without microbial phytase supplementation, the first control diet contained di – calcium phosphate while the second contained bone meal. Therefore, a total of 14 experimental treatments were used in this experiment.

Experimental birds:

A total number of 840 unsexed, one week old, Arbor Acres broiler chicks nearly having similar initial body weight (112 g) were randomly distributed into 14 treatments, each treatment contained 60 birds in 3 replicates of 20 chicks each. Chicks were kept in previously cleaned and fumigated littered floor poultry house in an open system under similar management conditions throughout the experimental period up to 7 weeks of age. The chicks were reared in floor pens (1.5 X 1.5 m) for each replicate.

Experimental diets:

The composition and calculated analysis of the 14 basic experimental diets during both growing and finishing periods are presented in Tables 1 and 2, respectively. Natuphos® was used as a source of microbial phytase (each gram of Natuphos contain 2500 phytase units). Therefore, Natuphos was added to the tested diets at levels of 200, 300 and 400 g / ton to achieve 500, 750 and 1000 FTU / kg of the diet, respectively as shown in Tables 1 and 2. In all experimental diets, crude protein, metabolizable energy, amino acids, and vitamins were adjusted according to the strain recommended catalog . All diets were of isonutritive value and offered in mash form with water ad–libitum during the experimental period which lasted for 7 weeks.

Criteria studied:

Broiler chicks performance:

Live body weights (BW) and feed intake (FI) values were recorded at growing and finishing periods. Also, values of body weight gain (BWG) and feed conversion ratio (FCR) were calculated during the grower and finisher periods.

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Digestibility trials:

At the end of the experimental period, 3 birds from each treatment were randomly chosen and individually housed in metabolic cages to determine the digestibility coefficient of nutrients and minerals retention of the experimental diets. The proximate analysis, calcium and phosphorus of feed and dried excreta were determine according to the official methods, ***A.O.A.C. (1990)***. Fecal nitrogen was determined according to ***Jakobson et al. (1960)***. Urinary organic matter was calculated according to ***Abou – Raya and Galal (1971)***.

Bone characteristics:

At the end the experimental period, a slaughter test was performed on three birds taken randomly from each treatment (one bird from each replicate) to study the effect of treatments on bone characteristics of broiler chicks. Bone samples, the right femur, tibia and toe (at the middle joint) of the slaughtered birds were prepared as described by ***Potter et al. (1995)*** and ***Ravindran et al. (1995)*** to determine phosphorus and calcium in the bone samples .

Economic efficiency:

The economic efficiency of meat production was calculated from the money output – input analysis and represented as the total cost per kilogram body weight as well as the net revenue per unit of total costs under local conditions.

Statistical analysis:

Data obtained were statistically analyzed for the analysis of variance using the General Linear model of SAS (1990). In this study, two models were used.

Model 1(factorial): 2 X 2 X 3 factorial design , considering the phosphorus source and level and phytase levels as the main effects , the used model was :

$Y_{ijkl} = \mu + A_i + B_j + C_k + e_{ijkl}$

Where: μ = overall mean.

A = effect of phosphorus source , i = (1 and 2)

B = effect of phosphorus level ,j = (1 and 2)

C = effect of microbial phytase level , k = (1 , 2 and 3)

e = experimental error

Model 2(one-way): considering the control groups for comparison, the model was :

$Y_{ij} = \mu + T_i + e_{ij}$

Where: μ = overall mean.

T = effect of treatments, i (1 to 14).

e = experimental error.

Means were compared ($P < 0.05$) using Duncan ' s new multiple range test ***(Duncan , 1955)*** .

RESULTS AND DISCUSSION

Broiler chick performance :

Body weight (BW) and body weight gain (BWG):

The effect of dietary treatments on BW and BWG is summarized in Table (3).

Results showed that there was a significant ($P < 0.05$) improvement in average values of BW and BWG for chicks fed diets containing bone meal compared to those consumed di – calcium phosphate diets during the growing or overall periods. Also, there was a significant increase in BW and BWG values due to feeding broiler chicks diets containing 0.35 % AP compared to which fed diets containing 0.25 % AP. During the different experimental periods, there was a significant ($P < 0.05$) improvement in average values of BW and BWG as microbial phytase was supplemented at 1000 FTU / kg of the diet compared to other levels (500 or 750 FTU / kg) . Results of growing period (2 – 4 weeks) showed that increasing microbial phytase level to 1000 FTU / kg in bone meal diet containing 0.25 % AP improved growth to the level of those fed either 0.45 % AP or 0.35 % AP supplemented with microbial phytase. During the finishing period (5 – 7 weeks) and overall period (2 – 7 weeks), data showed that the higher values of BW and BWG were observed for birds which fed diet containing bone meal, 0.35 % AP and 750 FTU phytase / kg. While, birds fed diet which containing di – calcium phosphate and 0.25 % AP with 500 FTU phytase / kg recorded the lowest BW and BWG values .This indicates that supplementing microbial phytase to the medium – AP diet (0.35 % AP) restore performance to the level obtained by the control (0.45 % AP). Also, results indicated a significant ($P < 0.05$) improvement in BW and BWG values as microbial phytase was supplemented at 1000 FTU / kg of the low - AP diets compared to other levels. This indicates that increasing phytase level can liberate more P and perhaps other nutrients to be available and as a result broiler performance can be improved. These results are in agreement with those obtained by ***Ahmed et al. (2000); Shirely and Edwards (2003)*** and ***Watson et al. (2006)*** who found that supplemental microbial phytase to low AP diets improved the average values of BW and BWG at growing and finishing periods .

In contrast to these results, ***Lesson et al. (2000)*** and ***Waldroup et al. (2000)*** found that there were no significant differences in the average values of BW and BWG when microbial phytase was supplemented to low AP broiler diets . Also, ***Abo El – Wafa et al. (2005)*** found that there was no significant difference in BW and BWG values due to using different sources of phosphorus (bone meal or di – calcium phosphate) in broiler chick diets.

Feed intake (FI) and feed conversion ratio (FCR):

The effect of dietary treatments on feed intake (FI) and feed conversion ratio (FCR) is presented in Table (4). Data showed a significant ($P < 0.05$) increase in average values of FI for chicks fed diets containing bone meal compared to those fed di – calcium phosphate diets during the different experimental periods. While, there was a significant improvement in FCR values during the finishing and overall periods for chicks fed di – calcium phosphate compared to those fed bone meal diets. Results observed a significant improvement in average values of FI and FCR due to increasing AP level from 0.25 % to 0.35 %. The same trend was obtained with increasing phytase level from 500 to 1000 FTU / kg . During the different experimental periods, the highest values of FI were recorded for birds fed diet containing bone meal and 0.35 % AP supplemented with 750 FTU phytase / kg. While, the lowest values of FI were recorded for those birds fed diet containing di – calcium phosphate, 0.25 % AP and 500 FTU phytase / kg. The previous results detected the superiority of diet containing bone meal as source of phosphorus, 0.35 % AP and supplemented phytase at 750 FTU / kg as compared to the other experimental dietary treatments. These results are in agreement with those obtained by ***Shirely and Edwards (2003)*** and ***Abd El – Hakim and Abd – Elsamee (2004)*** who found that addition of phytase at different levels varied between 250 and 1075 FTU / kg to low AP broiler diets improved the average values of FI .

In contrast to the results obtained herein, ***Ravindran et al. (2001);*** and ***Abd El – Hakim (2005)*** indicated that supplemented microbial phytase to broiler chick diets had no significant effect on FI values.

Data presented in Table (4) showed that the best values of FCR had been obtained by chicks fed diet contained di – calcium phosphate, 0.35 or 0.25 % AP and supplemented with 1000 FTU phytase / kg (T4 and T7) which were not significantly differ compared to the control treatment (T1).

While, the worst value was for birds which fed diet contained bone meal, 0.25 % AP and supplemented with 500 FTU phytase / kg (T 12) . This declared the positive effect of microbial phytase supplementation to low AP broiler diets which may lead to increase the efficiency of utilization of various dietary nutrients and consequently improved FCR values.

In agreement with our findings , ***Waldroup et al . (2000); Shirely and Edwards (2003)*** and ***Ibrahem (2006)*** found a significant improvement in FCR value due to addition of different levels of microbial phytase to broiler chick diets .

On the other hand, ***Ahmed et al. (2000); Yan et al. (2000)*** and ***Viveros et al. (2002)*** indicated that there was no effect on FCR values due to microbial phytase supplementation to broiler chick diets.

Digestion coefficients and minerals retention:

The effects of dietary treatments on both nutrients digestibility coefficients and minerals retention (phosphorus and calcium) are summarized in Table (5). In general, the lowest values of nutrient digestibility had been recorded by feeding broiler chicks diets with the lowest AP content, regardless of phosphorus sources and level of phytase supplementation. However, the addition of phytase particularly at the higher levels tend to improve the digestibility of most nutrients.This improvement may be due to releasing of phosphorus and other nutrients from phytate complexes. Also, phytase increased the activity of proteolytic enzymes (i. e, pepsin, trypsin and α – amylase) by releasing calcium from phytate complexes which is essential for the activity of these enzymes, so improved the amino acids and starch digestibility.

These results are in agreement with the findings of ***Zhang et al. (2000)*** and ***Ibrahem (2006)*** who found that the average digestibility coefficient values of most nutrients were improved by supplemental phytase at levels ranged between 250 and 1000 FTU / kg .

As shown in Table (5) , data indicated that birds which fed di – calcium phosphate diets recorded the highest phosphorus and calcium retention values compared to those fed bone meal diets . This could be attributed to the particle size and the availability of inorganic phosphorus in almost di – calcium phosphate than that of bone meal. Results showed that increasing dietary AP level increased phosphorus retention in the body to maintain physiological body functions, thus resulting in less phosphorus being excreted in the waste, and so higher retention. These results are similar to those obtained by ***Ravindran et al. (2000); Lan et al. (2002);***

Viveros et al. (2002) and ***Fayza et al. (2003)*** who indicated that phosphorus and calcium retention were decreased by decreasing dietary AP levels .

Also, there was a significant (P < 0.05) increase in values of both phosphorus and calcium retention when phytase was added at 1000 FTU / kg compared to those obtained when phytase was added at 500 or 750 FTU / kg. The improvement in phosphorus and calcium retention by addition of microbial phytase to low AP diets is expected because phytase tend to liberate phosphorus and calcium from P – Ca – phytate complex, so their availability were increased and resulted in increasing the utilization and retention of these mineral elements. These results are in agreement with the finding of ***Lei and Stahl (2000)*** and ***Hammad (2005)*** who reported that phytase supplementation to low AP broiler diets increased the average values of phosphorus and calcium retention.

Bone characteristics:

The effects of treatments on bone phosphorus and calcium are summarized in Table (6). Data indicated that there were no significant differences (P > 0.05) in average values of bone phosphorus and calcium due to feeding broiler chicks diets differ in phosphorus source and level. However, increasing microbial phytase level significantly (P < 0.05) increased toe phosphorus and calcium .It is interesting that when supplemented the low AP diets (0.25 %) with 750 or 1000 FTU / kg of the diet gave similar bone characteristics to the control treatment .These results confirmed that phytase supplementation to either medium (0.35 %) or low (0.25 %) AP diets restored bone characteristics to the optimum level of AP (0.45 %). The explanation of these effects may be due to the release of minerals from the phytate – mineral complex, and subsequent increase in the minerals for absorption and bone deposition.

These results are in agreement with several reports by ***Ahmed et al. (2000) ; Hammad (2005)*** and ***Angel et al .(2006)*** who found that phytase supplementation at levels ranged between 300 to 1000 FTU / kg to low AP broiler diets (0.30 or 0.35 %) resulted in improving tibia ash , phosphorus and calcium values . On the other hand, ***Ravindran et al. (2001)*** observed that tibia and toe ash percent were not influenced by phytase supplementation to low AP broiler diets.

Economic efficiency:

The effect of dietary treatments on economic efficiency is summarized in Table (7). Data indicated that the best value of economic efficiency and lowest value of feed cost required to produce 1 kg body weight were resulted from broiler chicks which fed diets containing either 0.45 or 0.35 % AP with microbial phytase supplementation. Also, results showed that when broiler diets have low level of AP (0.25 %), the addition of microbial phytase at 750 or 1000 FTU / kg tend to increase the net revenue and so improve the economical efficiency values, regardless of dietary source of phosphorus. It is worthy to note that diets contain the lowest level of AP (0.25 %) and supplemented with 500 FTU / kg of microbial phytase, increased the feed cost needed to produce one kilogram of live body weight and decreased economic efficiency values .

In this connection , ***Abd – Elsamee (2002)*** and ***Ibrahem (2006)*** found that the average values of economic efficiency were improved when broiler chicks fed diets supplemented with microbial phytase at different levels (from 200 to 1000 FTU / kg). On the other hand, ***Attia et al. (2003)*** found that there was no effect on the average values of economic efficiency due to adding phytase up to 1000 FTU / kg to broiler chick diet.

In conclusion, for practical application it is possible to feed broiler chicks diets containing either di – calcium phosphate or bone meal with 0.35 % available phosphorus supplemented with 750 or 1000 FTU phytase / kg to improve broiler chick performance, bone characteristics, nutrient digestibility, minerals retention and economic efficiency .

Table (1): Composition and calculated analysis of the experimental grower diets (2– 4 weeks).

Phosphorus source	Di – calcium phosphate							Bone meal						
AP level	**0.45%**	**0.35 %**			**0.25 %**			**0.45%**	**0.35 %**			**0.25 %**		
Phytase level	**----**	**500**	**750**	**1000**	**500**	**750**	**1000**	**----**	**500**	**750**	**1000**	**500**	**750**	**1000**
Ingredients	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**	**T11**	**T12**	**T13**	**T14**
Yellow corn	55.00	55.08	55.07	55.06	55.48	55.47	55.46	54.20	53.98	53.97	53.96	54.28	54.27	54.26
Soybean meal (44 %)	26.90	27.10	27.10	27.10	27.60	27.60	27.60	29.50	29.50	29.50	29.50	29.80	29.80	29.80
Corn gluten (60 %)	11.20	11.00	11.00	11.00	10.60	10.60	10.60	9.00	9.30	9.30	9.30	9.10	9.10	9.10
Vegetable oil	2.60	2.60	2.60	2.60	2.50	2.50	2.50	3.10	3.10	3.10	3.10	3.00	3.00	3.00
Limestone	1.40	1.90	1.90	1.90	2.00	2.00	2.00	0.50	1.20	1.20	1.20	1.70	1.70	1.70
Di-ca-phosphate	1.80	1.20	1.20	1.20	0.70	0.70	0.70	----	----	----	----	----	----	----
Bone meal	----	----	----	----	----	----	----	2.60	1.80	1.80	1.80	1.00	1.00	1.00
Nacl	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Vit& Min. premix*	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
L-lysine HCl	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
DL-methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Anti-coccidia	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Natuphose	----	0.02	0.03	0.04	0.02	0.03	0.04	----	0.02	0.03	0.04	0.02	0.03	0.04
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Calculated analysis **														
CP %	23.06	23.04	23.04	23.04	23.05	23.05	23.05	23.01	23.03	23.03	23.03	23.05	23.05	23.05
ME Kcal / kg	3100	3100	3100	3100	3100	3100	3100	3100	3100	3100	3100	3100	3100	3100
C/P	134	134	134	134	134	134	134	134	134	134	134	134	134	134
EE %	6.67	6.58	6.58	6.58	6.32	6.32	6.32	6.22	6.49	6.49	6.49	6.48	6.48	6.48
CF %	3.08	3.09	3.09	3.09	3.07	3.07	3.07	3.06	3.13	3.13	3.13	3.13	3.13	3.13
Lysine %	1.17	1.17	1.17	1.17	1.18	1.18	1.18	1.21	1.21	1.21	1.21	1.22	1.22	1.22
Meth . %	0.51	0.52	0.52	0.52	0.52	0.52	0.52	0.51	0.51	0.51	0.51	0.51	0.51	0.51
SAA %	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Ca %	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Total P. %	0.72	0.60	0.60	0.60	0.51	0.51	0.51	0.70	0.60	0.60	0.60	0.51	0.51	0.51
Av . P %	0.45	0.35	0.35	0.35	0.25	0.25	0.25	0.45	0.35	0.35	0.35	0.25	0.25	0.25
Price / ton (LE)	2144	2140	2146	2152	2129	2135	2141	2128	2163	2142	2148	2185	2139	2145

* Vitamin and Mineral Premix at 0.3 % of the diet supplies the following per Kg of the diet : Vit.A 12000 IU; Vit D_3 2000 IU; Vit. E 30 mg; Vit. K_3 3 mg; Vit. B_1 3 mg; Vit. B_2 8mg ; Vit. B_6 5mg; Vit. B_{12} .03 mg ; Niacin 70 mg; Pantothenic acid 12mg ; Folic acid 1.5 mg ;Biotin 0.5 mg ; Choline chloride 600mg; Mn,60mg; Cu, 10mg; Fe ,40 mg ; Zn, 70mg ; I_2, 0.3 mg ;Se, 0 .2 mg; Co, 0.25 mg.

According to **NRC , 1994.

Table (2): Composition and calculated analysis of the experimental fisher diets (5 – 7 weeks).

Phosphorus source	**Di – calcium phosphate**							**Bone meal**						
AP level	**0.45%**	**0.35 %**			**0.25 %**			**0.45%**	**0.35 %**			**0.25 %**		
Phytase level	**----**	**500**	**750**	**1000**	**500**	**750**	**1000**	**----**	**500**	**750**	**1000**	**500**	**750**	**1000**
Ingredients	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**	**T11**	**T12**	**T13**	**T14**
Yellow corn	60.20	60.48	60.47	60.46	61.28	61.27	61.26	61.50	60.98	60.97	60.96	60.88	60.87	60.86
Soybean meal (44 %)	23.70	23.80	23.80	23.80	23.30	23.30	23.30	22.90	24.30	24.30	24.30	24.40	24.40	24.40
Corn gluten (60 %)	7.80	7.70	7.70	7.70	8.00	8.00	8.00	8.00	7.00	7.00	7.00	7.10	7.10	7.10
Vegetable oil	4.00	3.90	3.90	3.90	3.60	3.60	3.60	3.50	3.80	3.80	3.80	3.80	3.80	3.80
Limestone	1.40	1.70	1.70	1.70	2.00	2.00	2.00	0.30	0.90	0.90	0.90	1.60	1.60	1.60
Di-ca-phosphate	1.80	1.30	1.30	1.30	0.70	0.70	0.70	----	----	----	----	----	----	----
Bone meal	----	----	----	----	----	----	----	2.70	1.90	1.90	1.90	1.10	1.10	1.10
Nacl	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Vit& Min. premix*	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
L-lysine HCl	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
DL-methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Anti-coccidia	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Natuphose	----	0.02	0.03	0.04	0.02	0.03	0.04	----	0.02	0.03	0.04	0.02	0.03	0.04
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Calculated analysis **														
CP %	20.01	20.02	20.02	20.02	20.05	20.05	20.05	20.07	20.00	20.00	20.00	20.03	20.03	20.03
ME Kcal / kg	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200
C/P	160	160	160	160	160	160	160	160	160	160	160	160	160	160
EE %	6.67	6.58	6.58	6.58	6.32	6.32	6.32	6.22	6.49	6.49	6.49	6.48	6.48	6.48
CF %	3.08	3.09	3.09	3.09	3.07	3.07	3.07	3.06	3.13	3.13	3.13	3.13	3.13	3.13
Lysine %	1.05	1.06	1.06	1.06	1.05	1.05	1.05	1.04	1.07	1.07	1.07	1.07	1.07	1.07
Meth . %	0.46	0.46	0.46	0.46	0.47	0.47	0.47	0.46	0.46	0.46	0.46	0.46	0.46	0.46
SAA %	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.80	0.80	0.80	0.80	0.80	0.80
Ca %	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Total P. %	0.69	0.60	0.60	0.60	0.49	0.49	0.49	0.69	0.59	0.59	0.59	0.50	0.50	0.50
Av . P %	0.45	0.35	0.35	0.35	0.25	0.25	0.25	0.45	0.35	0.35	0.35	0.25	0.25	0.25
Price / ton (LE)	2018	2018	2024	2029	2001	2007	2013	1987	1995	2001	2007	1993	1999	2005

* Vitamin and Mineral Premix at 0.3 % of the diet supplies the following per Kg of the diet : Vit.A 12000 IU; Vit D_3 2000 IU; Vit. E 30 mg; Vit. K_3 3 mg; Vit. B_1 3 mg; Vit. B_2 8mg ; Vit. B_6 5mg; Vit. B_{12} .03 mg ; Niacin 70 mg; Pantothenic acid 12mg ; Folic acid 1.5 mg ;Biotin 0.5 mg ; Choline chloride 600mg; Mn,60mg; Cu, 10mg; Fe ,40 mg ; Zn, 70mg ; I_2, 0.3 mg ;Se, 0 .2 mg; Co, 0.25 mg.

According to **NRC , 1994.

Table (3): Effect of microbial phytase supplementation to low – phosphorus diets on body weight and body weight gain.

Treatments				Growing period (2 - 4 wk)		Finishing period (5 - 7wk)		Overall period (2 -7 wk)	
No.	Phos. source	AP. level	Phyt. level	BW (g)	BWG (g)	BW (g)	BWG (g)	BW (g)	BWG (g)
Main effect of Phos. source									
-	Di-Ca-P	-	-	848^{b}	736^{b}	2084^{b}	1236^{a}	2084^{b}	1972^{b}
-	Bone.M	-	-	941^{a}	832^{a}	2155^{a}	1214^{b}	2155^{a}	2042^{a}
Main effect of AP. level									
-	-	0.35 %	-	920^{a}	807^{a}	2153^{a}	1233^{a}	2153^{a}	2040^{a}
-	-	0.25 %	-	869^{b}	757^{b}	2086^{b}	1217^{b}	2086^{b}	1974^{b}
Main effect of Phyt . level									
-	-	-	500	884^{b}	771^{b}	2085^{c}	1201^{c}	2085^{c}	1972^{c}
-	-	-	750	885^{b}	773^{b}	2118^{b}	1233^{b}	2118^{b}	2006^{b}
-	-	-	1000	916^{a}	805^{a}	2155^{a}	1239^{a}	2155^{a}	2044^{a}
Treatments									
1	Di-Ca-P	0.45%	0	873^{fg}	762^{ef}	2139^{ef}	1266^{bc}	2139^{ef}	2028^{d}
2	Di-Ca-P	0.35 %	500	874^{ef}	760^{ef}	2117^{g}	1243^{d}	2117^{g}	2003^{e}
3	Di-Ca-P	0.35 %	750	880^{de}	767^{de}	2144^{e}	1264^{bc}	2144^{e}	2032^{d}
4	Di-Ca-P	0.35 %	1000	868^{g}	758^{f}	2137^{f}	1269^{ab}	2137^{f}	2027^{d}
5	Di-Ca-P	0.25 %	500	810^{h}	697^{g}	1977^{j}	1167^{h}	1977^{j}	1864^{h}
6	Di-Ca-P	0.25 %	750	788^{i}	677^{h}	1984^{i}	1196^{g}	1984^{i}	1873g
7	Di-Ca-P	0.25 %	1000	869^{fg}	757^{f}	2143^{e}	1274^{a}	2143^{e}	2031^{d}
8	Bone.M	0.45 %	0	971^{a}	858^{a}	2174^{b}	1203^{fg}	2174^{b}	2061^{ab}
9	Bone.M	0.35 %	500	968^{a}	854^{a}	2167^{c}	1199^{g}	2167^{c}	2052^{c}
10	Bone.M	0.35 %	750	972^{a}	858^{a}	2181^{a}	1209^{ef}	2181^{a}	2067^{a}
11	Bone.M	0.35 %	1000	958^{b}	846^{b}	2170^{bc}	1212^{e}	2170^{bc}	2057^{bc}
12	Bone.M	0.25 %	500	883^{d}	771^{d}	2079^{h}	1196^{g}	2079^{h}	1967^{f}
13	Bone.M	0.25 %	750	898^{c}	787^{c}	2161^{d}	1263^{c}	2161^{d}	2050^{c}
14	Bone.M	0.25 %	1000	968^{a}	858^{a}	2170^{bc}	1202^{fg}	2170^{bc}	2060^{ab}

a , b , c , …… Means in each column , within each item , bearing the same superscripts are not differ significantly ($P < 0.05$) .

BW: Body weight; BWG: Body weight gain.

Di-Ca-P = Di – Calcium – Phosphate ; Bone M = Bone meal ; Phyt. level : Phytase level (FTU/kg).

Table (4): Effect of microbial phytase supplementation to low – phosphorus diets on feed intake and feed conversion ratio.

Treatments				Growing period (2 - 4 wk)		Finishing period (5 - 7wk)		Overall period (2 -7 wk)	
No.	Phos. source	AP. level	Phyt. level	FI (g)	FCR	FI (g)	FCR	FI (g)	FCR
Main effect of Phos. source									
-	Di-Ca-P	-	-	1254^{b}	1.70^{a}	2487^{b}	2.01^{b}	3740^{b}	1.89^{b}
-	Bone.M	-	-	1416^{a}	1.71^{a}	2614^{a}	2.15^{a}	4030^{a}	1.97^{a}
Main effect of AP. level									
-	-	0.35 %	-	1349^{a}	1.67^{b}	2602^{a}	2.11^{a}	3925^{a}	1.93^{a}
-	-	0.25 %	-	1320^{b}	1.74^{a}	2499^{b}	2.05^{a}	3819^{b}	1.93^{a}
Main effect of Phyt . level									
-	-	-	500	1328^{c}	1.72^{a}	2518^{c}	2.09^{a}	3846^{c}	1.95^{a}
-	-	-	750	1333^{b}	1.73^{a}	2526^{b}	2.04^{b}	3859^{b}	1.92^{b}
-	-	-	1000	1343^{a}	1.66^{b}	2607^{a}	2.10^{a}	3950^{a}	1.93^{b}
Treatments									
1	Di-Ca-P	0.45%	0	1276^{de}	1.67^{de}	2559^{e}	2.02^{de}	3835^{ef}	1.89^{de}
2	Di-Ca-P	0.35 %	500	1264^{fg}	1.66^{e}	2543^{f}	2.04^{d}	3807^{g}	1.90^{cd}
3	Di-Ca-P	0.35 %	750	1281^{d}	1.67^{de}	2563^{e}	2.02^{de}	3845e	1.89^{de}
4	Di-Ca-P	0.35 %	1000	1269^{ef}	1.67^{de}	2561^{e}	2.01^{e}	3831^{f}	1.88^{e}
5	Di-Ca-P	0.25 %	500	1220^{h}	1.75^{c}	2342^{h}	2.01^{e}	3562^{i}	1.91^{cd}
6	Di-Ca-P	0.25 %	750	1226^{h}	1.81^{a}	2348^{g}	1.96^{f}	3573^{h}	1.90^{cd}
7	Di-Ca-P	0.25 %	1000	1261^{g}	1.66^{e}	2563^{e}	2.01^{e}	3825^{f}	1.88^{e}
8	Bone.M	0.45 %	0	1424^{b}	1.66^{e}	2651^{bc}	2.20^{a}	4075^{b}	1.97^{b}
9	Bone.M	0.35 %	500	1432^{a}	1.68^{d}	2645^{cd}	2.20^{a}	4077^{ab}	1.98^{b}
10	Bone.M	0.35 %	750	1432^{a}	1.67^{de}	2655^{ab}	2.19^{ab}	4088^{a}	1.97^{b}
11	Bone.M	0.35 %	1000	1418^{b}	1.68^{d}	2643^{d}	2.17^{b}	4061^{c}	1.97^{b}
12	Bone.M	0.25 %	500	1396^{c}	1.81^{a}	2540^{f}	2.12^{c}	3937^{d}	2.00^{a}
13	Bone.M	0.25 %	750	1393^{c}	1.77^{b}	2539^{f}	2.01^{e}	3931^{d}	1.91^{cd}
14	Bone.M	0.25 %	1000	1424^{b}	1.66^{e}	2660^{a}	2.20^{a}	4084^{ab}	1.98^{b}

a , b , c , …… Means in each column , within each item , bearing the same superscripts are not differ significantly ($P < 0.05$) .

FI : Feed intake ; FCR : Feed conversion ratio .

Di-Ca-P = Di – Calcium – Phosphate ; Bone M = Bone meal ; Phyt. level : Phytase level (FTU/kg).

Table (5): Effect of microbial phytase supplementation to low – phosphorus diets on digestibility coefficient and mineral retention (%).

Treatments				Digestibility coefficient				Mineral retention	
No.	Phos. source	AP. level	Phyt. level	CP	EE	CF	NFE	P	Ca
Main effect of Phos. source									
-	Di-Ca-P	-	-	91.9[b]	82.8[a]	25.4[b]	85.5[a]	69.8[a]	61.5[a]
-	Bone.M	-	-	92.8[a]	80.1[a]	27.4[a]	84.4[b]	56.7[b]	50.8[b]
Main effect of AP. level									
-	-	0.35 %	-	93.1[a]	83.4[a]	26.9a	85.5[a]	65.3[a]	58.35[a]
-	-	0.25 %	-	91.6[b]	79.4[b]	25.9a	84.2[a]	61.3[b]	54.00[a]
Main effect of Phyt . level									
-	-	-	500	91.8[b]	75.9[c]	24.4[b]	83.3[b]	57.9c	50.2[b]
-	-	-	750	92.2[a]	81.0[b]	27.3[a]	84.6[ab]	63.9[b]	54.8[b]
-	-	-	1000	93.1[a]	87.2[a]	27.5[a]	85.9[a]	67.9[a]	63.5[a]
Treatments									
1	Di-Ca-P	0.45%	0	93.7[ab]	83.9[c]	24.6[bc]	85.1[bc]	66.7[bc]	96.4[ab]
2	Di-Ca-P	0.35 %	500	92.5[bc]	78.1[d]	24.2[bc]	83.1[cd]	62.2[de]	47.0[ef]
3	Di-Ca-P	0.35 %	750	92.6[bc]	83.6[c]	25.9[ab]	86.5[ab]	73.3[ab]	61.7[bc]
4	Di-Ca-P	0.35 %	1000	92.7[bc]	89.7[a]	26.1[ab]	87.2[a]	75.9[a]	74.6[a]
5	Di-Ca-P	0.25 %	500	90.8[d]	74.7[de]	22.5[d]	82.9[cd]	65.7[bc]	59.6[cd]
6	Di-Ca-P	0.25 %	750	90.9[d]	82.8[cd]	26.5[ab]	85.8[bc]	69.4[ab]	62.2[bc]
7	Di-Ca-P	0.25 %	1000	92.1[cd]	87.8[ab]	27.1[ab]	87.2[a]	72.1[ab]	63.9[bc]
8	Bone.M	0.45 %	0	94.2[a]	88.2[ab]	27.2[a]	80.2[d]	62.7[de]	47.9[ef]
9	Bone.M	0.35 %	500	93.3[ab]	77.3[d]	27.6[a]	85.4[bc]	55.4[gh]	50.6[ef]
10	Bone.M	0.35 %	750	93.6[ab]	85.3[bc]	28.7[a]	85.1[bc]	59.2[ef]	52.6[de]
11	Bone.M	0.35 %	1000	94.1[a]	86.4[bc]	28.7[a]	86.1[ab]	65.2[cd]	63.5[bc]
12	Bone.M	0.25 %	500	90.5[d]	73.8[e]	23.2[cd]	82.9[cd]	48.4[i]	43.4[f]
13	Bone.M	0.25 %	750	91.8[c]	72.4[e]	28.2[a]	83.9[cd]	53.6[hi]	43.1[f]
14	Bone.M	0.25 %	1000	93.7[ab]	85.1[bc]	27.9[a]	83.2[cd]	58.5[fg]	51.8[de]

a , b , c , …… Means in each column , within each item , bearing the same superscripts are not differ significantly ($P < 0.05$) .

Di-Ca-P = Di – Calcium – Phosphate ; Bone M = Bone meal ; Phyt. level : Phytase level (FTU/kg).

Table (6): Effect of microbial phytase supplementation to low – phosphorus diets on bone characteristics.

Treatments				Bone phosphorus (%)			Bone calcium (%)		
No.	Phos. source	AP. level	Phyt. level	Femur	Tibia	Toe	Femur	Tibia	Toe
Main effect of Phos. source									
-	Di-Ca-P	-	-	4.56	3.37	3.62^{a}	9.82	11.51	6.78^{a}
-	Bone.M	-	-	4.47	3.39	3.45^{b}	9.81	11.22	6.11^{b}
Main effect of AP. level									
-	-	0.35 %	-	4.62	3.41	3.62	9.78	11.33	6.18^{b}
-	-	0.25 %	-	4.42	3.35	3.40	9.86	11.40	6.71^{a}
Main effect of Phyt . level									
-	-	-	500	4.44	3.14	3.19^{b}	9.61	10.95	4.79^{b}
-	-	-	750	4.51	3.42	3.44^{ab}	9.84	11.38	6.67^{ab}
-	-	-	1000	4.61	3.59	3.91^{a}	10.00	11.76	6.87^{a}
Treatments									
1	Di-Ca-P	0.45%	0	4.76	3.61	3.89^{ab}	9.82	10.92	7.17^{a}
2	Di-Ca-P	0.35 %	500	4.62	3.01	3.48^{ab}	9.71	11.25	5.45^{b}
3	Di-Ca-P	0.35 %	750	4.69	3.63	3.68^{ab}	9.98	11.61	6.54^{ab}
4	Di-Ca-P	0.35 %	1000	4.83	3.75	4.49^{a}	10.24	11.62	6.64^{ab}
5	Di-Ca-P	0.25 %	500	4.33	3.00	3.04^{b}	9.49	11.17	6.26^{ab}
6	Di-Ca-P	0.25 %	750	4.35	3.34	3.22^{b}	9.74	11.27	7.82^{a}
7	Di-Ca-P	0.25 %	1000	4.56	3.52	3.49^{ab}	9.76	12.12	7.95^{a}
8	Bone.M	0.45 %	0	4.72	3.67	3.23^{b}	9.73	10.86	6.98^{ab}
9	Bone.M	0.35 %	500	4.40	3.16	3.15^{b}	9.39	10.97	5.88^{b}
10	Bone.M	0.35 %	750	4.57	3.32	3.33^{b}	9.64	11.07	6.27^{ab}
11	Bone.M	0.35 %	1000	4.61	3.59	3.63^{ab}	9.69	11.45	6.30^{ab}
12	Bone.M	0.25 %	500	4.41	3.38	3.09^{b}	9.86	10.39	5.58^{b}
13	Bone.M	0.25 %	750	4.41	3.38	3.51^{ab}	9.99	11.55	6.03^{ab}
14	Bone.M	0.25 %	1000	4.44	3.50	4.02^{ab}	10.34	11.88	6.62^{ab}

a , b , c , …… Means in each column , within each item , bearing the same superscripts are not differ significantly ($P < 0.05$) .

Di-Ca-P = Di – Calcium – Phosphate ; Bone M = Bone meal ; Phyt. level : Phytase level (FTU/kg).

Table (7): Effect of microbial phytase supplementation to low – phosphorus diets on economic efficiency.

Treatments N.	Phos. source	AP. level	Phyt. level	Fixed cost (LE)	Feed cost (LE)	Total cost (LE)	BW (kg)	Cost/kg (LE)	Total reve. (LE)	Net reve. (LE)	EEF	REEf
Main effect of Phos. source												
-	Di-Ca-P	-	-	3.50	7.56	11.06	2.09	5.29	13.59	2.53	0.23	
-	Bone.M	-	-	3.50	8.06	11.56	2.16	5.35	14.02	2.46	0.21	
Main effect of AP. level												
-	-	0.35 %	-	3.50	7.94	11.44	2.15	5.31	13.99	2.55	0.22	
-	-	0.25 %	-	3.50	7.63	11.13	2.09	5.33	13.55	2.42	0.21	
Main effect of Phyt . level												
-	-	-	500	3.50	7.69	11.19	2.09	5.35	13.57	2.38	0.21	
-	-	-	750	3.50	7.74	11.24	2.12	5.30	13.75	2.51	0.22	
-	-	-	1000	3.50	7.93	11.43	2.16	5.29	14.01	2.58	0.23	
Treatments												
1	Di-Ca-P	0.45%	0	3.50	7.73	11.23	2.14	5.25	13.90	2.67	0.238	100.0
2	Di-Ca-P	0.35 %	500	3.50	7.67	11.17	2.12	5.28	13.76	2.59	0.232	97.5
3	Di-Ca-P	0.35 %	750	3.50	7.77	11.27	2.14	5.26	13.94	2.67	0.237	99.6
4	Di-Ca-P	0.35 %	1000	3.50	7.77	11.27	2.14	5.27	13.89	2.62	0.232	97.5
5	Di-Ca-P	0.25 %	500	3.50	7.12	10.62	1.98	5.37	12.85	2.23	0.209	87.8
6	Di-Ca-P	0.25 %	750	3.50	7.17	10.67	1.98	5.38	12.90	2.23	0.209	87.8
7	Di-Ca-P	0.25 %	1000	3.50	7.64	11.14	2.14	5.20	13.93	2.79	0.250	105.0
8	Bone.M	0.45 %	0	3.50	8.09	11.59	2.17	5.33	14.13	2.54	0.219	100.0
9	Bone.M	0.35 %	500	3.50	8.12	11.62	2.17	5.36	14.08	2.46	0.212	96.8
10	Bone.M	0.35 %	750	3.50	8.16	11.66	2.18	5.35	14.18	2.52	0.216	98.6
11	Bone.M	0.35 %	1000	3.50	8.15	11.65	2.17	5.37	14.10	2.45	0.210	95.9
12	Bone.M	0.25 %	500	3.50	7.83	11.33	2.08	5.45	13.51	2.18	0.192	87.7
13	Bone.M	0.25 %	750	3.50	7.86	11.36	2.16	5.26	14.05	2.69	0.237	108.2
14	Bone.M	0.25 %	1000	3.50	8.18	11.68	2.17	5.38	14.10	2.42	0.207	94.5

Di-Ca-P = Di – Calcium – Phosphate ; Bone M = Bone meal ; Phyt. level : Phytase level (FTU/kg).
Fixed cost : Bird price and rearing cost .
Total reve.: Total revenue,assuming that the selling price of one kg live body weight is 6.50 LE
EEf : Economic efficiency , net revenue per unit total cost .
REEf : Relative economic efficiency , assuming that the group number 1 and 8 are represent the control for Di – calcium phosphate and Bone meal diets , respectively .

REFFERENCES

Abd El-Hakim, A.S., 2005. *Effect of using different levels of available phosphorus and microbial phytase on the performance of broiler chicks. 3 rd International Poultry Conference.4–7Apr. 2005, Hurghada , Egypt., 339 – 358.*

Abd El–Hakim, A.S.; and Abd- Elsamee, M.O., 2004. *Effect of feeding systems and phytase supplementation on the performance of broiler chicks during summer season. Egypt. Poult. Sci., 24:297–310.*

Abd–Elsamee, M.O., 2002. *Effect of different levels of crude protein , sulphur amino acids , microbial phytase and their interaction on broiler chick performance . Egypt. Poult. Sci., 22: 999–1021.*

Abou El–Wafa, S.; El–Husseiny, O. M.; and Shabaan, M., 2005. *Influence of microbial phytase and energy levels on broiler performance fed low phosphorus diets. 3 rd International Poultry Conference. 4–7 Apr. 2005, Hurghada, Egypt., 391-406.*

Abou–Raya, A. K.; and Galal, A. Gh., 1971. *Evaluation of poultry feeds in digestibility trials with reference to some factors involved. Egypt. J. Anim. Prod., 11:207.*

Ahmed, T .; Rasool, S.; and Sarwar, M., 2000. *Effect of microbial phytase produced froum fungus Aspergillus niger on bioavailability of phosphorus and calcium in broiler chickens. Anim. Feed Sci. Technol., 83: 103 – 114.*

Angel, R.; Saylor, W. W.; Mitchell, A. D.; Powers, W.; and Applegate, T. J., 2006. *Effect of dietary phosphorus, phytase, and 25 hydroxy cholecalciferol on broiler chicken bone mineralization, litter phosphorus, and processing yields. Poult. Sci., 85: 1031 – 1044.*

Association of Official Analytical Chemists., 1990. *(Official Methods of Analysis) 15 th Ed. Published by the A.O.A.C, Washington, D.C.*

Attia, Y. A.; Aggoar, F. A. M.; Qota, E. M. A.; and Hayam Abo – El Maaty, M. A., 2003. *Effect of crude protein levels and sources and phytase addition on productive performance, carcass and plasma constituents of roasters. Egypt. J. Nut. and Feed., 6 (Special issue): 61–75.*

Ceylon, N.; Scheideler, S. E.; and Stilbran, H. L., 2003. *High available phosphorus corn and phytase in layer diets. Poult. Sci., 82: 789 – 795.*

Duncan, D. B., 1955. *Multiple range and multiple F tests. Biometrics., 11:1– 42.*

Fayza, M. S.; El–Alaily, H. A.; El–Medany, N. M.; and Abd El–Galil, K. 2003. *Improving phosphorus utilization in broiler chick diets to minimize phosphorus pollution. Egypt. Poult. Sci., 23:201– 218.*

Hammad, A. M. S., 2005. *Effect of phytase enzyme in broiler plant protein diets contain descending levels of available phosphorus.2–Carcass characteristics, bone quality and mineral retention. Egypt. Poult. Sci., 25: 533 – 552.*

Ibrahem, M. R., 2006. *Effects of different dietary levels of Okara meal and microbial phytase on broiler performance. Egypt. Poult. Sci., 26: 235 – 246.*

Jakobson, P. E.; Kirston, S. G.; and Nelson, H., 1960. *Digestibility trials with poultry . 322 bertning laboratoriet, udgivet of stants. Husdyrbugsud valy – kaben havn .*

Kornegay, E. T.; Denbow, E. M.; and Zhang, Z., 1997. *Phytase supplementation of corn – soybean meal diets from three to seven weeks of age. Poult. Sci.; 76 (Suppl 1):6 (Abstr.).*

Lan, G. Q.; Abdullah, N.; Jalaludin, S.; and Ho, Y. W., 2002. *Efficacy of supplementation of a phytase producing bacterial culture on the performance and nutrient use of broiler chickens fed corn – soybean meal diets. Poult. Sci., 81: 1522 – 1532.*

Lei, X. G.; and Stahl, G. H., 2000. *Nutritional benefits of phytase and dietary determination of its efficacy. J. Appl. Anim. Res., 17: 97 – 112.*

Lesson, S.; Namkung, H.; Cottrill, M.; and Forsberg, C. W., 2000. *Efficiency of new bacterial phytase in poultry diets. Canadian .J. Anim. Sci., 80 : 527 – 528.*

Lott, J. N. A.; Ockenden, I.; Raboy, V.; and Batten, G. D., 2000. *Phytic acid and phosphorus in crop seeds and fruits. A global estimate. Seed Sci. Res., 10: 11 – 33.*

National Research Council, NRC., 1994. *Nutrient requirements of Poultry. 9 th Ed. National Academic Press, Washington, DC.*

Potter, L. M.; Korn, M. P.; Ravindran, V.; and Kornegay, E. T., 1995. *Bioavailability of phosphorus in various phosphate sources using body weight and toe ash as response criteria. Poult. Sci., 74: 813 – 820.*

Ravindran, V.; Bryden, W. L.; and Kornegay, E. T., 1995. *Phytase: occurrence bioavailability and implication in poultry nutrition. Poultry and Avain Biology Reviews., 6:125 – 143.*

Ravindran, V.; Cabahug, S.; Ravindran, G.; and Bryden, W. L., 1999. *Influence of microbial phytase on apparent ileal amino acid digestibility of feedstuffs for broilers. Poult. Sci., 78: 699 – 706.*

Ravindran, V.; Cabahug, S.; Ravindran, G.; Selle, P. H.; and Bryden, W. L., 2000. *Response of broiler chickens to microbial phytase supplementation as influenced by dietary phytic acid and non–phytate phosphorus. 11 – Effects on apparent metabolizable energy, nutrient digestibility and nutrient retention. Br. Poult. Sci., 41: 193 – 200.*

Ravindran, V.; Selle, P. H.; Ravindran, G.; Morel, P. C. H.; Kies, A. K.; and Bryden, W. L., 2001. *Microbial phytase improves performance, apparent metabolizabile energy and ileal amino acids digestibility of broilers fed a lysine – deficient diet. Poult. Sci.,80: 338 – 334.*

SAS Institute., 1990. *SAS user guide: Statistics. SAS Institute, Inc., Cary, N C.*

Sebastian, S.; Touchbutn, S. P.; and Chevez, E. R., 1998. *Implication of phytic acid and supplemental microbial phytase in poultry nutrition: a review. World's Poult. Sci., 54: 1760 – 1769.*

Shirely, R. B.; and Edwards, H. M., 2003. *Graded levels of phytase past industry standards improves broiler performance. Poult. Sci., 82:671 - 680.*

Viveros, A.; Brenes, A.; Arija, I.; and Centeno, C., 2002. *Effects of microbial phytase supplementation on mineral utilization and serum enzyme activities in broiler chicks fed different levels of phosphorus. Poult. Sci., 81: 1172 – 1183.*

Waldroup, P. W.; Kersey, J. H.; Saleh, E. A.; Fritts, C. A.; Yan, F.; Stilborn, H . L.; Crum, R. C.; and Raboy, V., 2000. *Non phytate phosphorus requirement and phosphorus excretion of broiler chicks fed diets compared of normal or high available phosphate* *corn with and without microbial phytase. Poult. Sci., 79:1451–1459.*

Watson, B. C.; Matthews, J. O.; Southern, L. L.; and Shelton, J. L., 2006. *The effects of phytase on growth performance and intestinal transit time of broilers fed nutritionally adequate diets and deficient in calcium and phosphorus . Poult. Sci.,85:493–497.*

Yan, F.; Kersey, J. H.; Fitts, C. A.; Waldroup, P. W.; Stilborn, H. L.; Crum, R. C.; Rice, D. W., and Raboy, V., 2000. *Evaluation of normal yellow dent corn and high available phosphorus corn in combination with reduced dietary phosphorus and phytase supplementation for broilers grown to market weights in litter pens. Poult. Sci.,79: 1282 – 1289.*

Yi, Z.; Korengay, E. T.; Ravindran, V.; and Denbow, D. M., 1996. *Improving phytate phosphorus availability in corn and soybean meal for broiler using microbial phytase and calculation of phosphorus equivalency values for phytase . Poult. Sci.,75:240–249.*

Zhang, Z. B.; Kornegay, E. T.; Radcliffe, J. S.; Denbow, D. M.; Veit, H. P.; and Larsen, C. T., 2000. *Comparison of genetically engineered microbial and plant phytase young broilers. Poult. Sci., 79: 709 – 717.*

الملخص العربى

استجابة دجاج اللحم لإضافة انزيم الفيتيز الميكروبى فى علائق تختلف فى مستوى ومصدر الفوسفور المتاح

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تم استخدام عدد ٨٤٠ كتكوت تسمين عمر أسبوع من نوع الأربور آيكرز فى هذه التجربة لدراسة تأثير اضافة مستويات مختلفة من انزيم الفيتيز الميكروبى إلى العلائق المنخفضة فى محتواها من الفوسفور المتاح على الأداء الإنتاجى ، معاملات الهضم ، المحتجز من العناصر المعدنية ، خصائص العظام والدم ، الكفاءة الإقتصادية . تم استخدام مصدرين للفوسفور هما فوسفات ثنائى الكالسيوم(مصدر غير عضوى) ، مسحوق العظم (مصدر عضوى) ، مستويين للفوسفور المتاح هما ٠,٣٥ % ، ٠,٢٥ % وثلاث مستويات من انزيم الفيتيز الميكروبى هى ٥٠٠ ، ٧٥٠ ، ١٠٠٠ وحدة فيتيز / كجم عليقة . بالإضافة إلى عليقتين للمقارنة كل منهما تحتوى على ٠,٤٥ % فوسفور متاح الأولى تحتوى على فوسفات ثنائى الكالسيوم والثانية تحتوى على مسحوق العظم وذلك بدون

إضـافة انـزيم الفيتيـز . وبنـاء عليـه قسمت الطيـور إلـى ١٤ معاملـة كل منهـا تحتـوى علـى ٦٠ طـائر موزعة على ٣ مكررات وتم تغذيتها على العلائق التجريبيـة تحت نفس الظروف من الرعايـة حتـى عمر ٧ اسابيع .

سجلت أفضل النتـائج لـوزن الجسم ومعدل الزيـادة فـى الـوزن ومعامـل التحويـل الغـذائى بالإضافة إلى أفضل خصائص للعظم عند تغذية الطيور على علائق تحتوى على مسحوق العظم كمصدر للفوسفور ومستوى ٠,٣٥ % فوسفور متاح مقارنة بالعلائق المحتوية على فوسفات ثنائى الكالسيوم وقد حدث تحسن فى النتائج بإضافة انزيم الفيتيز الميكروبى إلى العلائق عند مستوى ٧٥٠ أو ١٠٠٠ وحدة فيتيز / كجم عليقة .

بينما أدى انخفاض مستوى الفوسفور المتاح إلى ٠,٢٥ % إلى تأثير سلبى لجميع القياسات المأخوذة ولم يحدث أى تحسن فيها نتيجة إضافة انزيم الفيتيز الميكروبى بمستوى ٥٠٠ وحدة / كجم وانما حدث تحسن عند إضافة ١٠٠٠ وحدة انزيم . ومن الناحية الإقتصادية سجلت مجموعة الطيور المغذاة على العلائق المحتوية على ٠,٣٥ % فوسفور متاح مع إضافة انزيم الفيتيز الميكروبى بمستوى ٧٥٠ أو ١٠٠٠ وحدة / كجم أفضل كفاءة اقتصادية بغض النظر عن مصدر الفوسفور .

ويستنتج من هذه الدراسة امكانية تغذية كتاكيت اللحم على علائق منخفضة فى محتواها من الفوسفور المتاح مع إضافة انزيم الفيتيز الميكروبى بمستوى ٧٥٠ أو ١٠٠٠ وحدة / كجم للحصول على أفضل نتائج للنمو وخصائص العظم والكفاءة الإقتصادية .