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INFLUENCE OF DIETARY PHYTASE ON BROILERS PERFORMANCE FED LOW- PHOSPHORUS CORN/SOYBEAN OR SUNFLOWER DIETS BASED ON DIGESTABLE OR DEFICIENT AMINO ACIDS

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Abstract: *Two experiments were conducted to investigate the influence of using microbial phytase with low-nPP diets on broiler performance. Experiment I, was conducted to investigate the using of two dietary protein sources soybean meal (SBM) and sunflower meal (SFM), two levels of microbial phytase (0 and 750 FTU/kg). A positive control diet (adequate in non-phytate phosphorus (nPP) 0.45/0.35% (at starter and grower period) and Ca level 1%)) and based on total (TAA) and digestible (DAA) amino acids; methionine (Met) and lysine (Lys). A total number of 360 unsexed one-day old, Arbor Acres broiler chicks were randomly and equally distributed into 12 treatments of 30 chicks each, in three replicates (10 chicks, each).*

The experiment II, Two hundred and forty-unsexed, one-day old Arbor Acres broiler chicks were distributed into 8 treatments of 30 chicks each, in three replicates (10 chicks, each). A 2 × 2 × 2 factorial arrangement of treatments was used with two dietary protein sources (SBM and SFM), two levels of microbial phytase (0 and 750 FTU/kg) and adequate ***(NRC,1994)*** *or deficient amino acids levels (Met and Lys). The level of Ca in low-nPP diets plus phytase (750 FTU/kg diet) was 0.6%. Results obtained are as follows:*

Exp. I: The low-nPP without phytase supplementation diets caused a negative effect on growth performance ($P<0.01$), plasma P level, tibia weight and mineral retention compared to those fed the control diet or low- nPP diets plus phytase. Phytase supplementation to low- nPP diets improved broilers performance, nutrients digestibility coefficients, economic efficiency and increased plasma P level ($P<0.01$), tibia weight and mineral retention, and decreased plasma ($P<0.01$) Ca, Zn, and Mg levels compared to those fed low- nPP diets without phytase. Chicks either fed diets based on DAA or corn/ sunflower meal recorded

(P<0.01) the best growth performance and higher (P<0.01) plasma P, Ca and Mg levels compared to those fed TAA or corn /soybean meal.

Exp. II: Chicks fed diets deficient in AA recorded the lowest growth performance. Phytase supplementation to low-nPP diets improved broiler performance, minerals retention, economic efficiency and digestion coefficient of CP and NB. Phytase supplementation of low-nPP diets supplemented with AA (Met and Lys) recorded a comparable growth performance with chicks fed control diet. Chicks either fed diets based on adequate in AA or corn/soybean meal increased (P<0.01) BWG, breast meat and Mg concentrations and improved FC and economic efficiency and decreased abdominal fat percentage compared to those fed diets deficient in AA or corn/sunflower meal diets.

INTRODUCTION

Phosphorous (P) is an essential element in poultry diets for skeletal development, cell membrane structure, and protein, lipid, and energy metabolism. A large portion of the phosphorus in cereal grains and oilseed meals is organically bound in the form of phytate. This form is largely unavailable to poultry because birds do not process phytase enzymes or may be presented in insufficient amount. Therefore, limited amount of phytate phosphorus from 0 to 50 % is utilized ***(Sebastian et al., 1998).*** Protein phytate complex may be present in plant feedstuffs ***(Prattley and Stanley, 1982).***

At low pH, phytic acid forms electrostatic linkage with the basic amino acids (arginine, histidine and lysine), resulting in soluble complex. As the pH approaches the iso-electric point, the charge on the proteins neutralized and the phytate is no longer bound and becomes soluble. In this soluble state, phytate complex with protein because of the presence the divalent cation Ca, Mg or Zn which acts as a bridge between negatively charged carboxyl groups and the phytate. The earliest report indicating that phytase has a positive effect on protein availability in poultry ***(Van der klies and Versteegh, 1991)***; similar results were observed by ***Attia, (2003).*** Recent studies have indicated that phytase supplementation improved protein and amino acids utilization of broiler diets and this improvement was within the range from 4 to 6% and depends on the type of feedstuffs ***(Rutherfurd et al., 2004).***

Therefore, the present study was designed to evaluate the effect of microbial phytase supplementation either in corn/soybean meal or corn/sunflower meal diets based on total or digestible amino acids on broilers performance, carcass characteristics, minerals retention and digestion coefficients of experimental diets.

MATERIALS AND MAETHODS

Two experiments were carried out at El-Kanater El-Khiaria Poultry Research Station and Poultry Nutrition Department, Animal Production Research Institute, Agriculture Research Center, Ministry of Agriculture, Egypt. Chicks were housed in gas heated batteries and kept under similar conditions of management during the experimental period, which lasted for 42 days of age.

Experiment I:

A total number of 360 unsexed one-day old (49 gm), Arbor Acres broiler chicks were individually weighed, wing banded, then randomly and equally distributed into 12 treatments of 30 chicks each, in three replicates (10 chicks each). Diets formulated formulated based on digestible AA basis were calculated according to digestible coefficients of AA of ***NRC, (1994)*** and ***Dalibared and Paillard (1995)***. The experimental design were as follows:

The experimental design (Exp. I)

Treatments	Corn / SBM diet		Corn / SFM diet	
	Based on TAA[1]	Based on DAA2	Based on TAA1	Based on DAA2
Diets supplemented with dicalcium phosphate (positive control)	T1	T2	T7	T8
Low-nPP3 diets and without phytase supplementation (negative control)	T3	T5	T9	T11
Low-nPP[3] diets and supplemented with phytase (750 FTU/kg diet)	T4*	T6*	T10*	T12*

*The level of Ca for diets T4, T6, T10 and T12 is 0.6 %. 1-TAA: total amino acids (Methionine and lysine).
2-DAA: digestible amino acids (Methionine and lysine). 3-nPP: non phytate phosphorus.

Experiment II:

Two hundred and forty-unsexed one-day old (49 gm),Arbor Acres broiler chicks were distributed into 8 treatments of 30 chicks each, in three replicates (10 chicks each). The levels of methionine + cystine and lysine for deficient diets were 0.70 and 1.02 %, (with corn/soybean meal diet) and 0.93 and 0.61 % (with corn/sunflower meal diet),respectively. The experiment included eight treatments, as follows:

Experimental design (Exp.II).

Treatments	Corn / SBM diet		Corn / SFM diet	
	According to NRC, 1994	Deficient in amino acids (Met + Lys)	According to NRC requirements, 1994	Deficient in amino acids (Met + Lys)
Diets supplemented with dicalcium phosphate (positive control)	T1	T2	T5	T6
Low-NPP[1] diets and supplemented with phytase (750 FTU/kg diet)	T4*	T3*	T8*	T7*

*The level of Ca at diets T3, T4, T7 and T8 is 0.6 %. 1-NPP: non phytate phosphorus

All diets were formulated using linear programming to be isonitrogenous and isocaloric, 23% CP and 3200 kcal ME/kg diet (starter) and 20% CP and 3200 kcal ME/kg diets (grower) (Tables,1-4).

Feed and water were offered *ad-libitum*. Live body weight (BW) and feed intake (F1) were recorded weekly. Body weight gain (BWG) and feed conversion ratio (FC) were calculated. Mortality was daily recorded and the economic efficiency was calculated at the end of the experiment. The tested raw materials were analyzed for Kjeldah nitrogen by the methods outlined by Official Methods of Analysis ***(A.O.A.C. 1990).*** Amino acid concentrations in corn, soybean meal sunflower meal and corn gluten meal were analyzed with Biochrom 20 amino Acid Analyzer based on the described method of ***Spackman et al. (1958)***. Methionine and cystine were determined in samples oxidized with performic acid.

The digestibility coefficients of nutrients for the experimental diets were determined using 4 birds from each treatment. Faecal nitrogen was determined according to the method outlined by ***Ekman et al. (1949),*** while the urinary organic matter fraction was calculated according to ***Abou-Raya and Galal (1971).*** The proximate analysis of feeds and dried excreta was carried out according to the methods of the tested raw materials were analyzed for Kjeldah nitrogen by the methods outlined by Official Methods of Analysis ***(A.O.A.C. 1990).***

At the end of the experiment (6 weeks of age), four birds from each treatment were taken around the average BW of the treatment, for slaughtering and carcass measurements were calculated as a percentage of live body weight. Individual blood samples were obtained from the slaughtered chicks. The minerals (Ca, Zn, Mg and P) were using the

Atomic Absorption Spectrophotometer and according to the method outlined by the manufacturers. determined in blood samples, bone tibia, tested diets and fecal samples by using commercial kits (Bio-Merieux, France).

The economical efficiency (the net revenue per unit feed cost) was calculated from input-output analysis. The data were subject to a factorial design using General Linear Model of SAS® software statistical analysis (SAS, 1990). Significant means were separated by Duncan's Multiple Range Test (Duncan, 1955).

RESULTS

1. Chemical composition and amino acids profile of experimental ingredients: The chemical composition of experimental ingredients are summarized in Table (5). The crude protein values of yellow corn, soybean meal (SBM), sunflower meal (SFM) and corn gluten meal (CGM) were within the normal range of NRC (1994). Amino acids profile of SBM was rich in lysine, but deficient in methionine. However, SFM was rich in lysine and deficient in methionine. While, corn gluten meal CGM was rich in leucine and valine, but deficient in lysine (Mohamed, 1992). The results of chemical score and essential amino acid index were 31.46% and 75.04% for SBM, 46.94% and 73.96% for SFM and 22.77% and 63.21% for CGM, respectively.

Experiment I:

The growth performance, digestibilities, carcass characteristics and economical efficiency, of experimental broiler chicks are tabulated in Tables (6 and 7). Chicks fed low-nPP diets without phytase supplementation recorded the lowest growth performance compared to those fed the control diet or a low-P diet plus phytase. Formulating diets based on digestible (DAA) amino acids (Met and Lys) significantly improved body weight gain and feed conversion ratio (FC) compared to that achieved on total amino acids (TAA) basis at starter and grower periods. Moreover, chicks fed corn/ sunflower diet recorded the best body weight gain and feed conversion ratio compared to those fed corn /soybean meal diet. Digestibility coefficients of CP, EE, NFE and OM were significantly ($P<0.05$) increased with either the optimum level of available-P (0.45%) or supplementing phytase to low-nPP compared to those fed diets containing low-nPP without phytase supplementation (Table 6). However, insignificant effect was observed with digestible CF between the control and low-nPP plus phytase. No significant differences in nutrients digestibility coefficients between diets containing soybean meal and those containing sunflower meal.

Digestibility coefficients of CP, EE, NFE and OM were increased significantly ($P<0.05$) with either the optimum level of available-P (0.45%) or supplementing phytase to low-nPP compared to those fed diets containing low-nPP without phytase supplementation (Table 6). However, insignificant effect was observed with digestible CF between the control and low-nPP plus phytase. No significant differences in nutrients digestibility coefficients between diets containing soybean meal and those containing sunflower meal. Chicks fed low-nPP diets plus phytase recorded the highest ($P<0.01$) dressing percentage, and breast meat percentage compared to the other treatments. However, chicks fed diets based on DAA recorded decreased ($P<0.05$) abdominal fat and increased ($P<0.01$) breast meat percentage compared to those fed diets based on TAA. Regarding dietary protein sources, no significant effect on carcass characteristics for chicks fed either corn/soybean or corn/sunflower diets (Table 6). However, breast weight increased ($P<0.01$) and abdominal fat decreased ($P<0.05$) with chicks fed diets based on DAA.

Diets either supplemented with phytase or formulated DAA based recorded the best EEF. However diets containing soybean meal recorded the highest EEF compared to those containing sunflower meal. The low-nPP diet reduced ($P<0.01$) plasma P level and increased ($P<0.01$) plasma Ca, Zn, and Mg levels as compared to control. However, phytase supplementation increased ($P<0.01$) plasma P level and decreased ($P<0.01$) plasma Ca, Zn, and Mg levels as compared to low-in nPP diets. Chicks either fed diets based on DAA or corn/sunflower meal have ($P<0.01$) higher ($P<0.01$) plasma P, Ca and Mg levels compared to those fed TAA or corn /soybean meal with insignificant differences regarding plasma Zn level (Table 7).

The low-nPP diets without phytase supplementation caused a significant ($P<0.01$) decrease in tibia weight and ash percentage compared to those fed either low-nPP diet plus phytase or normal available-P diet. Chicks fed diets based on TAA (Met and Lys) recorded significantly ($P<0.01$) lower tibia weight than those fed diets based on DAA. No significant differences in tibia weight and ash percentage between chicks fed corn/soybean meal diet and those fed corn/sunflower meal diet. Adding phytase to low-nPP diet (corn/soybean or corn/ sunflower) not significantly increased tibia content of Ca and Mg. However, significant ($P<0.01$) increase in tibia P and Zn content was observed with adding phytase to low-nPP corn/sunflower diet compared to low-nPP diet without phytase supplementation (Table 7). Insignificant differences were observed between low-nPP diet plus phytase and that low -nPP diet regarding bone Ca and Mg percentage. Significant (P<0.05) differences were observed between chicks fed diets based on TAA and those fed diets based on DAA regarding to tibia P content. However, insignificant differences were observed between chicks fed either diet based on TAA or DAA regarding tibia Ca, Zn and Mg concentration. Similar trend was observed with chicks fed either corn/soybean diet or corn /sunflower diet regarding tibia P, Ca, Zn and Mg content (Table 7).

Phytase supplementation to low-nPP diet significantly (P<0.01) increased P (17%), Ca (19.5%), Zn (39.2%) and Mg (38%) retention compared to low-nPP diet. However, insignificant differences were observed between chicks fed either TAA or DAA regarding to mineral retention (Table 7). Similar trend was observed with chicks fed either corn/soybean or corn/sunflower diets.

Experiment II:

Summerized in Tables (8 and 9) are the growth performance, carcass characteristics and economical efficiency of experimental broilers chicks. Phytase supplementation of low-nPP diets increased significantly (P<0.01) the BWG compared with those fed positive control from 1-6 weeks of age. However, phytase supplementation had no significant effect on feed conversion.

Chicks fed diets based on adequate amino acids grew better (P<0.01) and utilized the feed more efficient (FC) than those fed diets based on deficient amino acids. Chicks fed corn/soybean meal diets recorded significantly (P<0.01) the best body weight gain and feed conversion compared to those fed corn/sunflower meal diets. However, chicks fed amino acid deficient (Met and Lys) diets recorded the lowest growth performance compared to those fed diets adequate in amino acids (Table 8). Phytase supplementation had a positive effect on CP digestibility. Adequate AA diets significantly (P<0.01) increased nutrients digestibility coefficients compared to those fed deficient AA (Met and Lys) diets. Moreover, significant differences were observed in NFE digestibility between diets containing corn/soybean and corn/sunflower meal.

Percentage of dressing, abdominal fat and breast meat for broiler chicks were not significantly affected by enzyme supplementation. Chicks fed deficient amino acids diet recorded a decrease (P<0.01) in dressing and breast meat percentages and an increase (P<0.01) in abdominal fat percentage compared to those fed diet adequate in amino acids.

Regarding dietary protein sources, no significant effect on dressing percentage for chicks fed either corn/soybean or corn/sunflower diets (Table 8). However, chicks fed corn/sunflower diet recorded higher (P<0.01) percentage of abdominal fat and lower (P<0.01) breast meat compared to those fed corn/soybean meal diet (Table 8). Replacing sunflower meal with soybean meal reduced significantly (P<0.01) breast percentage and increased (P<0.01) abdominal fat percentage.

Diets supplemented with phytase recorded the best EEF compared to those fed positive control. However, diets either deficient in AA or containing sunflower meal recoded the lowest EEF.

Chicks fed positive control diet recorded higher (P< 0.01) plasma P concentration and lower (P< 0.01) plasma Ca concentration compared to those fed low-nPP plus phytase. However, insignificant differences were absorbed between dietary treatments regarding plasma Zn and Mg concentrations (Table 9).

Insignificant differences were observed in plasma P , Ca and Zn concentration between chicks fed diets based on adequate AA and those fed deficient AA diets. However, significant differences (P<0.01) were observed in plasma Mg concentrations (Table 9).

No significant differences were observed in plasma P, Ca and Zn concentrations between chicks fed corn/soybean meal diet and those fed corn/sunflower meal diet. However, significant differences (P<0.01) were observed in plasma Mg concentration between chicks fed corn/soybean meal diet and those fed corn/sunflower meal in favor of sunflower meal (Table 9).

Phytase supplementation to low – nPP diet significantly (P<0.05) increased tibia weight of broiler chicks than those fed control diet. However, insignificant differences were observed in tibia ash percentage, P,Ca, Zn and Mg. Insignificant differences in Ca and Mg percentage and Zn content were observed between chicks fed AA adequate diets and those fed AA deficient diets. Similar trend was observed between chicks fed corn/soybean diets and those fed corn/sunflower diets regarding bone mineral contents (P, Ca, Zn and Mg). Insignificant differences were observed in mineral retention due to different treatments (Table 9).

DISCUSSION

Chicks fed low-nPP diets without phytase supplementation recorded the lowest growth performance compared to those fed either the control diet or a low-P diet plus phytase. This may be due to the presence of phytic acid which has been regarded as the primary storage form of both phosphate and inositol in almost seeds **(Cosgrove, 1966)**. Approximately 72 % of the P in corn **(Ravindran *et al.*, 1994)**, 66 % of the P in soybean meal and 77 % in sunflower meal **(Ewing, 1963)** is in the form of phytic acid. **Cowieson *et al.* (2004)** concluded that myo-inositol hexa-phosphate increases the excretion of endogenous minerals and amino acids in broiler chickens.

Phytase supplementation to low-nPP diets improved body weight gain and feed conversion of broiler chicks compared to those fed low-nPP diets without phytase. These results are in agreement with those reported by **(Zyla *et al.*, 2000)**. **Abd-El Samee (2002)** indicated that using microbial phytase improved significantly ($P<0.05$) growth performance of broiler chicks. The improvements in growth performance observed in broiler chicks fed low-P diets plus phytase may be due to : 1) the release of minerals from the phytate-mineral complex and 2) the utilization of inositol by chicks, or 3) increased starch digestibility or 4) increased availability of protein as suggested by **Simons *et al.* (1990)**. ***Mulyantini et al. (2004)*** cited that no significant ($P<0.05$) difference was observed in body weight gain between broiler chicks fed the control diet (standard phosphorous without phytase) and those fed diets supplemented low P + phytase 500 or 1000 U/kg in started or finisher diets. The authors added that no significant effect in feed conversion by phytase supplementation.

At the present study phytase supplementation of the low-nPP diet containing 0.6 % Ca resulted in a comparable body weight gain of broiler chicks with those fed the control diet containing a recommended level of Ca (1.0 %) as suggested by **Sebastian *et al.* (1996)** who concluded that phytase supplementation of the diet containing 0.6 % Ca resulted in optimum broiler performance. Recently, **Driver** *et al.* **(2004)** reported that the effect of adding phytase on growth performance was greatest at low levels of Ca and nPP.

Formulating diets based on digestible (DAA) amino acids (Met and Lys) significantly improved body weight gain and feed conversion ratio (FC) compared to that achieved on total amino acids (TAA) basis at starter and grower period. These results are in agreement with those reported by **Abou El-Wafa (2003)** who found that formulated diets based on DAA improved FC of broiler chicks. **Attia** *et al.* **(2001)** observed that enzyme addition or formulation on true amino acids digestibility basis improved performance of broiler chicks. Recently, **EL-**

Husseiny *et al.* **(2004)** reported that excessive dietary AA (Met and Lys) for the first 7 days of age improved growth performance.

Chicks fed corn/ sunflower diet recorded body weight gain and feed conversion ratio compared to those fed corn /soybean meal diet (Table 6). These results are in agreement with those reported by **EL-Deek** *et al.* **(1999)**. These may be interpreted on the basis that sunflower meal doesn't contain anti-nutritional factors such as beta- glucan and pectin **(Rinder, 1994)**. Moreover, supplemented sunflower meal with limiting amino acid (Lysine) and fat can be completely substitute soybean meal in broiler diets as reported by **Mushrafa (1991)**. Furthermore, **Desouky (2001)** reported that sunflower meal as a source of protein gave the best results especially with phytase supplementation. However, Chicks fed corn/soybean meal diet recorded significantly ($P<0.01$) the best body weight gain and feed conversion compared to those fed corn/sunflower meal diet (Table 8). This may be interpreted based on amino acid-deficient diets containing total sulphur amino acids (0.7% (corn/soybean) vs 0.93% (corn/sunflower)) and lysine (1.02 (corn/soybean) vs 0.61% (corn/sunflower)). In addition, the level of available-P is 0.2% in corn/soybean and 0.09% in corn/sunflower diets. This may explained the poor growth performance for chicks fed corn/sunflower meal diet compared to those fed corn/soybean meal diet (Table 8). Moreover, chicks fed amino acid deficient (Met and Lys) diets recorded the lowest growth performance compared to those fed diets adequate in amino acids (Met and Lys) (Table 8). These results somewhat are in agreement with those reported by **Biehl** and **Baker (1997)**. Several researches **(Ravindran** *et al.*, **1999** and **Zhang** *et al.*, **1999)** reported that lysine released by phytase (500 U/kg diet) supplementation represents a total of 0.0121% lysine or 1.2% of the total dietary lysine. Therefore, the amount of lysine released by phytase in corn/sunflower meal diet did not cover the requirements of chicks during the experimental period according to **NRC (1994)**. Recently, **Augspurger** and **Baker (2004)** showed that phytase supplementation did not improve protein efficiency ratio of chicks fed low-nPP soybean meal or corn gluten meal diets that were first limiting in either methionine or lysine. Also, **Boling-Frankenbach** ***et al.*** **(2001)** showed that phytase did not significantly increases the utilization of lysine or sulphur amino acids assessed by a PER growth assay. Furthermore, experimental diets containing sunflower meal need 0.6% lysine to meet the requirements of chicks according to **NRC (1994)** as suggested by **McGinnis** ***et al.*** **(1948)**. Diets based on adequate amino acids gave better ($P<0.01$) BWG and FC compared with diets based on deficient amino acids (Table 8). These results are in agreement with those reported by **Abd El-Samee (2002)**. Similarly, **Attia *et al*. (2001)** observed that enzyme addition or formulation on true amino acid digestibility basis improved performance of broiler chicks.

Digestibility coefficients of CP, EE, NFE and OM were increased significantly (P<0.05) with using either the optimum level of available-P(0.45%) or supplementing phytase to low-nPP compared to those fed diets containing low-nPP without phytase supplementation (Table 6). Also, phytase supplementation had appositive effect on CP digestibility (Table 8). However, insignificant effect was observed with CF digestibility between the control and low-nPP plus phytase (Table 6). These results are in agreement with those reported by **El-Nagmy** *et al*. **(2004)**. Results showed that formulating diets based on digestible amino acids (Met and Lys) significantly (P<0.05) increased CP digestibility (Table 6). These results are in agreement with those reported by **Abd El-Samee (2002)** who reported that using either high level of sulphur amino acids or phytase improved significantly nutrients digestibility coefficients. No significant differences in nutrients digestibility coefficients between diets containing soybean meal and those containing sunflower meal (Table 6 and 8). These results are in agreement with those reported by **Arafa** *et al*. **(2001).**

Chicks fed low-nPP diets plus phytase recorded the highest (P<0.01) dressing percentage, and breast meat percentage compared to the other treatments (Table 6). However, chicks fed diets based on DAA recorded decreased (P<0.05) in abdominal fat and increased (P<0.01) in breast meat percentage compared to those fed diets based on TAA (Table 6). However, chicks fed deficient amino acids diet recorded decreased (P<0.05) in dressing and breast meat percentage and increased (P<0.01) in abdominal fat percentages compared to those fed diets adequate in amino acids (Table 8). Improved digestibility of protein and amino acids may be due to phytase supplemented diets at studied phytate concentration were supported by, ***Ravindran et al. (2006)*** who feeding broiler chicks on diets inclusion rice bran and contained three levels of phytic acid (10.4, 11.8, and 13.6 g/kg) and phytase (0, 500, 750 and 1.000 FTU/kg), during starter diets.

Regarding dietary protein sources, no significant effect on carcass characteristics for chicks fed either corn/soybean or corn/sunflower diets (Tables 6 and 8). These results are in agreement with those reported by **Abd El-Hakim and Abd El-Samee (2004)** who reported that phytase supplementation significantly increased dressing percentage.

Breast weight increased (P<0.01) (Table 6) and abdominal fat decreased (P<0.05) with chicks fed diets based on DAA as reported by **Kidd *et al.* (1998)**. However, chicks fed deficient amino acids diets gave lower carcass characteristics compared to those fed adequate amino acids diets (Table 8). These findings agree with that reported by **Moran (1994)**. Moreover, lysine deficiency affected chick growth and greatly reduced breast muscle weight and proportion compared to other muscles as suggested by **Tesseraud *et al.* (1996)**.

Replacing sunflower meal with soybean meal reduced significantly (P<0.01) breast meat percentage and increased (P<0.01) abdominal fat percentage (Table 8). These results generally are in agreement with those reported by **Arafa** *et al.* **(2001)**. The low-nPP diet reduced (P<0.01) plasma P level and increased (P<0.01) plasma Ca, Zn, and Mg levels. However, phytase supplementation increased (P<0.01) plasma P level and decreased (P<0.01) plasma Ca, Zn, and Mg levels. Chicks either fed diets based on DAA or corn/sunflower meal have (P<0.01) higher (P<0.01) plasma P, Ca and Mg levels compared to those fed TAA or corn /soybean meal with insignificant differences regarding plasma Zn level (Table 7). These results are in agreement with reported by (**Sebastian** *et al.,* **1996)**. Moreover, **Viveros *et al.* (2002)** reported that phytase supplementation increased (P<0.01) plasma P level and decreased plasma (P<0.01) Ca and Mg levels. However, phytase supplementation to low-nPP significantly increased plasma Ca concentration (Table 9) as reported by **Attia** *et al.* **(2001)**.

Phytase supplementation to corn/sunflower diet gave a comparable plasma P concentration to those of the positive control diet as reported by **El-Deeb** *et al.* **(2000).** However, significant effect was observed with chicks fed corn/soybean meal diet. This may be interpreted based on diets containing sunflower meal had higher percentage of phytate phosphorus (77%) compared to soybean meal (60%). Therefore, phytase supplementation may release the P-bound in the phytate-phosphorus molecule in oil seeds. These results are in agreement with those reported by **Cheng** *et al.* **(2004)**.

The low-nPP diets without phytase supplementation caused a significant (P<0.01) decrease in tibia weight and ash percentage compared to those fed either low-nPP diet plus phytase or normal available-P diet (Table 7). These results are in agreement with those reported by **Salem** *et al.* **(2003)**.

Significant (P<0.01) increase in tibia P and Zn content were observed with adding phytase to low-nPP corn/sunflower diet compared to low-nPP diet without phytase supplementation (Table 7). These results are in agreement with those reported by **Salem** *et al.* **(2003)** who found that adding phytase to low-nPP increased tibia P percentage. This may be due to the release of inorganic P from the phytate molecule and subsequent increase P availability and its utilization by bone.

Phytase supplementation to low-nPP diet significantly (P<0.01) increased P, Ca, Zn and Mg retention compared to low-nPP diet (Table 9). Moreover, phytase supplementation low-nPP (corn/soybean or corn/sunflower) gave a comparable mineral (P, Ca, Zn and Mg) retention with those fed normal-available P, with insignificant differences between different dietary treatments (Table 9). These results are in agreement with those reported by **Viveros** *et al.* **(2002). Yan** *et al.* **(2001)** indicated that at lower P levels, chicks fed diets with phytase excreted less P than those fed high P diets without phytase. This reduction of P excretion is particularly important in the reduction of P pollution by poultry manure. **Simons** *et al.* **(1990)** reported that supplemental phytase could lower P excretion by more than 40 % by increasing P availability. Likewise, phytase supplementation increased Zn and Mg retention in spite of containing adequate Zn and Mg levels in the diet. The increase in Zn retention might have been due to greater availability of Zn from the phytate mineral complex The utilization of Zn by supplemental phytase have also been reported in chickens (**Sebastian** *et al.*, **1996)**. Moreover, the increase obtained in Mg retention by phytase supplementation may be caused by a decrease in endogenous Mg loss or by a significant reduction of Mg excretion.

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

Ingredients	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
Yellow corn 8.5%	49.00	49.53	50.07	52.44	50.55	52.95	44.12	44.17	45.71	47.67	45.71	47.65
Soybean meal 44%	35.50	34.90	35.50	35.00	34.88	34.40	-	-	-	-	-	-
Sunflower meal 33.1%	-	-	-	-	-	-	30.00	30.00	30.00	30.00	30.00	30.00
Corn gluten meal 60 %	5.11	5.11	5.00	5.00	5.06	5.00	13.85	13.65	13.60	13.33	13.44	13.20
Corn oil	6.50	6.33	6.14	5.37	5.97	5.20	7.58	7.57	7.09	6.45	7.08	6.43
Dicalcium phosphate	1.70	1.70	0.35	0.35	0.35	0.35	1.90	1.90	-	-	-	-
Limestone	1.44	1.44	2.20	1.10	2.20	1.10	1.30	1.30	2.36	1.30	2.36	1.30
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
NaCl (salt)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
DL-Methionine 99 %	0.15	0.24	0.14	0.14	0.24	0.24	-	0.16	-	-	0.10	0.11
L-lysine 98 %	-	0.15	-	-	0.15	0.16	0.65	0.71	0.64	0.65	0.71	0.71
Total	100	100	100	100	100	100	100	100	100	100	100	100
Calculated analysis												
ME kcal/kg	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200
CP %	23.04	23.05	23.05	23.04	23.09	23.06	23.04	23.05	23.01	23.02	23.05	23.07
Ca %	1.03	1.03	1.03	0.60	1.03	0.60	1.04	1.04	1.02	0.62	1.02	0.62
Total P %	0.70	0.70	0.46	0.46	0.45	0.46	0.82	0.82	0.47	0.47	0.47	0.47
Av. P %	0.45	0.45	0.20	0.20	0.20	0.20	0.45	0.45	0.09	0.09	0.09	0.09
Met. %	0.53	0.59	0.52	0.52	0.59	0.59	0.50	0.57	0.50	0.50	0.57	0.58
Met + Cys %	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Lys %	1.13	1.11	1.13	1.12	1.11	1.11	1.16	1.11	1.15	1.16	1.12	1.12
Price/kg (P.T)	166.6	170.9	162.7	161.4	167.3	166.1	189.4	192.5	183.8	182.9	187.2	186.3

* Supplied per kg of diet: Vit.A, 12000IU; Vit.D_3,2200IU; Vit.E, 10mg; Vit.K_3, 2mg; Vit.B_1, 1mg; Vit.B_2, 5mg; Vit.B_6, 1.5mg; Vit.B_{12}, 10µg; Nicotinic acid 30mg; Folic acid, 1mg; Pantothenic acid, 10mg; Biotin 50µg; Choline chloride, 250mg; copper, 10mg; iron, 30mg; Manganese, 60mg; Zinc, 50mg; Iodine, 1mg; Selenium, 0.1mg; Cobalt, 0.1mg.

Table (2): Composition of the grower experimental diets (Exp. I).

Ingredients	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
Yellow corn 8.5%	57.50	57.75	58.60	60.65	58.95	61.32	50.13	50.18	51.28	53.13	51.28	53.16
Soybean meal 44%	31.60	31.50	31.35	31.00	31.25	30.24	-	-	-	-	-	-
Sunflower meal 33.1%	-	-	-	-	-	-	30.00	30.00	30.00	30.00	30.00	30.00
Corn gluten meal 60%	2.00	1.65	2.00	2.00	1.56	2.00	8.30	8.20	8.2	7.87	8.05	7.75
Corn oil	5.60	5.56	5.25	4.55	5.19	4.35	7.67	7.65	7.30	6.70	7.29	6.70
Dicalcium phosphate	1.19	1.18	-	-	-	-	1.40	1.40	-	-	-	-
Limestone	1.45	1.45	2.14	1.14	2.12	1.15	1.30	1.29	2.10	1.10	2.10	1.10
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
NaCl (salt)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
DL-Methionine (99%)	0.06	0.15	0.06+	0.06	0.16	0.15	-	0.03	-	-	0.03	0.04
L-lysine (98%)	-	0.16	-	-	0.17	0.19	0.60	0.65	0.60	0.60	0.65	0.65
Total	100	100	100	100	100	100	100	100	100	100	100	100
Calculated analysis												
ME kcal/kg	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200
CP %	20.06	20.07	20.05	20.07	20.02	20.07	20.05	20.07	20.04	20.04	20.07	20.05
Ca %	0.91	0.91	0.91	0.53	0.91	0.53	0.92	0.92	0.92	0.54	0.92	0.54
Total P %	0.59	0.59	0.37	0.38	0.37	0.37	0.72	0.72	0.46	0.46	0.46	0.46
Av. P %	0.35	0.35	0.13	0.13	0.13	0.13	0.35	0.35	0.09	0.09	0.09	0.09
Met. %	0.38	0.44	0.38	0.38	0.45	0.44	0.43	0.43	0.43	0.43	0.43	0.44
Met + Cys %	0.72	0.72	0.72	0.72	0.72	0.72	0.78	0.72	0.78	0.78	0.72	0.72
Lys %	1.01	1.01	1.01	1.01	1.02	1.02	1.07	1.03	1.08	1.08	1.03	1.03
Price/Kg (P.T)	149.2	153.7	145.8	144.8	150.5	149.7	173.7	175.2	169.7	168.7	171.3	170.5

Table (3): Composition of the starter experimental diets (Exp.I I).

Ingredients	T1	T2	T3	T4	T5	T6	T7	T8
Yellow corn 8.5%	49.00	52.44	49.00	52.40	44.12	47.67	43.37	46.95
Soybean meal 44%	35.50	35.00	35.50	35.00	-	-	-	-
Sunflower meal 33.1%	-		-	-	30.00	30.00	30.00	30.00
Corn gluten meal 60%	5.11	5.00	5.25	5.20	13.85	13.33	15.20	14.65
Corn oil	6.50	5.37	6.50	5.35	7.58	6.45	7.63	6.50
Dicalcium phosphate	1.70	0.35	1.70	0.35	1.90	-	1.90	-
Limestone	1.44	1.10	1.45	1.10	1.30	1.30	1.30	1.30
Vit.&Min. (Premix)*	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
NaCl (salt)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
DL-Methionine (99%)	0.15	0.14	-	-	-	-	-	-
L-lysine (98%)	-	-	-	-	0.65	0.65	-	
Total	100	100	100	100	100	100	100	100
Calculated analysis								
ME kcal/kg	3200	3200	3200	3200	3200	3200	3200	3200
CP %	23.04	23.04	23.04	23.07	23.04	23.02	23.04	23.00
Ca %	1.03	0.60	1.03	0.60	1.04	0.62	1.04	0.62
Total P %	0.70	0.46	0.71	0.46	0.82	0.47	0.83	0.48
Av. P %	0.45	0.20	0.45	0.20	0.45	0.09	0.45	0.09
Met. %	0.53	0.52	0.37	0.38	0.50	0.50	0.52	0.52
Met + Cys %	0.90	0.90	0.70	0.77	0.90	0.90	0.93	0.93
Lys %	1.13	1.12	1.02	1.13	1.16	1.16	0.61	0.61
Price/kg (P.T)	166.6	158.7	161.3	163.6	189.4	176.6	182.9	183.2

*Supplied per kg of diet: Vit.A, 12000IU; Vit.D_3,2200IU; Vit.E, 10mg; Vit.K_3, 2mg; Vit.B_1, 1mg; Vit.B_2, 5mg; Vit.B_6, 1.5mg; Vit.B_{12}, 10µg; Nicotinic acid 30mg; Folic acid, 1mg; pantothenic acid, 10mg; biotin 50µg; Choline chloride, 250mg; copper, 10mg; iron, 30mg; manganese, 60mg; zinc, 50mg; iodine, 1mg; selenium, 0.1mg; cobalt, 0.1mg.

Table (4): Composition of the grower experimental diets (Exp.I I).

Ingredients	T1	T2	T3	T4	T5	T6	T7	T8
Yellow corn 8.5%	57.50	60.65	57.57	60.69	50.13	53.13	49.48	52.43
Soybean meal 44%	31.60	31.00	31.60	31.00	-	-	-	-
Sunflower meal 33.1%	-	-	-	-	30.00	30.00	30.00	30.00
Corn gluten meal 60%	2.00	2.00	2.00	2.00	8.30	7.87	9.50	9.11
Corn oil	5.60	4.55	5.60	4.57	7.67	6.70	7.72	6.76
Dicalcium phosphate	1.19	-	1.19	-	1.40	-	1.40	-
Limestone	1.45	1.14	1.44	1.14	1.30	1.10	1.30	1.10
Vit.&Min. (premix)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
NaCl (salt)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
DL-Methionine (99%)	0.06	0.06	-	-	-	-	-	-
L-lysine (98%)	-	-	-	-	0.60	0.60	-	-
Total	100	100	100	100	100	100	100	100
Calculated analysis								
ME kcal/kg	3200	3200	3200	3200	3200	3200	3200	3200
CP %	20.06	20.07	20.03	20.03	20.05	20.04	20.02	20.03
Ca %	0.91	0.53	0.91	0.53	0.92	0.54	0.92	0.54
Total P %	0.59	0.38	0.59	0.38	0.72	0.46	0.72	0.47
Av. P %	0.35	0.13	0.35	0.13	0.35	0.09	0.35	0.09
Met. %	0.38	0.38	0.32	0.33	0.43	0.43	0.45	0.45
Met + Cys %	0.72	0.72	0.66	0.66	0.78	0.78	0.81	0.81
Lys %	1.01	1.01	1.01	1.01	1.07	1.08	0.56	0.57
Price/kg (P.T)	149.2	143.5	144.8	147.9	173.7	158.3	168.7	163.2

Table (5): Amino acids composition (g) / 100 g protein, essential amino acids index (EAAI), chemical score (C.S) and limiting amino acids (LAA) of corn, soybean meal, sunflower meal and corn gluten compared to values of NRC (1994) and whole egg .

Amino acids (%) (AA)	**corn**	**soybean**	**sunflower**	**corn gluten**	**NRC (1994)**	**Whole egg**
Methionine	2.09	1.29	2.20	2.47	2.17	4.10
Cystein	2.32	1.47	1.74	1.64	1.74	2.40
TSAA	4.41	2.76	3.94	4.28	3.91	6.50
Lysine	3.14	5.90	3.38	1.64	4.78	7.20
Thrionine	3.60	3.83	3.64	3.26	3.48	4.90
Arginine	4.76	7.19	7.87	3.28	4.43	6.40
Iso-leucine	3.37	4.57	4.05	4.10	3.48	8.00
Leucine	12.08	7.56	6.25	16.25	5.21	9.20
Valine	4.65	4.71	4.89	4.64	3.91	7.30
Histidine	2.59	2.46	2.59	1.97	1.52	2.10
Phenyl alanine	2.00	4.60	4.93	5.84	3.13	5.70
Glycine	3.76	3.96	6.05	2.74	-	2.20
Serine	4.12	4.88	4.45	4.86	-	-
Tyrosine	3.41	4.07	2.71	5.04	-	-
Tryptophan	0.82	1.31	1.30	0.59	-	1.50
Total	52.71	57.80	56.05	55.04	-	53.80
T. essential	39.10	43.42	41.10	40.76	-	-
EAAI %	63.17	75.04	73.96	63.21		100
C.S %	35.08	31.46	46.94	22.77	-	-
1st LAA	Phenyl alanine	Methionine	Lysine	Lysine		
2nd LAA	Iso-leucine	Iso-leucine	Iso-leucine	Tryptophan		
3rd LAA	Lysine	Valine	Methionine	Arginine		
B.V %*	57.16	70.09	68.92	57.19		
CP %	8.49	46.66	33.20	60.90		

*B.V%= 1.09 (EAAI) – 11.7 (Albanese, 1959).

Table (6): Growth performance, digestion coefficients, carcass characteristics and economical efficiency of broiler chicks as affected by different dietary treatments (Exp. I).

Items	Treatments						
	Enzyme supplementation			Dietary amino acids		Dietary protein sources	
	Control	Low-nPP + phytase	Low-nPP + Without phytase	Total amino acids (TAA)	Digestible amino acids (DAA)	Corn/ soybean meal	Corn/ sunflower meal
	Growth performance						
Form 1-6 week old							
Body weight gain (g, BWG)	1927a±14.09	1953a±12.58	1387b±12.92	1727b±64.86	1784a±62.59	1740b±62.02	1772a±65.89
Feed conversion (g feed/ g gain, FC)	1.74b±0.01	1.64c±0.01	1.81a±0.01	1.75a±0.01	1.71b±0.01	1.75a±0.01	1.72b±0.02
	Digestion coefficients						
Crude protein (CP)%	90.93b±0.53	93.77a±0.93	85.67c±0.92	89.13b±0.86	91.12a±1.15	89.81±1.01	90.44±1.08
Crude fiber (CF)%	25.43a±0.55	25.15a±0.48	21.69b±0.87	23.35±0.60	24.42±0.69	24.23±0.69	23.94±0.64
Ether extract (EE)%	91.25a±0.86	91.69a±0.75	83.93b±0.68	88.30±1.07	89.62±1.02	88.74±0.99	89.18±1.12
Nitrogen free extract (NFE)%	76.36a±0.98	77.57a±0.70	66.74b±0.58	72.63±1.26	74.48±1.35	73.29±1.31	73.82±1.34
Organic matter(OM)%	79.60a±0.82	81.08a±0.77	94.71b±1.05	77.36±0.85	79.90±0.98	78.23±0.91	79.02±1.01
Nitrogen balance(NB)%	91.76b±0.75	94.50a±0.91	85.79c±0.85	89.91±0.85	91.45±1.22	90.48±1.07	90.89±1.06
	Carcass characteristics						
Live body weight (g)	1963	1936	1464	1746	1829	1795	1780
Dressing %	68.93ab±0.56	69.79a±0.47	67.51b±0.43	68.57±0.41	68.92±0.49	68.78±0.26	68.71±0.58
Abdominal fat %	2.24±0.05	2.20±0.06	2.35±0.05	2.34a±0.04	2.18b±0.05	2.23±0.05	2.29±0.04
Breast %	23.49a±0.42	24.25a±0.44	21.20b±0.28	22.35b±0.35	23.61a±0.46	23.07±0.24	22.89±0.46
	Economic efficiency						
Economic Efficiency (EEF)1	0.811	0.939	0.656	0.793	0.811	0.877	0.727
Relative economic efficiency2	100	116	81	100	102	100	83

[a, b, c] means in each treat within the same row with different superscripts are significantly different ($P < 0.01$).

1-Net revenue per unit total costs. 2-Assuming that the relative EEF of the control group equal 100.

Table (7): Plasma minerals, tibia ash and minerals and minerals retention of broiler chicks as affected by different dietary treatments (Exp.I).

Items	Treatments						
	Enzyme supplementation			Dietary amino acids		Dietary protein sources	
	Control	Low-nPP + phytase	Low-nPP +Without phytase	Total amino acids (TAA)	Digestible amino acids (DAA)	Corn/ soybean meal	Corn/ sunflower meal
Plasma minerals							
P (mg/100 ml)	15.26[a]±0.16	14.12b±0.16	11.75c±0.28	13.65b±0.41	14.26a±0.32	13.49b±0.39	13.92a±0.38
Ca (mg/100 ml)	11.68[c]±0.12	12.32b±0.06	14.64a±0.11	12.65b±0.30	13.11a±0.32	12.73b±0.32	13.03a±0.32
Zn (µg/100 ml)	223.0[b]±10.6	211.0c±2.09	261.0a±4.09	224.2±7.59	239.1±6.89	226.7±7.37	236.7±7.37
Mg (mg/100 ml)	2.19[c]±0.02	2.34b±0.02	2.74a±0.03	2.39b±0.05	2.46a±0.06	2.37b±0.06	2.48a±0.06
Tibia ash and minerals							
Tibia weight (g)	8.71a±0.06	8.95a±0.05	7.35b±0.24	8.14b±0.24	8.45a±0.15	8.30±0.20	8.38±0.20
Tibia ash %	43.68a±0.51	43.79a±0.60	40.00b±0.77	41.76±0.72	43.22±0.55	42.35±0.68	42.62±0.65
P %	18.54b±0.10	19.23a±0.17	18.07c±0.09	18.46b±0.10	18.77a±0.18	18.51±0.14	18.72±0.15
Ca%	38.82±0.73	39.97±.0.65	38.24±0.84	38.84±0.63	39.18±0.61	38.86±0.40	39.16±0.78
Zn ppm	354.26ab±4.	367.59a±5.7	342.98b±6.2	352.05±4.37	357.84±5.72	352.78±4.45	357.11±5.69
Mg%	0.809±0.01	0.812±0.01	0.797±0.01	0.803±0.01	0.809±0.01	0.800±0.01	0.812±0.01
Minerals retention							
P %	58.26a±0.51	59.40a±0.60	50.74b±0.27	55.87±1.01	56.39±0.99	55.85±0.96	56.41±1.04
Ca%	48.28b±0.57	50.74a±0.70	40.83c±0.50	46.18±1.11	47.06±1.13	46.42±1.07	46.82±1.17
Zn %	29.66a±0.41	30.65a±0.52	22.02b±0.43	27.07±1.02	27.83±0.97	27.17±0.98	27.72±1.02
Mg%	29.58b±0.22	30.69a±0.33	22.23c±0.33	27.23±0.93	27.77±0.94	27.19±0.89	27.82±0.97

[a, b] means within the same row with different superscripts are significantly different ($P < 0.01$).

Table (8): Growth performance, digestion coefficients, carcass characteristics and economical efficiency of broiler chicks as affected by different dietary treatments (Exp. II).

Items	Treatments					
	Enzyme supplementation		Dietary amino acids		Dietary protein sources	
	Control	Low-nPP + phytase	Adequate in amino acids	Deficient in amino acids	Corn/ soybean meal	Corn/ sunflower meal
	Growth performance					
Form 1-6 week old						
Body weight gain (g, BWG)	1559b±151.4	1598a±153.9	1915a±11.82	1242b±161.3	1831a±21.8	1326b±186.1
Feed conversion (g feed/ g gain, FC)	1.89±0.07	1.84±0.07	1.72b±0.01	2.02a±0.06	1.78b±0.01	1.96a±0.08
	Digestion coefficients					
Crude protein(CP)%	87.72b±0.82	89.96a±0.91	90.87a±0.69	86.82b±0.72	89.44±0.75	88.24±1.05
Crude fiber (CF)%	22.59±0.80	23.75±0.61	24.52a±0.43	21.82b±0.75	23.03±0.79	23.32±0.66
Ether extract (EE)%	88.15±1.09	89.65±0.81	91.05a±0.69	86.74b±0.79	89.42±0.88	88.37±1.06
Nitrogen free extract (NFE)%	71.14±1.86	73.39±1.44	75.95a±0.71	68.58b±1.68	74.14a±0.69	70.39b±2.05
Organic matter (OM)%	75.09±1.46	77.31±0.89	79.04a±0.67	73.37b±1.12	77.16±0.89	75.25±1.48
Nitrogen balance (NB)%	87.94b±1.18	90.88a±1.03	91.78a±0.77	87.05b±1.11	90.07±1.05	88.75±1.29
	Carcass characteristics					
Live body weight(g)	1624	1568	1938	1273	1890	1321
Dressing %	67.67±0.63	67.85±0.76	69.52a±0.28	65.99b±0.57	68.13±0.48	67.38±0.85
Abdominal fat %	2.58±0.13	2.57±0.20	2.31b±0.05	2.84a±0.21	2.29b±0.08	2.85a±0.19
Breast %	21.65±0.55	21.46±0.90	23.34a±0.17	19.77b±0.72	22.62a±0.33	20.49b±0.90
	Economic efficiency					
Economic efficiency (EEF)1	0.612	0.741	0.834	0.518	0.906	0.446
Relative economic efficiency2	100	121	100	62	100	49

a, b means within the same row with different superscripts are significantly different ($P < 0.01$).
1-Net revenue per unit total costs.
2-Assuming that the relative EEF of the control group equal 100.

Table (9): Plasma minerals, tibia ash and minerals and minerals retention of broiler chicks as affected by different dietary treatments (Exp.II).

Items	Treatments					
	Enzyme supplementation		Dietary amino acids		Dietary protein sources	
	Control	Low-nPP + phytase	Adequate in amino acids	Deficient in amino acids	Corn/ soybean meal	Corn/ sunflower meal
Plasma minerals						
P (mg/100 ml)	14.72a±0.10	13.70b±0.17	14.28±0.19	14.14±0.22	14.06±0.22	14.36±0.17
Ca (mg/100 ml)	11.23b±0.09	12.27a±0.16	11.81±0.15	11.69±0.24	11.60±0.20	11.90±0.20
Zn (µg/100 ml)	200±9.33	212±3.16	209±8.22	203±5.85	200±6.89	212±7.06
Mg (mg/100 ml)	2.17±0.02	2.21±0.02	2.25a±0.01	2.13b±0.02	2.14b±0.02	2.24a±0.02
Tibia ash and minerals						
Tibia weight (g)	7.92b±0.37	8.10a±0.37	8.84a±0.03	7.18b±0.39	8.63a±0.08	7.38b±0.45
Tibia ash %	41.62±0.26	41.50±0.72	42.97a±0.65	39.94b±0.52	41.75±0.62	41.16±0.84
P %	18.31±0.08	18.57±0.17	18.69a±0.10	18.20b±0.14	18.38±0.10	18.50±0.17
Ca%	38.31±0.73	38.89±0.78	39.18±0.82	38.02±0.65	38.61±0.64	38.60±0.86
Zn ppm	348.44±5.54	353.63±7.13	357.44±5.05	344.62±7.06	351.81±4.23	350.25±8.05
Mg%	0.799±0.01	0.802±0.01	0.807±0.01	0.794±0.01	0.800±0.01	0.801±0.01
Mineral retention						
P %	57.65±0.53	58.16±0.64	58.57±0.62	57.24±0.48	57.95±0.50	57.86±0.67
Ca%	47.54±0.48	48.89±0.70	49.10±0.66	47.33±0.47	48.06±0.50	48.37±0.74
Zn %	28.78±0.53	29.49±0.62	29.83±0.55	28.44±0.54	28.99±0.62	29.28±0.55
Mg%	28.83±0.28	29.44±0.38	29.85a±0.31	28.42b±0.24	28.97±0.26	29.30±0.42

[a, b] means within the same row with different superscripts are significantly different ($P < 0.01$).

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الملخص العربي

تأثير انزيم الفيتيز على أداء بدارى التسمين التى تتغذى على علائق منخفضة فى مستوى الفوسفور وتحتوى على ذرة وكسب فول الصويا او كسب عباد الشمس على اساس الاحماض الامينية المهضومة او الناقصة عن الاحتياجات

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اجريت تجربتين لدراسة تأثير استخدام انزيم الفيتيز الميكروبى فى علائق منخفضة فى محتوى الفوسفور غير العضوى (لايحتوى على فيتات) ، وقد اجريت التجربة الاولى لدراسة استخدام مصدرين من البروتين النباتى (كسب فول الصويا أوكسب عباد الشمس) مع مستوين من انزيم الفيتيز الميكروبى (0 and 750 FTU/kg) فى وجود مستوى كالسيوم وفوسفور مناسب للاحتياجات وآخر مستوى ناقص فى الاحتياجات على اساس الاحماض الامينية الكلية والمهضومة. وقد استخدم ٣٦٠ كتكوت من سلالة اربو ايكرز عمر يوم غير مجنس وتم توزيعها عشوائياً على ١٢ معاملة متساوية فى العدد (٣٠ كتكوت لكل معاملة فى ثلاث مكررات متساوية).

واستخدم فى التجربة الثانية ٢٤٠ كتكوت من سلالة اربو ايكرز عمر يوم غير مجنس وزعت عشوائياً الى ٨ معاملات متساوية فى العدد (٣٠ كتكوت لكل معاملة فى ثلاث مكررات متساوية). واستخدم تصميم عاملى ٢ × ٢ × ٢ عبارة عن مصدرين بروتين نباتى (كسب فول صويا أوكسب عباد الشمس) ، مستويين من انزيم الفيتيز الميكروبى (0 and 750 ftu/kg) على اساس الاحماض الامينية مناسبة طبقاً للاحتياجات وآخر ناقص فى الاحتياجات.

<u>سجلت النتائج ما يلى :</u>

(١) التجربة الأولى :

أدت التغذية على علائق منخفضة فى محتوى الفوسفور غير العضوى الى تأثير سلبى معنوي علـى معدلات النمو ومستوى فوسفور بلازما الدم ووزن العظم ومحتوى العناصر المعدنية المحتجزة ، بالمقارنة بالعلائق المقارنة ، وكان لاضافة انزيم الفيتيز فى تلك العلائق تحسين معدلات النمو ومعاملات هضم العناصر الغذائية والكفاءة الاقتصادية وزاد مستوى فوسفور البلازما ووزن العظم ومحتوى احتجاز العناصر المعدنية ونقص مستوى البلازما من الكالسيوم والزنك والمغنسيوم .

وكان أفضل اداء لبدارى التسمين ومعدلات نموها فى حالة التغذية بعلائق على اساس الاحماض الامينية المهضومة او المحتوى ذرة مع كسب عباد الشمس.

(٢) التجربة الثانية :

ادت التغذية على علائق ناقصة الاحتياجات فى الاحماض الامينية من الاحتياجات الى اقل معدلات نمو وأداء لبدارى التسمين ، واضافة انزيم الفيتز الى علائق منخفضة فى محتوى الفوسفور غير العضوى ادى الى تحسين معدلات الاداء والكفاءة الاقتصادية ومعامل هضم البروتين وميزان الازوت . وكان لاضافة انزيم الفيتيز فى علائق منخفضة فى محتوى الفوسفور غير العضوى مع اضافة ميثونين وليسين تأثير ايجابى على معدلات النمو والاداء.

وقد وجد ان تغذية بدارى التسمين عل علائق اساسها المستوى المناسب من الاحماض الامينية او ذرة مع كسب فول صويا كان لها تأثير ايجابى على معدلات الاداء والكفاءة الاقتصادية ونقص نسبة دهن البطن.