# PHYSIOLOGICAL AND IMMUNOLOGICAL STUDIES ON BROILERS FED DIETS SUPPLEMENTED WITH DIFFERENT LEVELS OF MICROBIAL PHYTASE ENZYME

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***Abstract***

The present experiment was conducted to evaluate the effect of adding different levels of microbial phytase and available phosphorus on some physiological and immunological parameters of broiler chicks. A total of 270 one-day-old chicks was divided into nine treatments of 30 birds each, which subsequently were subdivided into 3 replicates, 10 birds each. The nine treatments were 1- 0.45 AvP%+ 0 FU (control group), 2-0.45 AvP%+ 500 FU, 3- 0.45 AvP% + 750 FU, 4- 0.30 AvP%+ 0 FU, 5- 0.30 AvP%+ 500 FU, 6- 0.30 AvP% + 750 FU, 7- 0.15 AvP% + 0 FU, 8- 0.15 AvP%+ 500 FU, 9- 0.15 AvP%+ 750 FU. The experiment was run rfor 6 weeks. Body weight, feed consumption and feed conversion were recorded weekly. At the end of experiment (6 weeks), three birds were randomly taken from each treatment and slaughtered. Plasma calcium, phosphorus, cholesterol, total lipids, total protein, acid, alkaline phosphates and some blood constituents (hematocrit %, hemoglobin %, Red blood cells, ($10^6 m^3$), M.C.H. ($10^{-15}$L), M.C.V. ($10^{-12}$g) and M.C.H.C. % were measured at 6 weeks of age. The main results can be summarized as follows:

- The higher level of microbial phytase gave significantly the best live body weight and weight gain at 2 and 6 weeks of age in the group fed 750 FU phytase level, no significant difference between the two phytase levels (500-750 FU) was detected at 4 weeks of age.
- The low P diet (0.15%) significantly decreased feed consumption of broilers at 2, 4 & 6 weeks of age, while, the groups fed 500 & 750 FU phytase levels showed high feed consumption and better feed conversion compared with the control group at 0-6 weeks of age.
- The birds fed low P (0.15%) and high phytase (750 FU) diet has significant higher relative weight of thymus, however thyroid gland, spleen and bursa relative weights were not affected.
- The shank relative weight and tibia length were higher in the group fed (0 FU) phytase and high P diet (0.45 %) compared with other groups fed high phytase and low P diet, while, no significant differences in tibia weight and dry tibia weight were observed in all groups.
- At 6 weeks of age, the plasma calcium, total protein, alkaline phosphatase in the group fed 500 FU phytase were

significantly higher than the control group (0 FU) phytase. The groups using 750 FU phytase gave significan higher phosphorus and lower total lipids , in plasma cholesterol it was significantly lower, in plasma acid phosphates, it was significantly higher in control group (0 FU phytase) than the phytase treated groups.

- Some blood constituents (immunity traits) were significantly ($p<0.05$) affected by Phytase treatment, for example, hematocrit %, hemoglobin %, and M.C.V. ($10^{-12}$g) were significantly higher with high level of 750 FU in broiler chicks fed different levels of available phosphorus compared with 500 and 0 FU of Phytase at 6 weeks of age.
- The addition of phytase in diets significantly improved the physiological, immunolgical and productive performance in broiler chicks.

## INTRODUCTION

It is well known that plant foodstuffs, especially cereals, legumes and oilseed meals, are considered the most little cost ingredients of poultry diets (Chung, 2002). About two-thirds of the phosphorus of plant origin is present as phytic acid in the form of myoinositol phosphates (Sebastian *et al*, 1997). Phosphorus in the phytic acid form (phytate-p) is poorly available to most monogastric animals such as poultry and pigs, because of the lack of endogenous phytase (the enzyme that hydrolyzes phytic acid into inositol and orthophosphate) (Medany and Afifi, 2002).

The addition of phytase to diets to release phosphorus from its phytic acid forms was reported to improve dietary phosphorus and minerals utilization (Lan *et al*, 2002, Lim *et al*, 2003). Phytase is one of the alternatives that help to reduce phosphorus excretion by poultry by at least 30-40% in order to fully explore the potential of phytase (Chung, 2002). It is of paramount importance to identify factors that potentially influence its responses in practical diets (Yan *et al.*, 2001).

This experiment was done to study the effect of adding different levels of microbial phytase and available phosphorus to broiler rations on some physiological and immunological parameters enhancing its utilization aiming to reduce phosphorus excretion which causes subsequent pollution problems.

## MATERIALS AND METHODS

### Experimental design

A total of 270 one-day-old unsexed Ross broiler chicks was housed in the Poultry Physiology Laboratory, Faculty of Agriculture, Ain Shams University, to study the effect of three different phytase levels on reducing excreta phosphorus. Three

different levels of available phosphorus {0.45-0.30-0.15}, combined with three levels of microbial phytase {0-500-750 FU} were allotted to constitute a 2*2 factorial experiment.

Microbial phytase (phy) was supplemented to the three basal diets containing the recommended requirements of NRC (1994),except that of available phosphorus (Av.P) as listed in Table 1.

Birds were randomly assigned to nine treatment groups of 30 birds each, which subsequently were subdivided into 3 replicates, 10 birds each.

The first group was fed on a diet containing (0.45 AvP% & 0 FU), the 2nd group (0.45 AvP%-500 FU), the 3rd group (0.45 AvP%-750 FU), the 4th group (0.30 AvP%-0 FU), the 5th group (0.30 AvP%-500 FU), the 6th group (0.30 AvP%-750 FU), the 7th group (0.15 AvP%-0 FU), the 8th group (0.15 AvP%-500 FU), the 9th group (0.15 AvP%-750 FU).

All birds were reared under similar environmental, managerial and hygienic conditions. Feed and water were provided *ad libitum.* Vaccination programs were applied according to the scheme of vaccination used in the laboratory.

## Measurements and observations

Body weight and feed consumption were recorded weekly.

Three birds from each treatment were randomly chosen and slaughtered at 6 weeks of age and blood samples were withdrawn into heparinzed tubes, centrifuged (4000 rpm) for 15 min, and then, stored at -20 °C till biochemical assay. Plasma calcium (Ca), phosphorus (P), cholesterol, total lipids, total protein, acid phosphates and alkaline phosphates, were determined by commercial kits at Animal Production Research Institute, Ministry of Agriculture, Cairo.

Hematocrit volume was estimated by using the microhematocrit method according to Bauer (1970). Blood samples were packed in heparinzed capillary tubes sealed at one end and the tubes were centrifuged in a microhematocrit centrifuge at 12000 rpm for 5 minutes and the packed cell volume was estimated on micro-capillary reader estimated. Hemoglobin (Hb) concentration was estimated in gm / 100 ml blood by using photoelectric Hemoglobinometer according to Singh (1983). The Red blood cells (RBCs) were counted (x $10^6$ $mm^3$) by hemocytometer using the method of Bauer (1970), M.C.V., M.C.H. and M.C.H.C were calculated according to Mangrum (1975).

Organs weight, shank length and tibia weight and length and ash percentage were recorded. Tibia breaking strength was measured in the Faculty of Engineering, Ain Shams University by using a universal testing machine (Tinuls Olsen Toting Machine Co).

**Statistical analysis**

Data were subjected to the two-way analysis of variance procedure using the general linear models (GLM) of SAS user's Guide (SAS, 1994).

The statistical model used in this study was as follows:

$Yijk= \mu+Ti+Pj+TP+eijk$

Where $\mu$ = Overall mean

Ti =Treatment effect of i phosphorus levels.

Pj = Treatment effect of j phytase levels.

T*P =Interaction between T, P.

Eijk =Error.

## RESULTS AND DISCUSSION

**Productive Performance**

**Live body weight (LBW) and weight gain (WG)**

Dietary phosphorus level and microbial phytase showed pronounced effects on live body weight gain during the whole experimental period (Table 2). It is clear from the results that, dietary available phosphorus level alone has a significant effect on LBW at 2,4 and 6 weeks of age. Of great interest in the present study is the results obtained for chicks that fed low phosphorus (0.15) diet. Birds of this group have the heaviest LBW compared with both the control (0.45) and the other treated group (0.30) at different ages.

Results show also, that the higher level of microbial phytase gave significantly the best LBW at 2 and 6 weeks of age, however, significant difference between the two phytase levels at 4 weeks of age. Concerning the effect of Av.P and FU levels on body weight gain (WG), the present results indicate that birds fed lower Av.P diet combined with higher PHY level, gained more than the other treatment groups at different ages. In general, the results are in close agreement with many other workers who reported that dietary PHY supplementation enhances both LBW and WG of broiler chicks (Medany and Afifi, 2002, Abdel-Latiff and Kamal, 2003, Dilger, *et al.*, 2004). It is important to notice that lower dietary Av.P + 750 FU PHY diet gave the best body weight which support the previous results indicating that microbial PHY

improved dietary phosphorus utilization and its addition can compensate for and or enhance phosphorus availability. It is suggested that, adding 750 FU of microbial PHY may be required for maximum growth of broiler chicks, especially with the low phosphorus diets.

**Feed consumption and conversion**

The effects of phytase supplementation on feed consumption and conversion are summarized in Table 3. Compared to the normal-p diet (0.45), the low-p diet significantly increased feed intake of broilers at 2,4 and 6 weeks of age. A similar trend was noticed for the phytase-supplemented groups. This increase coincident with the higher body weight gain observed in the present study, and may be attributed to the progressive needs for inorganic p in the formation of bones. Feed conversion, however, was better for birds fed high phytase diets. It appears that phytase may release the phytate-bound protein and improved nitrogen retention and amino acids utilization. It seems also, that phytase enhances the availability of Ca, P and other minerals for utilization in growth. These findings are in agreement with the studies of Rojas and Scott (1969) and Moroz *et al.* (1994) who reported that phytase digestibility of some minerals improved the productive performance in birds fed low phosphorus diets. Also, Broz *et al.* (1994) and Yi *et al.* (1994) observed that phytase enhances the availability of minerals in the digestive tract of birds.

**Physiological and immunological parameters**

**Relative organs weight and tibia bone characteristics**

Table 4 illustrates the effect of P and PHY levels on some important organs in broiler chicks at 6 weeks of age. It is clear that birds that fed low P and high PHY diets have no significant high relative weight of thymus, however, P and PHY levels did not affect thyroid gland, spleen and bursa relative weights. Moreover, liver weight (%) was higher ($p<0.05$) in birds fed the basal unsupplemented diets, followed by those fed higher PHY 750 FU diets. Also, the relative weight of liver was significantly greater in birds fed the 0.30 P diet irrespective of the phytase level. It is also important to notice that the relative weight of kidneys was significantly higher in birds fed the higher dietary P diets and in those fed the control and the higher PHY diets. That the thymus relative weight increased, may suggest the importance of PHY in improving cellular immunity of chicks. This was also indicative by the numerical increase observed in bursa and spleen relative weights. Thyroid relative weight was not affected due to its independent role in general body growth and nutrient

metabolism. Of great interest is the decreased kidney weight of birds fed the low phosphorus diet, although, those birds were the heaviest in bodyweight. It was observed from our laboratory results that the kidneys of birds fed higher levels of P have larger cortical layer and hypertrophy epithelial cells lining the collecting duct, when the kidney was examined histologically (unpublished data). The present results are in agreement with the findings of (Yi *et al.*1994) and (Dilger *et al.* 2004).

Table 5 illustrates the effect of different levels of phosphorus (p) and phytase (phy) on shank relative weight and tibia measurements. At 6 weeks of age, there is no significant difference in tibia relative weight and dry tibia relative weight in all groups, while shank relative weight and tibia length were higher in-group of birds fed (0 FU) phytase and high P diet (0.45%) compared with other treated groups. This did not agree with (Perney *et al.*1993) who reported that the percentage of tibia ash was significantly improved by the addition of dietary phytase.

**Plasma parameters**

Table 6 illustrates the effect of different levels of P and Phytase on some constituents plasma. At 6 weeks of age, it could be observed that plasma Calcium level in the group using 500 FU was significantly higher than the control group, whereas, the phytase treated group using 750 FU was significantly higher compared to the control group in plasma phosphorus. Plasma cholesterol level was significantly lower in control group than the phytase treated groups and in birds fed the lower phytase diet than the control ones. It seems that the low phytase level enhances the plasma level of cholesterol.

However, total lipids were considerably higher in the control than in the treated groups.

On the other hand, total protein was higher in the plasma of birds fed 500 FU and those fed low P diets.

Acid and alkaline phosphatase enzymes have been observed in the plasma of all groups.

**Blood immunity constituents**

Table 7 illustrates the effect of different levels of P and Phytase on blood immunity constituents. Broiler chicks fed different levels of available phosphorus and microbial phytase at 6 weeks of age insignificantly affected some blood immunity constituents, however, some blood immunity constituents were significantly higher ($p<0.05$) as affected by Phytase treatment, for example hematocrit %, hemoglobin

%, and M.C.V. ($10^{-12}$g) were significantly higher with the highest phytase level 750 FU in broiler chicks fed different levels of available phosphorus compared with 500 and 0 FU of Phytase at 6 weeks of age .

These results agree with Abdel-Latif and Kamal, (2003) and Lim *et al.* (2003). They found that the highest level 750 FU of Phytase increased the immunity of broiler and improved the egg quality of laying hens.

From these results, it could be concluded that phytase supplementation to poultry diet, whatever the P level enhanced the most blood immunity constituents and some blood parameters which reveals an improved productive traits.

Table 1. Composition and calculated analysis of the basal diets.

| Ingredients % | Phosphorus levels | | |
|---|---|---|---|
| | 0.45% | 0.30% | 0.15% |
| Yellow corn | 60.00 | 60.00 | 60.00 |
| Soybean meal (44%) | 24.35 | 24.35 | 24.35 |
| Glutin (60%) | 8.50 | 8.50 | 8.50 |
| Wheat bran | 0.00 | 1.20 | 2.46 |
| Molasses | 3.05 | 3.05 | 3.05 |
| Lime stone | 1.40 | 1.00 | 0.58 |
| Di-calcium phosphate | 1.750 | 0.950 | 0.110 |
| Lysine | 0.20 | 0.20 | 0.20 |
| DL-Methionine | 0.20 | 0.20 | 0.20 |
| Premix* | 0.30 | 0.30 | 0.30 |
| Salt | 0.25 | 0.25 | 0.25 |
| Anti fungi | 0.10 | 0.10 | 0.10 |
| Total | 100 | 100 | 100 |
| **Calculated analysis** | | | |
| Crude protein % | 21.102 | 21.288 | 21.477 |
| ME Keal/kg diet | 2940.022 | 2955.622 | 2972.002 |
| Calcium % | 0.90 | 0.60 | 0.30 |

* Premix is contains vitamin and minerals mixture 0.3 g/kg

Each 1.5 kg contains the following: vitamin A 12 miu, vitamin D3 2 miu, vitamin E 10g, vitamin K 2g, vitamin B1 1g, vitamin B2 4g, vitamin B2 1g, vitamin B2 4g, vitamin B6 20g, Nicotinic acid 20g, Folic acid 1.5g, vitamin B12 10g, Pantothenic acid 10g,, Choline 300, Copper 10 g , Iodine 1g , Maganese 30 g , Zinc 55 g , Slenium 0.1 g .

Table 2. Means (±SE) of live body weight (LBW) and body weight gain (WG) of broiler chicks fed different levels of phosphorus (P) and microbial phytase (Phy).

| Age (week) | P level | PHY | | | Overall |
|---|---|---|---|---|---|
| | | 0 (FU) | 500 (FU) | 750 (FU) | |
| LBW (g) | | | | | |
| One-day old chicks | 0.45 | 42.6±0.2 | 42.4±0.1 | 42.3±0.3 | 42.4±0.1 |
| | 0.30 | 42.9±0.4 | 42.7±0.3 | 42.9±0.5 | 42.8±0.6 |
| | 0.15 | 42.8±0.4 | 42.8±0.1 | 42.6±0.2 | 42.7±0.1 |
| | Overall | 42.8±0.1 | 42.6±0.1 | 42.6±0.2 | |
| 0 - 2 | 0.45 | 194.6±0.5$^{c}$ | 192.4±7.5$^{c}$ | 216.5±11.0$^{b}$ | 201.2±7.7$^{c}$ |
| | 0.30 | 215.5±4.2$^{b}$ | 228.6±2.3$^{b}$ | 256.4±1.1$^{a}$ | 233.5±12.1$^{b}$ |
| | 0.15 | 266.9±1.1$^{a}$ | 269.9±7.3$^{a}$ | 262.8±6.1$^{a}$ | 266.5±2.1$^{a}$ |
| | Overall | 225.7±21.5$^{b}$ | 230.3±22.4$^{b}$ | 245.2±14.5$^{a}$ | |
| 2 - 4 | 0.45 | 595.9±51.0$^{c}$ | 558.0±57.7$^{c}$ | 643.6±46.1$^{c}$ | 599.1±24.8$^{c}$ |
| | 0.30 | 600.2±42.7$^{b}$ | 715.5±31.5$^{b}$ | 819.3±28.7$^{b}$ | 711.7±63.3$^{b}$ |
| | 0.15 | 872.6±9.2$^{a}$ | 963.6±2.4$^{a}$ | 921.8±5.9$^{a}$ | 919.3±26.3$^{a}$ |
| | Overall | 689.6±91.5$^{b}$ | 745.7±118.1$^{b}$ | 794.9±81.2$^{a}$ | |
| 4 - 6 | 0.45 | 1111.0±60.6$^{c}$ | 1131.3±94.9$^{c}$ | 1376.4±83.7$^{c}$ | 1206.3±85.3$^{c}$ |
| | 0.30 | 1224.2±19.8$^{b}$ | 1412.4±66.0$^{b}$ | 1634.8±77.2$^{b}$ | 1423.8±118.7$^{b}$ |
| | 0.15 | 1708.3±37.5$^{a}$ | 1932.1±22.6$^{a}$ | 1843.7±32.8$^{a}$ | 1828.0±65.1$^{a}$ |
| | Overall | 1347.8±183.2$^{c}$ | 1419.1±22.6$^{b}$ | 1618.3±135.1$^{a}$ | |
| W G (g) | | | | | |
| 0 - 2 | 0.45 | 152.0±5.0$^{c}$ | 150.0±57.6$^{c}$ | 174.3±11.3$^{b}$ | 158.8±7.8$^{c}$ |
| | 0.30 | 172.6±4.2$^{b}$ | 195.9±2.5$^{b}$ | 213.5±1.6$^{a}$ | 194.0±11.8$^{b}$ |
| | 0.15 | 224.1±1.4$^{a}$ | 227.1±7.4$^{a}$ | 220.0±6.2$^{a}$ | 223.7±2.0$^{a}$ |
| | Overall | 182.9±21.4$^{b}$ | 191.0±22.8$^{ab}$ | 202.6±14.3$^{a}$ | |
| 2 - 4 | 0.45 | 401.2±50.3$^{b}$ | 365.1±50.9$^{c}$ | 427.1±35.8$^{c}$ | 397.8±18.0$^{c}$ |
| | 0.30 | 384.7±44.5$^{b}$ | 486.9±29.6$^{b}$ | 562.8±27.7$^{b}$ | 478.2±51.6$^{b}$ |
| | 0.15 | 605.7±8.9$^{a}$ | 693.7±5.8$^{a}$ | 659.2±1.9$^{a}$ | 652.9±25.6$^{a}$ |
| | Overall | 463.9±71.1$^{c}$ | 515.2±95.9$^{b}$ | 549.7±67.3$^{a}$ | |
| 4 - 6 | 0.45 | 515.3±52.1$^{c}$ | 573.9±37.2$^{c}$ | 732.9±58.2$^{c}$ | 607.3±65.0$^{c}$ |
| | 0.30 | 623.9±23.5$^{b}$ | 699.9±52.1$^{b}$ | 815.5±48.7$^{b}$ | 713.1±55.7$^{b}$ |
| | 0.15 | 835.7±32.7$^{a}$ | 968.±21.1$^{a}$ | 921.9±28.8a | 908.7±38.9$^{a}$ |
| | Overall | 658.3±94.1$^{c}$ | 747.4±116.4$^{b}$ | 823.4±54.7$^{a}$ | |
| 0 - 6 | 0.45 | 1068.5±60.8$^{c}$ | 1089.9±95.0$^{c}$ | 1334.1±93.8$^{c}$ | 1164.2±85.2$^{c}$ |
| | 0.30 | 1181.3±19.5$^{b}$ | 1369.7±65.9$^{b}$ | 1591.9±77.7$^{b}$ | 1381.0±118.7$^{b}$ |
| | 0.15 | 1655.5±37.7$^{a}$ | 1889.3±22.7$^{a}$ | 1801.1±33.0$^{a}$ | 1785.3±65.1$^{a}$ |
| | Overall | 1305.1±183.1$^{c}$ | 1449.6±234.2$^{b}$ | 1575.7±135.0$^{a}$ | |

a.,b,c, means within treatments with different superscripts are significantly different (P<0.05)

Table 3. Means (±SE) of feed consumption and feed conversion of broiler chicks fed different levels of phosphorus (P) and microbial phytase (Phy).

| Age (week) | P level | PHY | | | Overall |
|---|---|---|---|---|---|
| | | 0 (FU) | 500 (FU) | 750 (FU) | |
| Feed consumption (g) | | | | | |
| 0 - 2 | 0.45 | 138.0±5.08$^{c}$ | 139.97±4.56$^{b}$ | 150.10±17.6$^{b}$ | 142.69±30.75$^{c}$ |
| | 0.30 | 155.03±7.19$^{b}$ | 171.83±4.26$^{b}$ | 194.97±3.66$^{b}$ | 173.94±11.58$^{b}$ |
| | 0.15 | 225.60±12.48$^{a}$ | 322.40±12.30$^{a}$ | 308.37±7.56$^{a}$ | 285.46±30.20$^{a}$ |
| | Overall | 172.88±26.82$^{b}$ | 211.40±56.26$^{a}$ | 217.81±47.09$^{a}$ | |
| 2 - 4 | 0.45 | 403.93±44.40$^{b}$ | 315.70±37.56$^{c}$ | 515.20±76.69$^{c}$ | 411.61±57.72$^{c}$ |
| | 0.30 | 385.93±8.31$^{c}$ | 547.97±64.10$^{b}$ | 633.73±28.71$^{b}$ | 522.54±72.65$^{b}$ |
| | 0.15 | 716.87±38.01$^{a}$ | 824.70±18.75$^{a}$ | 783.43±24.40$^{a}$ | 775.0±31.41$^{a}$ |
| | Overall | 502.24±107.44$^{c}$ | 562.79±147.12$^{b}$ | 664.12±77.61$^{a}$ | |
| 4 - 6 | 0.45 | 775.90±51.59$^{c}$ | 855.50±7.97$^{b}$ | 846.23±17.3$^{c}$ | 825.88±25.13$^{b}$ |
| | 0.30 | 845.27±8.06$^{b}$ | 829.93±6.24$^{c}$ | 949.83±49.67$^{b}$ | 875.01±37.67$^{b}$ |
| | 0.15 | 1004.20±15.67$^{a}$ | 1061.03±30.01$^{a}$ | 1023.53±44.99$^{a}$ | 1029.59±16.68$^{a}$ |
| | Overall | 875.12±67.57$^{b}$ | 915.49±73.14$^{a}$ | 939.87±51.42$^{a}$ | |
| 0 - 6 | 0.45 | 2301.57±61.34$^{c}$ | 2361.57±102.62$^{c}$ | 2693.87±126.75$^{c}$ | 2452.34±122.0$^{c}$ |
| | 0.30 | 2479.03±47.95$^{b}$ | 2836.73±69.90$^{b}$ | 3196.20±143.05$^{b}$ | 2837.32±207.03$^{b}$ |
| | 0.15 | 3426.50±86.78$^{a}$ | 2845.17±21.41$^{a}$ | 3735.33±32.83$^{a}$ | 3669.0±125.33$^{a}$ |
| | Overall | 2735.70±349.18$^{c}$ | 3014.49±437.40$^{b}$ | 32.08.47±300.71$^{a}$ | |
| Feed conversion | | | | | |
| 0 - 2 | 0.45 | 1.45±0.02$^{b}$ | 1.50±0.04$^{b}$ | 1.35±0.14$^{b}$ | 1.43±0.04$^{b}$ |
| | 0.30 | 1.48±0.02$^{a}$ | 1.41±0.01$^{b}$ | 1.40±0.01$^{b}$ | 1.43±0.03$^{b}$ |
| | 0.15 | 1.46±0.05$^{b}$ | 2.02±0.05$^{a}$ | 2.07±0.01$^{a}$ | 1.85±0.20$^{a}$ |
| | Overall | 1.46±0.01$^{b}$ | 1.64±0.19$^{a}$ | 1.61±0.23$^{a}$ | |
| 2 - 4 | 0.45 | 1.90±0.23 | 1.69±0.02 | 2.15±0.25 | 1.91±0.13$^{b}$ |
| | 0.30 | 2.02±0.20 | 2.08±0.22 | 2.06±0.12 | 2.05±0.02$^{a}$ |
| | 0.15 | 2.07±0.09 | 2.09±0.04 | 2.08±0.09 | 2.08±0.01$^{a}$ |
| | Overall | 2.0±0.05$^{b}$ | 1.95±0.13$^{c}$ | 2.10±0.03$^{a}$ | |
| 4 - 6 | 0.45 | 3.18±0.53 | 3.80±0.49 | 2.54±0.28 | 3.17±0.36$^{a}$ |
| | 0.30 | 3.08±0.33 | 4.01±1.44 | 2.45±0.23 | 3.18±0.45$^{a}$ |
| | 0.15 | 2.86±0.25 | 2.43±0.19 | 2.52±0.11 | 2.60±0.13$^{b}$ |
| | Overall | 3.04±0.09$^{b}$ | 3.41±0.50$^{a}$ | 2.50±0.03$^{c}$ | |
| 0 - 6 | 0.45 | 2.16±0.07 | 2.19±0.11 | 2.02±0.03 | 2.12±0.05$^{a}$ |
| | 0.30 | 2.10±0.02 | 2.08±0.09 | 2.01±0.02 | 2.06±0.03$^{b}$ |
| | 0.15 | 2.06±0.01 | 2.04±0.03 | 2.07±0.02 | 2.06±0.01$^{b}$ |
| | Overall | 2.11±0.03$^{a}$ | 2.10±0.04$^{a}$ | 2.03±0.02$^{b}$ | |

a.,b,c, means within treatments with different superscripts are significantly different ($P<0.05$)

Table 4. Means (±SE) of relative organs weight of broiler chicks fed different levels of available phosphorus (p) and microbial phytase (phy) at 6 weeks of age.

| Age (week) | P level | PHY | | | Overall |
|---|---|---|---|---|---|
| | | 0 (FU) | 500 (FU) | 750 (FU) | |
| Thymus | 0.45 | 0.43±0.04 | 0.50±0.08 | 0.49±0.06 | 0.47±0.02$^{b}$ |
| | 0.30 | 0.51±0.03 | 0.42±0.01 | 0.51±0.07 | 0.48±0.03$^{b}$ |
| | 0.15 | 0.51±0.01$^{b}$ | 0.51±0.11$^{b}$ | 0.63±0.04$^{a}$ | 0.55±0.04$^{a}$ |
| | Overall | 0.48±0.03$^{b}$ | 0.48±0.03$^{b}$ | 0.54±0.04$^{a}$ | |
| Thyroid | 0.45 | 0.02±0.003$^{a}$ | 0.01±0.003 | 0.01±0.002 | 0.01±0.003 |
| | 0.30 | 0.01±0.001$^{b}$ | 0.01±0.001 | 0.01±0.01 | 0.01±0.001 |
| | 0.15 | 0.01±0.01$^{b}$ | 0.01±0.001 | 0.01±0.003 | 0.01±0.001 |
| | Overall | 0.013±0.002 | 0.01±0.001 | 0.01±0.001 | |
| Spleen | 0.45 | 0.10±0.01 | 0.12±0.02 | 0.12±0.01 | 0.11±0.01 |
| | 0.30 | 0.13±0.01 | 0.10±0.01 | 0.10±0.004 | 0.11±0.01 |
| | 0.15 | 0.12±0.01 | 0.09±0.02 | 0.11±0.02 | 0.11±0.01 |
| | Overall | 0.12±0.01 | 0.10±0.01 | 0.11±0.004 | |
| Liver | 0.45 | 2.34±0.04 | 2.39±0.10 | 2.17±0.07 | 2.30±0.07 |
| | 0.30 | 2.70±0.15 | 2.25±0.21 | 2.78±0.18 | 2.58±0.17 |
| | 0.15 | 2.55±0.24 | 2.35±0.34 | 2.34±0.26 | 2.41±0.07 |
| | Overall | 2.53±0.11$^{a}$ | 2.33±0.04$^{c}$ | 2.43±0.18$^{b}$ | |
| Kidney | 0.45 | 0.77±0.15$^{a}$ | 0.67±0.14$^{b}$ | 0.75±0.01$^{a}$ | 0.73±0.03$^{a}$ |
| | 0.30 | 0.70±0.06$^{b}$ | 0.70±0.05$^{b}$ | 0.84±0.07$^{a}$ | 0.75±0.05$^{a}$ |
| | 0.15 | 0.65±0.12$^{b}$ | 0.52±0.07$^{b}$ | 0.52±0.01$^{b}$ | 0.56±0.04$^{b}$ |
| | Overall | 0.71±0.04$^{a}$ | 0.63±0.06$^{b}$ | 0.70±0.10$^{a}$ | |
| Bursa | 0.45 | 0.18±0.02 | 0.18±0.04 | 0.15±0.01 | 0.17±0.01 |
| | 0.30 | 0.14±0.01 | 0.15±0.05 | 0.17±0.01 | 0.16±0.01 |
| | 0.15 | 0.22±0.02 | 0.18±0.01 | 0.15±0.03 | 0.19±0.02 |
| | Overall | 0.18±0.02 | 0.17±0.01 | 0.16±0.01 | |

a,b,c.... means within treatments with different superscripts are significantly different ($p<.05$).

Table 5. Means (± SE) of shank relative weight and tibia measurements of broiler chicks fed different levels of phosphorus (p) and phytase (phy) at 6 weeks of age.

| Organs | P level | PHY | | | Overall |
|---|---|---|---|---|---|
| | | 0(FU) | 500(FU) | 750(FU) | |
| Shank weight (g) | 0.45 | 0.6±0.02$^{a}$ | 0.5±0.004$^{bc}$ | 0.5±0.03$^{c}$ | 0.5±0.04 |
| | 0.30 | 0.5±0.02$^{ab}$ | 0.5±0.04$^{bc}$ | 0.5±0.01$^{bc}$ | 0.5±0.02 |
| | 0.15 | 0.5±0.01$^{bc}$ | 0.5±0.03$^{bc}$ | 0.4±0.01$^{c}$ | 0.5±0.01 |
| Overall | | 0.5±0.03 | 0.5±0.01 | 0.5±0.01 | |
| Tibia length (cm) | 0.45 | 0.7±0.01$^{a}$ | 0.6±0.01$^{b}$ | 0.6±.03$^{b}$ | 0.6±0.10 |
| | 0.30 | 0.7±0.05$^{a}$ | 0.6±0.04$^{b}$ | 0.6±0.001$^{c}$ | 0.6±0.03 |
| | 0.15 | 0.6±0.01$^{b}$ | 0.6±0.03$^{b}$ | 0.6±0.01$^{a}$ | 0.6±0.003 |
| Overall | | 0.7±0.05$^{a}$ | 0.6±0.01$^{b}$ | 0.6±0.01$^{b}$ | |
| Tibia weight (g) | 0.45 | 0.9±0.05 | 0.9±0.05 | 0.9±0.1 | 0.9±0.01 |
| | 0.30 | 0.9±0.1 | 0.9±0.1 | 0.9±0.03 | 0.9±0.02 |
| | 0.15 | 0.9±0.1 | 0.9±0.1 | 0.9±0.05 | 0.9±0.02 |
| Overall | | 0.9±0.01 | 0.9±0.03 | 0.9±0.001 | |
| Dry tibia weight (g) | 0.45 | 0.4±0.1 | 0.4±0.02 | 0.4±0.04 | 0.4±0.01 |
| | 0.30 | 0.4±0.02 | 0.4±0.01 | 0.4±0.1 | 0.4±0.02 |
| | 0.15 | 0.3±0.05 | 0.4±0.03 | 0.4±0.04 | 0.4±0.02 |
| Overall | | 0.4±0.03 | 0.4±0.03 | 0.4±0.01 | |

a.b, c...means within treatments with different superscripts are significantly different ($p<0.05$).

Table 6. Means (±SE) of some blood plasma constituents concentration of chicks fed different levels of phosphorus (P) and microbial phytase (Phy) at 6 weeks of age.

| Parameters | P level | PHY | | | Overall |
|---|---|---|---|---|---|
| | | 0 (FU) | 500 (FU) | 750 (FU) | |
| Calcium (mg/dl) | 0.45 | 8.6±2.2 | 12.8±3.4 | 12.4±1.6 | 11.3±1.3$^{a}$ |
| | 0.30 | 10.2±3.1 | 9.9±2.6 | 10.2±3.3 | 10.1±0.1$^{a}$ |
| | 0.15 | 10.6±2.4 | 9.4±3.7 | 6.3±3.0 | 8.7±1.3$^{b}$ |
| | Overall | 9.8±0.6$^{b}$ | 10.7±1.1$^{a}$ | 9.6±1.8$^{b}$ | |
| Phosphorus (mg/dl) | 0.45 | 9.5±1.5 | 17.6±4.4 | 16.2±4.6 | 14.4±2.5$^{b}$ |
| | 0.30 | 17.1±3.1 | 10.7±1.0 | 11.3±1.7 | 13.0±2.1$^{b}$ |
| | 0.15 | 15.8±2.8 | 13.4±4.5 | 20.8±1.6 | 16.7±2.2$^{a}$ |
| | Overall | 14.1±2.3$^{b}$ | 13.9±2.0$^{b}$ | 16.1±2.8$^{a}$ | |
| Cholesterol (mg/dl) | 0.45 | 124.8±6.2 | 144.8±16.3 | 151.2±26.4 | 140.3±7.9$^{a}$ |
| | 0.30 | 59.8±13.3 | 89.6±4.1 | 144.5±36.7 | 98.0±24.8$^{b}$ |
| | 0.15 | 102.0±43.9 | 100.9±29.7 | 77.1±21.5 | 93.4±8.1$^{b}$ |
| | Overall | 95.5±19.1$^{c}$ | 111.8±16.8$^{b}$ | 124.3±23.6$^{a}$ | |
| Total lipids (g/dl) | 0.45 | 0.85±0.1 | 0.6±0.1 | 0.5±0.1 | 0.6±0.1$^{b}$ |
| | 0.30 | 1.4±0.6 | 0.6±0.1 | 0.6±0.2 | 0.9±0.3$^{a}$ |
| | 0.15 | 0.9±0.1 | 0.6±0.1 | 0.8±0.2 | 0.8±0.1$^{a}$ |
| | Overall | 1.0±0.20$^{a}$ | 0.6±0.02$^{b}$ | 0.7±0.1$^{b}$ | |
| Total protein (g/dl) | 0.45 | 3.7±0.1 | 4.4±0.5 | 3.4±0.3 | 3.8±0.3$^{a}$ |
| | 0.30 | 3.2±0.3 | 3.7±0.3 | 3.7±0.2 | 3.5±0.2$^{b}$ |
| | 0.15 | 3.7±0.1 | 4.0±0.6 | 4.0±0.5 | 3.9±0.1$^{a}$ |
| | Overall | 3.6±0.2$^{b}$ | 4.0±0.2$^{a}$ | 3.7±0.2$^{b}$ | |
| Acid phosphates (U/L) | 0.45 | 10.1±0.4 | 8.6±2.5 | 6.2±2.6 | 8.3±1.2$^{b}$ |
| | 0.30 | 5.9±4.5 | 7.6±1.6 | 5.8±1.3 | 6.4±0.6$^{c}$ |
| | 0.15 | 10.2±3.6 | 8.5±1.0 | 8.3±4.2 | 9.0±0.6$^{a}$ |
| | Overall | 8.6±1.4$^{a}$ | 8.2±0.3$^{b}$ | 6.8±0.8$^{c}$ | |
| Alkaline phosphates (U/L) | 0.45 | 1025.3±164$^{c}$ | 1171.7±231.9$^{b}$ | 1112.3±151.6$^{a}$ | 1103.1±42.5$^{a}$ |
| | 0.30 | 1168.0±252.4$^{b}$ | 1204.7±149.6$^{a}$ | 809.3±243.1$^{b}$ | 1060.7±126.1$^{b}$ |
| | 0.15 | 1250.7±176.6$^{a}$ | 1190.3±133.6$^{a}$ | 1087.7±175.7$^{b}$ | 1176.2±47.6$^{a}$ |
| | Overall | 1148±0.6$^{a}$ | 1188.9±9.6$^{a}$ | 1003.1±97.2$^{b}$ | |

a.,,b., c.., means within treatments with different superscripts are significantly different ($P<0.05$)

Table 7. Means (±SE) of some blood immunity constituents of chicks fed different levels of phosphorus (P) and microbial phytase (Phy) at 6 weeks of age.

| Parameters | P level | PHY | | | Overall |
|---|---|---|---|---|---|
| | | 0 (FU) | 500 (FU) | 750 (FU) | |
| Hematocrit % | 0.45 | 31.0±1.5$^{b}$ | 32.7±1.5$^{a}$ | 34.8±1.6$^{a}$ | 32.8±1.6$^{b}$ |
| | 0.30 | 32.5±1.8$^{b}$ | 37.5±1.4$^{a}$ | 38.8±1.3$^{a}$ | 36.3±1.4$^{a}$ |
| | 0.15 | 31.3±1.3$^{b}$ | 35.4±1.4$^{a}$ | 36.7±1.6$^{a}$ | 34.5±1.4$^{a}$ |
| | Overall | 31.6±1.6$^{b}$ | 35.2±1.1$^{a}$ | 36.8±1.8$^{a}$ | |
| Hemoglobin % | 0.45 | 10.6±0.42$^{b}$ | 11.5±0.23$^{ab}$ | 13.8±0.30$^{a}$ | 12.0±0.25 |
| | 0.30 | 11.2±0.31$^{b}$ | 12.4±0.46$^{ab}$ | 14.3±0.35$^{a}$ | 12.6±0.39 |
| | 0.15 | 10.1±0.38$^{b}$ | 12.0±0.38$^{ab}$ | 13.9±0.32$^{a}$ | 12.0±0.35 |
| | Overall | 10.6±0.32$^{b}$ | 12.0±0.39$^{ab}$ | 14.0±0.37$^{a}$ | |
| Red blood cells ($10^{6}m^{3}$) | 0.45 | 2.98±0.04 | 2.98±0.03 | 3.02±0.04 | 2.99±0.04 |
| | 0.30 | 2.98±0.03 | 2.99±0.04 | 3.01±0.04 | 2.99±0.04 |
| | 0.15 | 2.96±0.03 | 2.97±0.03 | 3.03±0.05 | 2.99±0.03 |
| | Overall | 2.97±0.04 | 2.98±0.05 | 3.02±0.05 | |
| M.C.H. ($10^{-15}$L) | 0.45 | 37.2±0.52 | 37.6±0.58 | 39.1±0.56 | 37.9±0.58 |
| | 0.30 | 36.8±0.48 | 36.7±0.49 | 38.3±0.54 | 37.2±0.50 |
| | 0.15 | 36.0±0.50 | 37.1±0.54 | 38.5±0.54 | 37.2±0.52 |
| | Overall | 36.6±0.53 | 37.1±0.55 | 38.6±0.53 | |
| M.C.V. ($10^{-12}$g) | 0.45 | 102.4±5.3$^{b}$ | 112.4±4.9$^{ab}$ | 128.5±6.2$^{a}$ | 114.4±4.8 |
| | 0.30 | 106.6±5.4$^{b}$ | 118.0±5.7$^{ab}$ | 125.0±5.9$^{a}$ | 116.5±5.6 |
| | 0.15 | 104.2±5.0$^{b}$ | 115.6±5.1$^{ab}$ | 119.3±5.2$^{a}$ | 113.0±5.2 |
| | Overall | 104.4±5.2$^{b}$ | 115.3±5.1$^{ab}$ | 124.3±5.5$^{a}$ | |
| M.C.H.C. % | 0.45 | 30.7±2.1 | 31.7±2.7 | 32.2±2.5 | 31.5±2.6 |
| | 0.30 | 31.2±2.0 | 32.0±3.1 | 33.0±3.0 | 32.1±2.8 |
| | 0.15 | 30.8±2.2 | 32.4±2.6 | 32.9±2.8 | 32.0±2.8 |
| | Overall | 30.9±2.2 | 32.0±2.9 | 32.7±2.8 | |

a.,, b.,,c.., means within treatments with different superscripts are significantly different ($P<0.05$)

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# دراسات فسيولوجية ومناعية على بدارى التسمين المغذاة على علائق مضاف اليها مستويات مختلفة من انزيم الفيتيز الميكروبى

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أستخدم عدد ٢٧٠ كتكوتاً من سلالة الروس من عمر يوم حتى ٦ أسابيع تم تقسيمها على ٩ معاملات بالتساوى و كل معاملة بها ٣ مكررات هى:١- فو متاح (٠,٤٥%) مقسم الى ثلاث معاملات بدون فيتيز، + ٥٠٠ وحدة فيتيز، + ٧٥٠ وحدة فيتيز ٢- فو متاح (٠,٣٠%) بدون فيتيز، + ٥٠٠ وحدة فيتيز، + ٧٥٠ وحدة فيتيز ٣- فو متاح (٠,١٥%) بدون فيتيز، + ٥٠٠ وحدة فيتيز، + ٧٥٠ وحدة فيتيز . تم تسجيل وزن الجسم و استهلاك العلف و معامل التحويل الغذائي أسبوعيا و عند نهاية التجربة تم اخذ ٣ طيور من كل معامله حيث ذبحت و أخذت أوزان الغدة الثيموسية و الدرقية و الطحال و الكبد و الكلية و البرسا بالإضافة الى وزن و طول عظمة الفخذ و الساق كما أخذت عينات دم لتقدير كل من: الكالسيوم، الفوسفور ، الكوليسترول ، الدهون الكلية ، البروتين الكلى ، أنزيمات الفوسفاتيز الحامضى و القاعدي من البلازما وكذلك تم تقدير نسبة المكونات الخلوية ونسبة الهيموجلوبين وعدد كرات الدم الحمراء ومتوسط تركيز الهيموجلوبين.

**وكانت أهم النتائج هى :**

١- أدت إضافة الفيتيز بمستوى عالي (٧٥٠ وحدة فيتيز ) إلى زيادة وزن الجسم و عند عمر ٢ ،٤، ٦ أسابيع من العمر كما أدت إضافة الفوسفور المتاح بمستوى منخفض ٠,١٥% الى انخفاض استهلاك العليقة عند أعمار ٢، ٤، ٦ أسابيع ، بينما المجاميع المغذاة على ٧٥٠،٥٠٠ وحدة فيتيز زادت فيها كمية الغذاء المأكول و تحسن معامل التحويل الغذائى مقارنة بمجموعة الكنترول عند ٦ أسابيع من العمر.

٢- أدت إضافة الفيتيز بمستوى عالي ٧٥٠ وحدة دولية ومستوى منخفض من الفوسفور المتاح ٠,١٥% لإعطاء أعلى وزن نسبى لغدة الثيموسية المناعية ، أدت إضافة الفوسفور المتاح بنسبة عالية٠,٤٥% و خالية من الفيتيز بالعليقة لإعطاء أعلى وزن نسبى لعظمة الساق و أكبر طول لعظمة الساق و ارتفع مستوى الكالسيوم، البروتين الكلى، الفوسفاتيز القاعدى فى بلازما المجاميع المغذاة على ٥٠٠ وحدة فيتيز مقارنة بمجموعة الكنترول بينما المجاميع المغذاة على ٧٥٠ وحدة فيتيز ارتفع فيها مستوى الفوسفور و الفوسفاتيز الحامضى و انخفض مستوى الدهون الكلية و الكوليستيرول

٣- ادت اضافة الفيتيز للعلائق بمستوى ٧٥٠ وحدة فيتيزإلى زيادة معنوية فى المكونات الخلوية والنسبة المئوية للهيموجلوبين ومتوسط تركيز الهيموجلوبين مما ادىإلى زيادة المناعة فى هذة المجاميع مقارنة بالكنترول عند ٦ أسابيع من العمر وبالتالي كان لإضافة الفيتيز بمستويات مختلفة تأثير واضح على الاستفادة من فوسفور العليقة و تحسين الحالة الفسيولوجية والمناعية والانتاجية لكتاكيت التسمين.