An Najah Nattional University
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Effects of different level of Phytase on Broilers Performance and Body Status of Phosphorus

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This thesis was defended successfully on 25/5/2008 and approved by:

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DEDICATION

This work is dedicated to :

My father and mother;

To brothers and sisters;

To my friends.

ACKNOWLEDGMENT

I would like to express my deepest thanks and gratitude to my advisor Prof. Jamal Abo Omar for his support and help since the start of my university study. Thanks to my committee. Special thanks to Dr. Hassan Abu Qauod for his help in statistical analysis. Special thanks to all of my colleagues and friends especially Mr. Omar Abu Baker and Mr. Omar Nasr of Hebron University.

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CP	Crude Protein.
CF	Crude Fiber.
PP	Phytate phosphorus.
PPM	Part Per Million.
P	Phosphorous.
IP	Inorganic phosphate.
Ca	Calcium.
Zn	Zinc.
PU	Phytase Unit.
PA	Phytic acid.
K	Potassium.
NPP	Nonphytate phosphorous.
DM	Dry Matter.
ADF	Acid Detergent Fiber.
NDF	Neutral Detergent Fiber.

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Abstract

This experiment was conducted to investigate the effect microbial phytase supplementation on broilers performance, nutrient digestibility, visceral organ mass, carcass cuts and body status of Ca and P. a total of 200 day-old Cobb 500 chicks were used in the experiment. Birds were partitioned into five experimental groups of 40 birds in each. Each treatment was composed of 4 replicates with 10 birds in each. The control group was fed a commercial starter and finisher diet. The second treatment was a phosphorus deficient diet, while the third, fourth and fifth treatments were fed a phosphorus deficient diets plus the microbial phytase. Phytase enzyme was incorporated at levels 1000, 2000 and 3000 PU/kg feed for the last three treatments, respectively. At the last week of experiment, three birds from each replicate were used in metabolic trial. However, at time of termination of the experiment, the same birds were killed for carcass cuts, visceral organ mass and tibia ash content investigations. The experiment lasted for 42 days. Results of the experiment showed that addition of phytase to P-deficient diets improved ($P<0.5$) broilers performance with impact starting from the beginning of the fourth week of the feeding trial. However, it has no effect on feed intake. Feed conversion ratio and dressing percent were increased ($P<0.05$) in birds fed P-deficient diets supplemented with phytase. Phytase supplementation had no significant effect on both male and female carcass cuts compared to birds fed the low P diets. Variable effects of phytase supplementation at different levels on gastrointestinal tract and its associated organs of both male and female broilers were observed. Male and female birds fed P-deficient diets incorporated with phytase enzyme at different levels had more ($P<0.05$) ash, Ca and P compared to birds fed the P-deficient diet. Also results of this

investigation showed that phytase enzyme increased ($P<0.05$) the digestibility of dry matter, crude protein and ash. Phytase supplementation decreased the excreta content of Ca and P indicating the improvement of the retention of these two minerals. The overall results indicated that incorporation of phytase in broiler ration could be economically feasible as significant portion of P in diets could be reduced.

Chapter One

Introduction

Introduction:

Large portion of phosphorus (P) in plant feed ingredients is present in the form of phytate, which is largely unavailable for nonruminants (Rezaei, et al., 2007). Phytic acid can ionically binds minerals and proteins in aqueous medium (Sebastian, et al., 1997). The interest in the use of microbial feed enzymes such as phytase arises from the need to improve the availability of phytate bound phosphorus and to reduce phosphorus levels in effluent from intensive livestock operations.

In the studies to reduce excretory P of broilers (Nelson, 1967; Kornegay, 1999) reported that phytase supplementation improved the utilization of phytate P derived from plant feedstuffs, and decreased excretory P by approximately one-third without depressing performance. However, these studies were conducted at only the starter phase at seven to 14 days of age. Practically the data at the finishing phase are needed, but there are few reports which covered all of the feeding phase in broilers.

One such application in poultry, Phytic acid, that is abundant in all plant seeds, serve as the chief storage form of phosphorus. The phytic acid molecule has a high P content (28.2%), and since a major portion of poultry and pig diets consist of plant derived ingredients, P from the phytic acid assumes considerable nutritional significance. The ability of poultry and pigs to use phytate P is poor (Ravindran, et al., 2006; Wu, et al., 2003; National Research Council, 1994) due to insufficient quantities or lack of intestinal phytase secretion. This inadequacy of poultry and pigs to use phytate P resultes in the excretion of large amounts of P in the manure, posing an environmental concern especially in areas of intensive animal production. For the phytate-P to be used by monogastric animals, the phytate must be dephosphorylated, and this requires the provision of exogenous sources of phytase. During the past decade, advances in biotechnology and fermentation technology have resulted in the large-scale production of microbial phytases capable of hydrolyzing phytic acid and releasing phytate bound P. Two distinct phytase products are available in the market: one derived from submerged liquid fermentation that uses genetically manipulated organisms to achieve maximum enzyme production and the other based on solid state fermentation that uses normal organisms for enzyme production. Because of the technology and the nature of organism used, the latter phytase product also contains several side enzyme activities, including protease, amylase, cellulase, xylanase, and β-glucanase (Potter, 1988).

The aims of the present study were to investigate the influence of a phytase, produced by solid-state fermentation, on the performance, digestibility, carcass merits and P status of broilers (tibia ash contents) of male and female broiler chicken fed corn-soybean based diets.

Chapter Two

Literature Review

Literature Review:

The poultry (broilers and layers) sector plays an important role in agriculture in the Palestinian Authority. This sector contributes about 13.1 % of the total income from agriculture. Recent statistics showed that the number of raised broilers is 30.15 % (Palestinian Central Bureau of Statistics, 2006).

There are several obstacles facing the local livestock sector, among these is the feed and feed supplements problem. It is well documented that local feed costs make up more than 75% of total costs of any livestock operation in the Palestinian Authority (Abo Omar, 2003). One significant fraction of formulated feeds is the source of phosphorus (about 2% of broilers rations). The cost of feeds ingredients reduces profitability of livestock (especially broiler) business to a marginal level. On the other hand, large fraction of dietary phosphorus which is not available to animal is dumped into manure creating significant hazards to the environment (Mondal, et al., 2007).

To help solving this problem, attempts were made to use some feed additives or enzymes. These enzymes had variable effects on animal's general performance and the utilization of feed phosphorus. Phytase enzyme is one of the promising additives to solve part of the stated problem.

What is phytase?

Phytase is an enzyme that breaks down the indigestible phytic acid (phytate) portion in grains and oil seeds; thereby, releasing digestible phosphorus and calcium for the nonruminants (Nelson, 1967; O'Dell, Et al., 1972; Raboy, 1990; Ravindran, et al., 1999; Todd, et al., 2004). Phosphorus from the phytate molecule can be made more available to poultry by the addition of phytaze enzymes (Denbow, et al., 1995; Qian, et al., 1997; Zanini and Sazzad, 1999; Ravindran, et al., 2000).

Phytic acid (PA) occurs naturally in plants and serves as the storage form of phosphorus. The primary storage site of PA implants is in seeds, which are the primary ingredients in poultry diets. The P in seed – based ingredients used in poultry diets, 50 to 80% found as phytate phosphorus (PP), phytate phosphorus is poorly available to poultry (Taylor and Coleman, 1979; Sebastion, et al., 1996; Zanini and Sazzad, 1999)

Approximately two-third of the phosphorous in plant feedstuffs is present as phytic acid (Cromwell, 1980).

Phytic acid is highly reactive and readily forms chemical complex with Ca, Fe, Mg, Cu, Zn, carbohydrate and proteins (Radcliffe, 2002).

Phytic acid can also act as an anti-nutrient due to the ability of the complex to bind starch, protein and trace minerals such as phosphorus, zinc, iron, calcium and magnesium (Kornegay, 1999; Camden. et al., 2001; Radcliffe, 2002).

Phytic acid has the ability to bind protein at acidic, alkaline, and neutral PH (Anderson, 1985). However, the interaction between phytic acid and protein leads to decreased solubility of protein and eventually reduce its utilization (Cheryan, 1980). Some workers have found that microbial phytase has a positive influence on the utilization of nutrients other than P, such as amino acids (Yi, et al., 1996; Namkung and Leeson, 1999; Ravindram, et al., 1999; Ravindram, et al., 2000).

Furthermore, it was reported that mineral-phytate complexes might prevent lipid utilization, and by preventing the formation of mineral-phytate complex, phytase might reduce the degree of soap formation in the gut and enhance the utilization of energy derived from lipids (Ravindran, et al., 2001).

Phytate refers to the PA molecule, which is generally chelated to Mg, Ca, Na, and K, and cases to proteins and starch (Selle, et al., 2000).

Studies have indicated that the inclusion of phytase in nonruminants diets has increased the availability of phytate phosphorus in a corn-soy diet from approximately 15% to 45% (McMullen, 2006).

Phytase activity is expressed as "phytase units" or "FTU" per unit of feed (i.e. - FTU/kg or FTU/lb.) FTU is a worldwide standard unit. One phytase unit is the activity of phytase that generates 1 micromole of inorganic phosphorus per minute from an excess of sodium phytate at pH 5.5 and 37 degrees Celsius (Zyla, et al., 1995).

Management of phytase enzyme:

Phytase, a high molecular weight protein, is sensitive to the presence of moisture and high temperature. Therefore, shelf life of the product must be considered and proper storage of the product needs to be maintained (McMullen, 2006).

Phytase products should be stored in a dark, cool, and dry area. Label should be checked for proper storage and length of shelf life. If phytase is contained within a commercial supplement or premix product, recommended storage method should be also reviewed.

Because of the heat and moisture associated with pelleting, enzymes are destroyed; therefore, the phytase stability in pelleted diets should be considered. Consequently, when phytase is added to a pelleted diet, spraying a liquid phytase product onto the cooled pellet will allow stability of the phytase (McMullen, 2006).

Manufacturers of Phytase:

There are different forms of the enzyme. Each manufacturer has its type of the product as the following:

1 BASF - (Natuphos 600[a] /dry, Natuphos 5000[a] /dry & liquid, and Natuphos 1000[a] /dry -{[a] = FTU/gram}).
2 Alltech, Inc. - (Allzyme Phytase / dry or liquid).
3 Roche - (Ronozyme P / dry or liquid).

There are 2 main types of microbial phytase classified on the basis of the site of initial hydrolysis on phytase 3- phytase and 6- phytase. The 3-phytase ,such as phytase from *Aspergillus ficuum* or *Aspergillus niger*, initiate phytate degradation by removing inorganic phosphate (IP) from position 3.The 6-phytase such as phytase from *peniophora lycii* or *Escherichia coli* begin phytate degradation by removing IP from the sixth position on the phytic acid molecule (Todd and Angel, 2004).

Phytase effects on swine:

The inclusion rate for phytase in all stages of swine diets is 115 to 227 FTU/lb. For a corn-soybean based diet without supplemental fat, the inclusion rate would be approximately 115 to 150 FTU/lb. A diet with a significant amount of supplemental fat should be increased to approximately 150 to 227 FTU/lb. Use a higher inclusion rate in the initial diet phase and decrease the rate over the duration of the phases. At these inclusion rates, the total phosphorus level can be reduced approximately 10%. In addition, calcium should also be reduced approximately 10% to maintain the proper calcium: phosphorus ratio (McMullen, 2006).

Several studies showed that feeding of phytase will increase trace mineral absorption and it also has the potential to increase amino acid digestibility (Yi, et al., 1994).

Supplementation of swine diet with exogenous phytase sources, such as that produced by *Aspergillus Niger*, has consistently been shown to markedly improve phytate-P utilization (Cromwellus, et al., 1993; Simons, et al., 1990). With the recommended phytase inclusion level, the phytase addition will not increase the cost of the diet.

Effects of phytase on broilers:

Phytase supplementation increased the availability of phosphorus and Ca (Rezaei, et al., 2007; Schooner, et al.,1991; Broze, et al., 1994; Kornegay, et al., 1996; Sebastian, et al., 1996). Similarly, phytase increased the availability of nutrient, when was included at rate of 500 FUK /Kg phytase. Toe ash , and toe ash Ca and P percentages were increased with the addition of phytase in both sexes but without significant effect on blood phosphorus concentration (Rezaei, et al., 2007).

In another study when phytase was added at the level of 250 PU/Kg to a low P broiler diets it increased body weight gain and feed conversion efficiency, more Ca and P in tibia ash and Ca and phosphorus retention was significantly increased (Mondal, et al., 2007).

However, inclusion of phytase had no effects broilers growth performance and body levels of Ca and P (Akyurek, et al., 2005).

When phytase was added to a corn based diet had a significant increase in body weight in the broiler fed for 49 days (Huff, et al., 1998). Serum activity of alkaline phosphates was significantly decreased in the diet supplemented with phytase, while serum cholesterol was significantly decreased (Huff, et al., 1998).

When phytase was added to broiler diets at level of 600 ppm had no effects on broilers growth (Hussein, 2005).

It has been reported that phytase supplementation improved N retention in broiler chickens (Farrell, et al., 1993). Shirley, et al., (2003) indicated that broilers consuming a total P-deficient corn-soybean meal diet can achive maximum performance when phytase is supplemented at 12000 U\Kg diet and that current phytase supplementation levels within the poultry industry may need to be reevaluated.

Mondal, et al., (2007); Orban, et al., (1999); Atia, et al., (2000); Ciftci, et al., (2005) suggested that phytate phosphorous released by phytase is sufficient to meet starter and finisher broiler's growth requirement.

Effects of phytase on layer hen feed:

This effect was investigated by several researchers. Ciftci, et al., (2005), Musapuer, et al., (2005) reported that phytase supplementation had a positive impact on hen's general performance and egg production. It was concluded that phytase supplementation to hens with P deficient diets improved P and Ca retention.. Both egg production and egg average weight were improved by addition of phytase to low P diets (Scott, et al., 1999). However, Peter, (1992) reported that feeding laying hens a low nonphytate phosphorous (NPP) diet supplemented with phytase had significantly higher egg production, egg weights and feed consumption compared to hens that consumed the low nonphytate phosphorous diet free of phytase. Similarly, supplementation of phytase at level of 300 PU/kg diet caused an increase in egg production and a significant decline in number of broken eggs and premature egg production rates (Lim et al., 2003).

It has been also reported that phytase supplementation improved N retention in laying hens (Vander Klis and Verteegh, 1991).

Phytase effects on nutrients digestibility:

Effects of phytase enzyme supplementation on feed nutrients digestibility were investigated by some experiments. Sebastian, et al., (1997) reported that supplementation of phytase significantly improved of ileal digestibility of crude fat. Phytase may also improve the utilization of protein, amino acid and apparent metabolic energy of the broiler diets supplemented with phytase enzyme (Ravindran, et al., 1999).

Rutherfurd, et al., (2004) also showed that microbial phytase improved phytate P and total (P digestibility) as well as true ileal amino acid digestibility for a corn – soybean based diets.

Onyange, et al (2005) indicated that phytase improved broiler retention of P. Ca, N, and a number of amino acids. Microbial phytase on broiler diet has shown reduce phosphorus excretion (Simons, et al, 1990). Yan, et al., (2006) P excretion of broilers could be markedly reduced by phytase supplementation.

Several recent studies have explored the utilization of phytase from 3 to 6 week of age (Sohail and Roland, 1999; Yan, et al., 2001).

Phytase effect on toe ash content:

When phytase was added to broiler diets at level of 600 ppm, it decreased the ash of tibia and toe bones compared to the control (Hussein, 2005). In contrast, inclusion of phytase had no effect on toe ash content (Akyurek, et al., 2005). Yan, et al., (2006) reported an optimum broilers performance and tibia bone ash content.

Effects of phytase on feed intake:

This effect was variable (Hussein, (2005) it was reported that addition of phytase to P deficient diets increased feed intake and general performance of broilers. This finding contrasted with the finding of Scott, et al., (1999) where phytase supplementation had no effect on feed intake.

Yan, et al., (2006) reported that level of Ca of 0.7% was sufficient to maintain proper performance of broilers.

Effect of phosphorus on environment:

As a general rule, the amount of phosphorus reduction in the diet will cause a similar phosphorus reduction in the manure. With the reduction of phosphorus in the manure, less land would be required for manure application while still maintaining the appropriate dietary phosphorus requirement of the nonruminants. Phytase addition to swine diets will reduce the amount of phosphorus in the manure. The amount of reduction will depend on diet type, inclusion rate of phytase, degree of replacement of inorganic phosphorus, and the dietary phosphorus relative to the animal needs(McMullen, 2006).

Lim, et al., (2003) reported that supplementation of microbial phytase at a level of 300 U\Kg diet of laying hens can decrease phosphorous excretion. Also, the lower excreta of phosphorus by using phytase on laying hens could decrease pollution (Musapuer, et al., 2005).

Chapter Three

Materials and Methods

Ration preparation:

The experimental rations were formulated at the experimental site. Raw ingredients were bought from a local feed factory then mixed rations to fit the (NRC, 1994) requirements. Two types of rations were formulated, the starter ration which was fed from day 1 to day 21, and the finishing diet which was fed from age of 22 days till the termination of the experiment. Rations used in the experiment are shown in tables 1 and 2:

Diet 1: Control diet contains the recommended levels of Ca and P, with no phytase enzyme.
Diet 2: low phosphorous with no phytase enzyme.
Diet 3: low phosphorous diet contains 1000 PU/Kg diet.
Diet 4: low phosphorous diet contains 2000 PU/Kg diet.
Diet 5: low phosphorous diet contains 3000 PU/Kg diet.
Phytase enzyme used was bought from China. The concentration of the active ingredient is 5000 units/g.

Table (1). Composition and chemical analysis of the 5 starter experimental rations used in the experiment.

diet	control	P-deficient	P-def.+1000PU/kg	P-de.+2000PU/kg	P-def.+3000PU/kg
Diet composition %					
Corn	**57**	**57**	**57**	**57**	**57**
Soybean meal	**37.5**	**37.5**	**37.5**	**37.5**	**37.5**
Oil	**3**	**3**	**3**	**3**	**3**
Limestone	**1**	**1.32**	**1.32**	**1.32**	**1.32**
Di-calcium Phosphorous	**0.75**	**0.42**	**0.42**	**0.42**	**0.42**
Premix*	**0.75**	**0.75**	**0.75**	**0.75**	**0.75**
Phytase enzyme	**0**	**0**	**1000**	**2000**	**3000**
Chemical analysis%					
Dry matter	**90.1**	**90**	**90**	**89.9**	**89.9**
Crude protein	**22**	**22.1**	**21.9**	**22**	**22.2**
Crude fiber	**4.25**	**4.25**	**4.25**	**4.25**	**4.25**
Crude fat	**5.46**	**5.46**	**5.46**	**5.46**	**5.46**
Ash	**5.04**	**5.04**	**5.04**	**5.04**	**5.04**
Calcium	**0.77**	**0.77**	**0.77**	**0.77**	**0.77**
Phosphorous	**0.4**	**0.34**	**0.34**	**0.34**	**0.34**

* Contents Premix Per 1 Ton Feed: Vitamin A 12 iu, Vitamin D3 3 iu, Vitamin E 50 iu, Vitamin K3 2.5 Gram, Vitamin B1 1 Gram, Vitamin B2 7 Gram, Panototic Acid 14 Gram, Niacin 37 Gram Vitamin B6 3 Gram, Vitamin B12 10Mg, Folic Acid 1 Gram, Biotin 150 Mg, Cholin Chloride 200 Gram, Cobalt 0.20 Gram, Copper 15 Gram, Iron 20 Gram, Manganese 80 Gram, Iodine 1.20 Gram, Selenium 0.20 Gram, Zinc 50 Gram, Limestone 1897.09 Gram, Anilox 125 Gram, Methionin 2000 Gram, Lysine 1500 Gram.

Table (2). Composition and chemical analysis of the 5 finisher experimental rations used in the experiment

diet	control	P-deficient	P-def.+1000PU/kg	P-de.+2000PU/kg	P-def.+3000PU/kg
Diet composition %					
Corn	**60**	**60**	**60**	**60**	**60**
Soybean meal	**31**	**31**	**31**	**31**	**31**
Oil	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**
Limestone	**1.86**	**2.6**	**2.6**	**2.6**	**2.6**
Di-calcium Phosphorous	**1.37**	**0.59**	**0.59**	**0.59**	**0.59**
Premix*	**1.37**	**1.37**	**1.37**	**1.37**	**1.37**
Phytase enzyme	**0**	**0**	**1000**	**2000**	**3000**
Chemical analysis%					
Dry matter	**90**	**90.1**	**89.9**	**90**	**90**
Crude protein	**19.04**	**19.04**	**19.04**	**19.04**	**19.04**
Crude fiber	**3.8**	**3.8**	**3.8**	**3.8**	**3.8**
Crude fat	**7.87**	**7.87**	**7.87**	**7.87**	**7.87**
Ash	**4.87**	**4.87**	**4.87**	**4.87**	**4.87**
Calcium	**1.29**	**1.3**	**1.3**	**1.3**	**1.3**
Phosphorous	**0.5**	**0.36**	**0.36**	**0.36**	**0.36**

* Contents Premix Per 1 Ton Feed: Vitamin A 8.5 iu, Vitamin D3 2.5 iu, Vitamin E 50 iu, Vitamin K3 2 Gram, Vitamin B1 0.80 Gram, Vitamin B2 6 Gram, Panototic Acid 11.20 Gram, Niacin 30 Gram Vitamin B6 2.40 Gram, Vitamin B12 8 Mg, Folic Acid 0.80 Gram, Biotin 150 Mg, Cholin Chloride 200 Gram, Cobalt 0.20 Gram, Copper 15 Gram, Iron 20 Gram, Manganese 80 Gram, Iodine 1.20 Gram, Selenium 0.20 Gram, Zinc 50 Gram, Limestone 1666.96 Gram, Anilox 125 Gram, Methionin 1100 Gram, Lysine 1200 Gram.

Performance experiment:

A 200 one day-old broiler chicks (Cobb 500) were bought from a local hatchery (Poultry Company of Palestine, Tulkarm, Palestine). Chicks were immediately transferred to the experimental site and divided into five dietary treatment groups of 40 chicks in each. Each group was composed of 4 replicates with 10 chicks each. Chicks were housed on floor of a suitable size house and managed as any commercial broiler flock. Chicks were weighed at weekly basis till the end of the experiment which lasted for 42 days. Feed intake, body weight and mortality rate were weekly recorded, and weight gain and feed conversion efficiency were calculated.

Metabolism trial:

A metabolic trial of 3 days duration was conducted during the last three days of feeding trial. This trial was after an adaptation period of another three days. During the metabolic trial a total collection of daily feed intake and feces from 4 birds of each treatment was performed. Feed and feces samples were kept for later chemical analysis.

Visceral organs and carcass cuts preparation and sampling:

At termination of the feeding trial, 8 chicks were taken randomly from each feeding group. Chicks were killed according to the routine practices adopted in commercial broiler slaughter house after a fasting period of 10 hours. Chicks were then eviscerated and viscera were measured. Weights of visceral organs like liver, heart, kidneys, were recorded as percent of carcass weight.

Weights of total digestive tract and segments as esophagus, provintriculus, gizzard, small intestine, cecum and large intestine were also recorded.

Total cool carcass weight was recorded then each carcass was split into its cuts, breast, and thighs were each cut weight was recorded. Weights of wings, neck, head and feet were also recorded. The tibia of each killed bird was removed and frozen for later Ca and P analysis.

Chemical analysis:

Feed and feces were analyzed for dry matter (DM), crude protein (CP), fiber, crude fat (CF), Ca and P utilizing the A.O.A.C (1995) procedures. Toe Ca and P contents were determined using the flame photometry procedure.

Statistical analysis:

All data were analyzed by ANOVA using the linear model procedure of SAS (SAS, 1988) to determine the effect of addition of phytase enzyme to broiler rations on body weight development, feed intake, feed conversion, visceral organ mass, gastrointestinal tract components and carcass cuts and toe ash contents.

Chapter Four

Results and Discussion

Broiler performance:

The effect of phytase enzyme supplementation on the broilers chicks is shown in Table 3. Reducing P level in the second treatment in both starter and finisher diets depressed body weight starting from week 2, compared to control and diets supplemented with different levels of phytase. This lower body weight was due to the deficiency of P in the broilers fed the lower level of P which is lower than the recommended levels for broilers during starter and finisher periods (NRC, 1994). This effect of P deficiency was also reported in broilers (Sohail and Roland, 1999; Fernandez, et al., 1999; Bozkurt, et al., 2006; Mondal, et al., 2007) and ducks (Orban, et al., 1999).

Phytase supplementation at levels of 1000, 2000 and 3000 PU/kg in both starter and finisher diets solved the problem of P deficiency and resulted in birds average body weights similar to control. However, levels of phytase lower than 500 PU/kg had no effect on improving broilers body weights (Mondal, et al., 2007). Results of this experiment also is in agreement with those of Qian, et al., (1997), Huff, et al. (1998), Namkung and Leeson, (1999), Zyla, et al., (2000) and Bozkurt, et al., (2006) which reported that the growth rate and feed conversion ratio of broilers fed low P diets containing phytase were comparable or even better than those obtained for broilers fed the standard P diets. These results supported the concept that phytase was improving P availability and P level can be lowered in corn-soybean meal based broiler starter and finisher added phytase.

Table (3). Average weekly body weights development broilers on different treatments (g).

age/ weeks	control	P-deficient	P-def. +1000PU/kg	P-def. +2000PU/kg	P-def. +3000PU/kg
0	46.5	46.5	46.5	46.5	46.5
1	114.6a	106b	108.9ab	108.9ab	106.9b
2	221.1a	197.5b	217.1a	216.8a	217.6a
3	372.1a	328.6a	357.9a	347.1a	352.6a
4	849a	738b	837.5a	849.8a	862.8a
5	1399.2a	1184.1b	1399.2a	1442.4a	1415a
6	2012a	1568.7b	2011.2a	1991.9a	2016.4a

Rows of different letters are significantly different ($P<0.05$)

Feed intake:

Feed intake of broilers fed P-deficient diets supplemented with phytase at different levels was similar to those fed control diet. Phytase enzyme supplementation improved ($P<0.05$) feed intake in broilers fed P-deficient diets. The results indicate that phytase at levels of 1000 PU/kg and higher released phytate P that was utilized for growth in a similar manner as would P supplied by di-calcium phosphate (Table 4). Similar findings were reported by Monndal, et al., (2007) when broilers fed with P-deficient diets supplemented with phytase at levels higher than 500 PU/kg. However, phytase levels lower than 500 PU/kg had no impact on feed intake and feed conversion efficiency.

Table (4). Average daily feed intake of broilers under different (g)

age/ weeks	control	P-deficient	P-def. +1000PU/kg	P-def. +2000PU/kg	P-def. +3000PU/kg
1	19.21a	17.4b	18.28a	19.06a	18.65a
2	33.19a	28.71b	30.45a	35.21a	33.17a
3	41.1a	40.98b	42.2a	42.15a	43.23a
4	78.6a	76.15b	78.32a	79.96a	80.07a
5	121.46a	113.8b	117.44a	116.46a	121.86a
6	151.18a	114.55b	146.14a	141.77a	149.19a

Rows of different letters are significantly different ($P<0.05$)

Similar intake trends were observed for duck, turkey and layer diets (Mondal, et al., 2007; Orban, et al., 1999; Atia, et al., 2000; Ciftci, et al., 2005), respectively.

Feed conversion efficiency:

Phytase supplementation to low P diets at levels starting from 1000 PU/kg improved ($P<0.05$) feed conversion ratio of broilers at weight of marketing compared to with low P diets (Table 5). The current study supports the observations of Huff, et al., (1998), Sohail and Roland, (1999), Ravindan, et al., (2001), Bozkurt, et al., (2006) and Mondal et al. (2007) who reported that phytase supplementation to broiler diets caused numerical improvement in feed efficiency of broilers fed a P-deficient diets fed without phytase.

Table (5). Feed conversion ratio of broilers under different treatments

age/weeks	control	P-deficient	P-def. +1000PU/kg	P-def. +2000PU/kg	P-def. +3000PU/kg
Feed Conversion	1.583a	1.833b	1.520a	1.589a	1.599a

Rows of different letters are significantly different (P<0.05)

Visceral organ mass:

The edible parts:

The parts concerned are gizzard, liver and heart. Although it was reported by Moharrery and Mohammadpour, (2005) that phytase supplementation had no impact on gizzard and liver weights, our experiment showed an influence in the male broilers' heart and liver (Table 6).

Results showed that hearts of male birds fed the P-deficient diets had the highest (P<0.05) weight percentages. Hearts of males fed with control and the highest two levels of phytase broilers had the lowest (P<0.05) percentages. However, supplementation of phytase had different effects on female broilers where gizzards of female broilers fed the highest two levels of phytase had the lowest (P<0.05) percentages compared to females fed deficient P and the control diets (Table 7). Hearts of female broilers fed the P-deficient diet had the highest percentages, however, it is similar to that of broilers fed the control and broilers fed phytase at levels of 2000 and 3000 PU/kg. the only significance effect was compared to percentages of female broilers fed phytase at 1000 PU/kg level. Again, the highest percent of liver was observed in females fed the P-deficient diet which was higher (P<0.05) compared to birds fed the lowest level of phytase, but was similar to percentages in other treatments.

Table (6). Edible parts of male broilers under different treatments (% of live weight).

Organs	control	P-deficient	P-def. +1000PU/kg	P-def. +2000PU/kg	P-def. +3000PU/kg
Gizzard	2.3a	2.6a	2.3a	2.1a	2.3a
heart	0.52c	0.7a	0.56bc	0.64ab	0.57bc
liver	2.2ab	2.5ab	2.2ab	2.5a	2.1b

Rows of different letters are significantly different (P<0.05

Table (7). Edible parts of female broilers under different treatments (% of live weight).

Organs	control	P-deficient	P-def. +1000PU/kg	P-def. +2000PU/kg	P-def. +3000PU/kg
Gizzard	3.2ab	2.9ab	3.6a	2.8ab	2.7b
Heart	0.59ab	0.73a	0.54b	0.6ab	0.56b
Liver	2.2ab	2.4a	2b	2.3a	2.1ab

Rows of different letters are significantly different (P<0.05)

The inedible parts:

They include: crop, proventriculus and spleen.

Results showed that phytase supplementation had no significant effect on all of the inedible items of male broilers (Table 8). Similar trend was observed for the crop of female broilers (Table 9). However, the lowest phytase level caused a significant increase (P<0.05) compared to to the highest level, but similar to spleen percentages in other treatments.

Table (8). Inedible parts of male broilers under different treatments (% of live weight).

Organs	control	P-deficient	P-def. +1000PU/kg	P-def. +2000PU/kg	P-def. +3000PU/kg
Proventriculus	0.51a	0.53a	0.47a	1.2a	0.51a
Crop	0.59a	0.76a	0.51a	0.71a	0.59a
spleen	0.12a	0.09a	0.13a	0.1a	0.09a

Rows of different letters are significantly different (P<0.05)

Table (9). Inedible parts of female broilers under different treatments (% of live weight)

Organs	control	P-deficient	P-def. +1000PU/kg	P-def. +2000PU/kg	P-def. +3000PU/kg
Proventriculus	0.91a	0.49b	0.75ab	0.69ab	0.57ab
Crop	0.59a	0.5a	1.3a	1.5a	0.48a
Spleen	0.11ab	0.11ab	0.15a	0.12ab	0.08b

Rows of different letters are significantly different (P<0.05)

Gastrointestinal tract:

Results of our experiment showed that phytase supplementation had no effects on gastrointestinal tract and its components (Tables 10, 11). Males fed the P-deficient diet had higher percentages of small intestine, cecum and total digestive tract content compared to small intestines of male birds in other treatments. However the large intestine percentages were the highest in male birds fed the 2000 PU/kg phytase level.

The percentages of these segments were larger in male's broilers in general but the gut contents had the opposite.

Table (10). Components of the gastrointestinal and digestive tract of male broilers under different treatments (% of live weight).

Organs	control	P-deficient	P-def. +1000PU/kg	P-def. +2000PU/kg	P-def. +3000PU/kg
Small intestine	3.9a	4.3a	4a	3.9a	4a
Large intestine	0.2a	0.27a	0.35a	0.49a	0.26a
Cecum	0.81a	0.9a	0.87a	0.85a	0.81a
Total dig. Tract and content	7.8a	8.6a	8.1a	7.9a	8a

Rows of different letters are significantly different (P<0.05)

Table (11). Components of the gastrointestinal and digestive tract of female broilers under different treatments (% of live weight)

Organs	control	P-deficient	P-def. +1000PU/kg	P-de. +2000PU/kg	P-def. +3000PU/kg
Small intestine	4.2	4.1	4	5.6	3.8
Large intestine	0.25	0.73	0.27	0.17	0.23
Cecum	0.94	0.77	1	0.85	0.73
Total dig. Tract and content	9.2	9.1	9	9	8

Rows of different letters are significantly different (P<0.05)

Percentage of some carcass cuts and meat:

The parts investigated were thighs, neck, head, back, legs, wings, and breast. Phytase supplementation had no effect on percentages of all male and female cuts as well (Table 12, 13).

These results agrees with previous findings of Angel, et al., (2007) but contradicts with those of Pillai, et al., (2006) who showed that phytase supplementation significantly increased percentages of most of carcass merits compared to P-deficient diets.

Table (12). Carcass cuts of male broilers under different treatments(% of live weight).

Organs	control	P-deficient	P-def. +1000PU/kg	P-def. +2000PU/kg	P-def. +3000PU/kg
neck	4.6	4.7	4.1	4.7	4.3
thighs	20.8	22.1	20.3	20.6	20.2
head	2.1	2	1.99	2.1	1.9
back	13.9	12.3	12.8	13	13.6
legs	4.8	5	4.4	4.2	4.1
wings	7.2b	8a	7.8ab	7.6ab	7.9ab
breast	26.6	24.5	24.7	24.3	25.7

Rows of different letters are significantly different ($P<0.05$)

Table (13). Carcass cuts of female broilers under different (% of live weight).

Organs	control	P-deficient	P-def. +1000PU/kg	P-de. +2000PU/kg	P-def. +3000PU/kg
Neck	4.6	4.5	4	4.8	4.4
Thighs	20	21.2	20.1	20.3	21
Head	2	6.1	1.8	1.8	1.8
Back	13.9	13.6	14.3	13.9	14.4
Legs	3.8	4.8	4.1	3.8	4.1
Wings	7.8	8.4	7.8	7.3	7.6
Breast	24.7	24	24.8	24.1	26.4

Rows of different letters are significantly different ($P<0.05$)

The dressing percent:

As shown in (Tables 14 and 15) the dressing percent of the birds was not affected by phytase supplementation in both males and females. However, dressing percent values reported in this experiment were higher than values reported by (Khawaja, 2003) in broilers fed commercial rations.

Table (14). Dressing percent of male broilers under different treatments

Parameter	control	P-deficient	P-def. +1000PU/kg	P-def. +2000PU/kg	P-def. +3000PU/kg
Live weight (g)	2190	1898.7	1980	2075	2148.7
Carcass weight (g)	1621.25	1382.5	1435	1498.75	1545
Dressing percent (%)	74a	72.8a	72.4a	72.1a	72a

Rows of different letters are significantly different (P<0.05)

Table (15). Dressing percent of female broilers under different treatments.

Parameter	control	P-deficient	P-def. +1000PU/kg	P-def. +2000PU/kg	P-def. +3000PU/kg
Live weight (g)	1895	1682.5	2076	2215	2033
Carcass weight (g)	1346.25	1208.75	1460	1556.25	1495
Dressing percent (%)	71	71.7	70.1	70.4	73.5

Rows of different letters are significantly different (P<0.05)

Mineral content of tibia:

The effect of microbial phytase supplementation to low P diets on mineral content is shown in (Table 16). The percentage of male and female broilers tibia crude ash was significantly increased by the addition of dietary phytase. This agrees with the several studies on broilers (Sebastian, et al., 1996; Zyla, et al., 2000; Mondal, et al., 2007), pekin ducks (Orban, et al., 1999) and turkeys (Atia, et al., 2000). However, it disagrees with others (Fernandez, et al., 1999; Harter-Dennis and Sterling, 1999; Bozkurt, et al., 2006).

Phytase supplementation to diets increased the content of Ca and P in the tibia compared to diets containing low P. This is a good indication of increased availability of P from phytase mineral complex by the action of phytase (Sebastian, et al., 1996; Mondal, et al., 2007). Our findings are similar to previous work with broilers and ducks, in which dietary phytase does increase tibia ash and P percentages.

Bone Zn level was increased ($P<0.05$) when phytase was added to the diet. This result is in agreement with those reported by Zanini and Sazzad, (1999) and Mondal, et al., (2007), where they reported an increase in the concentration of Ca and Zn in the tibia by phytase supplementation. Phytase can decrease Zn availability by chelating divalent Zn which increases its concentration in bone tissue.

Table (16). Tibia minerals of male and female broilers under different treatments, %

	control		P-deficient		P-def. +1000PU/kg		P-de. +2000PU/kg		P-def. +3000PU/kg	
	M	F	M	F	M	F	M	F	M	F
Ash	9.0	9.8	6.0	6.6	9.2	10.5	10.2	9.3	10.7	10.8
Ca	.92	1.0	.81	.80	1.1	1.3	1.1	1.2	1.0	.91
P	1.1	1.0	.9	.89	1.4	1.3	1.2	1.4	1.2	1.2
Zn	.22	.25	.12	.15	.22	.3	.27	.25	.25	.26

Effect of phytase supplementation on digestibility:

Phytase tended ($P<0.05$) to increase apparent digestibility of dry matter, crude protein and crude ash, however, it had no effects on cell wall contents (ADF and NDF) (Table 17). These results can be explained that phytase enzyme had a positive influence on digestive enzymes of gastrointestinal tract that leads to the increase in digestibility observed in birds fed with P-deficient diets. These results are in agreement with previous findings on broiler (Ravindran, et al., 1999; Rutherfurd, et al., 2004; Onyange, 2005; Mondal, et al., 2007).

Table (17). Digestibility of nutrients in broilers under different treatments, %.

Trait	control	P-deficient	P-def. +1000PU/kg	P-def. +2000PU/kg	P-def. +3000PU/kg
DM	83.0	80.1	83.2	82.9	83.2
Crude protein	81.0	78.1	82.1	82.4	81.8
Ash	82.6	79.4	82.0	82.4	82.6
ADF	75.5	76	75.2	76.1	75.6
NDF	72.9	72.6	72	73.4	73.7

Retention of calcium and phosphorus:

Retention of Ca and P was improved by the addition of phytase to low P diet. This indicates that phytase reduced the amount of inorganic P in starter and finisher broiler diets. The phytase supplementation improved P bioavailability resulting in low P excretion (Um, et al., 2000) and increased retention of Ca and P (Lim, et al., 2001; Mondal, et al., 2007).

Results of this experiment suggests that phytase in broiler starter and finisher diets enhanced the bioavailability of P that supported the growth performance, ash P content and retention of Ca and P (Table 18).

Table (18). Broilers excreta of Ca, P and Zn, %

	control	P-deficient	P-def. +1000PU/kg	P-def. +2000PU/kg	P-def. +3000PU/kg
Ca, %	1.11	2.3	1.2	1.9	2.0
P, %	1.3	1.8	1.1	.9	1.4
Zn , %	2.1	2.6	2.0	2.3	2.3

Chapter Five

Conclusions and Recommendations

Conclusions:

1. The results of this study suggest that microbial phytase in broiler starter and finisher diet enhanced the bioavailability of P that supported the growth performance.

2. Incorporation of phytase in corn- soybean based broiler starter and finisher diets improved Ca and P bioavailability.

3. It can be concluded that, dietary P can be reduced to .44 and .56% in starter and finisher diets, respectively of broilers without affecting performance.

4. Feed intake was not affected by phytase supplementation among all experimental groups.

5. Feed conversion ratio and dressing percentages were not influenced by phytase supplementation.

6. Phytase supplementation had no impact on carcass cuts of both male and female broilers.

7. Phytase enzyme had variable effects on gastrointestinal tract and its associated organs of both males and females.

8. Digestibility of dry matter, ash, crude protein, Ca and P was improved by addition of phytase to broilers starter and finisher diets.

9. Tibia ash, Ca and P content increased by the incorporation of phytase in broilers starter and finisher diets.

Recommendations:

It can be recommended by the study that incorporation of microbial phytase in starter and finisher diets of broilers at levels from 1000 to 3000 PU/kg feed proved to be beneficial. However, since amount of P could be reduced to .44 and .56% in starter and finisher diets, significant amount of savings could be achieved.

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Appendices

Table (1): Body weight of individual birds of the 5 treatments at end of week 1.

Replicate	1	2	3	4	5
R 1	**1**	**2**	**3**	**4**	**5**
	159	*99*	*99*	*95*	*100*
	119	*111*	*111*	*105*	*104*
	98	*111*	*102*	*105*	*97*
	110	*114*	*120*	*113*	*109*
	115	*127*	*109*	*110*	*98*
	115	*100*	*118*	*110*	*108*
	114	*111*	*106*	*110*	*92*
	117	*118*	*100*	*110*	*88*
	117	*111*	*101*	*90*	*123*
sum r 1	*94*	*105*		*104*	*109*
Average	1158	*1107*	*966*	*1052*	*1028*
R 2	**116**	**111**	**107**	**105**	**103**
	120	*94*	*111*	*125*	*97*
	116	*109*	*97*	*101*	*116*
	120	*110*	*111*	*109*	*109*
	114	*118*	*127*	*123*	*111*
	112	*102*	*123*	*104*	*114*
	98	*119*	*100*	*98*	*94*
	136	*94*	*94*	*112*	*112*
	121	*112*	*125*	*85*	*100*
	123	*94*	*114*	*77*	*87*
sum r 2	*122*	*108*	*119*	*89*	*125*
Average	1182	*1060*	*1121*	*1023*	*1065*
R 3	**118**	**106**	**112**	**102**	**107**
	118	*101*	*117*	*114*	*98*
	110	*112*	*89*	*115*	*113*
	124	*109*	*119*	*138*	*117*
	122	*99*	*115*	*123*	*109*
	98	*107*	*103*	*127*	*114*
	112	*101*	*110*	*130*	*99*
	107	*103*	*125*	*126*	*111*
	130	*115*	*99*	*108*	*100*
	116	*102*	*122*	*116*	*110*
sum r 3	*120*	*120*	*98*	*115*	*104*

Average	1157	1069	1097	1212	1075
R 4	**116**	**107**	**110**	**121**	**108**
	95	115	83	103	136
	124	110	97	110	123
	103	99	107	112	107
	107	90	112	115	106
	120	94	109	115	111
	116	110	120	99	91
	107	81	120	114	119
	91	94	91	111	117
	120	108	122	99	96
sum r 4	107	103	105	92	103
Average	1090	1004	1066	1070	1109
Av. Of trt	**109**	**100**	**107**	**107**	**111**
	115	**106**	**109**	**109**	**107**

Table (2): Body weight of individual birds of the 5 treatments at end of week 2.

Replicate	1	2	3	4	5
R 1	248	197	192	170	174
	243	183	209	205	215
	166	213	188	230	191
	235	250	232	230	284
	225	196	214	190	195
	227	235	243	210	236
	213	207	209	200	224
	211	182	184	210	186
	233	206	198	175	253
	185	188		195	216
sum r 1	2186	2057	1869	2015	2174
Average	**219**	**206**	**208**	**202**	**217**
R 2	263	180	198	267	151
	238	220	177	200	258
	269	219	242	231	221
	255	228	237	226	256
	220	192	220	236	216
	186	207	236	227	197
	198	184	177	263	198
	202	200	245	163	222
	242	148	257	161	165

	217	*177*	*218*	*161*	*214*
sum r 2	*2290*	*1955*	*2207*	*2135*	*2098*
Average	**229**	**196**	***221***	***214***	***210***
R 3	*227*	*207*	*248*	*262*	*180*
	202	*204*	*180*	*280*	*234*
	207	*176*	*232*	*222*	*260*
	243	*121*	*204*	*242*	*191*
	174	*193*	*248*	*229*	*245*
	253	*187*	*254*	*229*	*185*
	250	*228*	*205*	*217*	*205*
	237	*219*	*194*	*201*	*222*
	173	*194*	*221*	*217*	*216*
	190	*234*	*189*	*205*	*201*
sum r 3	*2156*	*1963*	*2175*	*2304*	*2139*
Average	**216**	**196**	**218**	**230**	**214**
R 4	*167*	*240*	*248*	*235*	*292*
	275	*156*	*180*	*232*	*267*
	275	*194*	*232*	*280*	*227*
	250	*184*	*204*	*218*	*214*
	248	*219*	*248*	*206*	*240*
	228	*210*	*254*	*215*	*191*
	192		*205*	*232*	*215*
	181	*184*	*194*	*214*	*238*
	176	*169*	*221*	*219*	*205*
	223	*177*	*189*	*170*	*206*
sum r 4	*2215*	*1733*	*2175*	*2221*	*2295*
Average	**222**	**193**	**218**	**222**	**230**
Av. Of trt	**221**	**198**	**216**	**217**	**218**

Table (3): Body weight of individual birds of the 5 treatments at end of week 3.

Replicate	1	2	3	4	5
R 1	*420*	*355*	*305*	*200*	*225*
	350	*310*	*315*	*350*	*380*
	260	*365*	*255*	*345*	*310*
	405	*420*	*370*	*455*	*405*
	365	*340*	*340*	*340*	*325*
	415	*400*	*400*	*335*	*365*
	300	*370*	*300*	*315*	*375*
	350	*280*	*300*	*330*	*255*
	405	*280*	*285*	*225*	*425*

	315	*315*		*345*	*340*
sum r 1	*3585*	*3435*	*2870*	*3240*	*3405*
Average	**359**	**344**	**319**	**324**	**341**
R 2	*415*	*230*	*330*	*450*	*205*
	430	*350*	*270*	*340*	*285*
	440	*310*	*315*	*375*	*325*
	455	*350*	*370*	*375*	*460*
	360	*340*	*335*	*200*	*295*
	275	*320*	*345*	*320*	*325*
	325	*270*	*240*	*435*	*310*
	340	*290*	*360*	*225*	*325*
	435	*200*	*475*	*210*	*250*
	305	*305*	*340*		*325*
sum r 2	*3780*	*2965*	*3380*	*2930*	*3105*
Average	**378**	**297**	***338***	***326***	***311***
R 3	*380*	*330*	*440*	*425*	*295*
	365	*275*	*335*	*430*	*455*
	310	*305*	*345*	*405*	*455*
	430	*205*	*370*	*410*	*310*
	395	*290*	*335*	*465*	*430*
	415	*395*	*430*	*335*	*395*
	390	*415*	*350*	*365*	*310*
	390	*325*	*300*	*340*	*340*
	290	*325*	*325*	*340*	*350*
	305	*410*	*335*	*340*	*320*
sum r 3	*3670*	*3275*	*3565*	*3855*	*3660*
Average	**367**	**328**	**357**	**386**	**366**
R 4	*275*	*420*	*420*	*250*	*510*
	445	*285*	*420*	*300*	*420*
	505	*330*	*550*	*355*	*435*
	410	*300*	*380*	*420*	*370*
	450	*425*	*420*	*430*	*435*
	440	*360*	*420*	*390*	*300*
	345		*400*	*385*	*390*
	310	*335*	*355*	*355*	*380*
	300	*395*	*400*	*400*	*355*
	370	*275*	*420*	*250*	*340*
sum r 4	*3850*	*3125*	*4185*	*3535*	*3935*
Average	**385**	**347**	**419**	**354**	**394**
Av. Of trt	**372**	**329**	**358**	**347**	**353**

Table (4): Body weight of individual birds of the 5 treatments at end of week 4.

Replicate	1	2	3	4	5
R 1	*835*	*845*	*735*	*590*	*590*
	615	*715*	*900*	*850*	*930*
	870	*790*	*715*	*1005*	*860*
	885	*970*	*940*	*965*	*995*
	865	*715*	*755*	*800*	*820*
	975	*960*	*900*	*805*	*975*
	850	*825*	*745*	*915*	*925*
	860	*580*	*765*	*890*	*675*
	915	*680*	*755*	*650*	*1115*
	505	*765*		*710*	*965*
sum r 1	*8175*	*7845*	*7210*	*8180*	*8850*
Average	**818**	**785**	**801**	**818**	**885**
R 2	*1085*	*605*	*850*	*1120*	*585*
	995	*840*	*705*	*895*	*950*
	935	*650*	*900*	*960*	*845*
	930	*815*	*1010*	*960*	*920*
	860	*710*	*810*	*510*	*855*
	580	*700*	*905*	*720*	*875*
	755	*585*	*550*	*1015*	*795*
	790	*630*	*835*	*620*	*850*
	960	*450*	*795*	*515*	*680*
	890	*665*	*865*		*840*
sum r 2	*8780*	*6650*	*8225*	*7315*	*8195*
Average	**878**	**665**	***823***	***813***	***820***
R 3	*755*	*830*	*855*	*1065*	*780*
		655	*615*	*995*	*930*
	795	*660*	*805*	*1035*	*980*
	1005	*885*	*900*	*965*	*775*
	820	*660*	*940*	*915*	*1020*
	720	*515*	*895*	*870*	*705*
	930	*895*	*765*	*930*	*720*
	870	*785*	*755*	*785*	*910*
	700	*770*	*635*	*855*	*845*
	720	*940*	*805*	*860*	*730*
sum r 3	*7315*	*7595*	*7970*	*9275*	*8395*
Average	**813**	**760**	**797**	**928**	**840**
R 4	*680*	*920*	*885*	*645*	*1120*
	1015	*665*		*710*	*1020*

	1070	*780*	*1185*	*900*	*945*
	935	*610*	*920*	*1035*	*920*
	945	*770*	*935*	*840*	*920*
	980	*920*	*930*	*900*	*765*
	875		*800*	*935*	*955*
	725	*695*	*805*	*975*	*870*
	765	*665*	*945*	*855*	*800*
	890	*665*	*960*	*615*	*760*
sum r 4	*8880*	*6690*	*8365*	*8410*	*9075*
Average	**888**	**743**	**929**	**841**	**908**
Av. Of trt	**849**	**738**	**838**	**850**	**863**

Table (5): Body weight of individual birds of the 5 treatments at end of week 5.

Replicate	1	2	3	4	5
R 1	*1470*	*1350*	*1205*	*1120*	*1065*
	1120	*1185*	*1545*	*1310*	*1445*
	1485	*1350*	*1285*	*1730*	*1579*
	1470	*1430*	*1525*	*1530*	*1580*
	1475	*1100*	*1470*	*1390*	*1430*
	1470	*1525*	*1445*	*1370*	*1585*
	1450	*1285*	*1220*	*1535*	*1500*
	1410	*1130*	*1340*	*1490*	*1205*
	1520	*960*	*1275*	*1060*	*1430*
	850	*1255*		*1015*	*1565*
sum r 1	*13720*	*12570*	*12310*	*13550*	*14384*
Average	**1372**	**1257**	**1368**	**1355**	**1438**
R 2	*1705*	*995*	*1360*	*1935*	*1130*
	1125	*1410*	*1330*	*1470*	
	1605	*1035*	*1530*	*1525*	*1535*
	1485	*1280*	*1630*	*1600*	*1565*
	1470	*1140*	*1370*	*1065*	*1455*
	1160	*1190*	*1550*	*1130*	*1495*
	1295	*945*	*1170*	*1655*	*1265*
	1290	*1065*	*1405*	*1150*	*1320*
	1560	*725*	*1375*	*970*	*1170*
	1565	*1090*	*1540*		*1550*
sum r 2	*14260*	*10875*	*14260*	*12500*	*12485*
Average	**1426**	**1088**	***1426***	***1389***	***1387***
R 3	*1335*	*1245*		*1835*	*1335*
		915	*1120*	*1265*	*1505*

	1285	*1000*	*1305*	*1520*	*1530*
	1575	*1300*	*1310*	*1630*	*1300*
	1230	*1105*	*1485*	*1510*	
	1060	*915*	*1565*	*1620*	*1205*
	1675	*1465*	*1350*	*1210*	*1305*
	1435	*1210*	*1310*	*1350*	*1550*
	1215	*1195*	*1025*	*1370*	*1235*
	1275	*1450*	*1430*	*1085*	*1265*
sum r 3	*12085*	*11800*	*11900*	*14395*	*12230*
Average	**1343**	**1180**	**1322**	**1440**	**1359**
R 4		*1440*	*1430*	*1670*	*1670*
	1840	*1130*		*1660*	*1615*
	1265	*1315*	*1770*	*1710*	*1490*
	1475	*1030*	*1425*	*1660*	*1550*
	1500	*1200*	*1555*	*1610*	*1380*
	1585	*1505*	*1540*	*1435*	*1375*
	1485		*1350*	*1660*	*1645*
	1210	*1100*	*1320*	*1345*	*1385*
	1300	*1155*	*1320*	*1515*	*1420*
	1445	*1035*	*1620*	*1600*	*1225*
sum r 4	*13105*	*10910*	*13330*	*15865*	*14755*
Average	**1456**	**1212**	**1481**	**1587**	**1476**
Av. Of trt	**1399**	**1184**	**1399**	**1442**	**1415**

Table (6); Body weight of individual birds of the 5 treatments at end of week 6.

Replicate	1	2	3	4	5
R 1	*1920*	*1525*	*1715*	*1670*	*1590*
	1725	*1455*	*2390*	*1815*	*1965*
	2345	*1325*	*2150*	*2500*	*2185*
	2050	*1830*	*2250*	*2020*	*2200*
	2130	*1120*	*2095*	*1980*	*2105*
	2090	*1370*	*1930*	*1970*	*2335*
	2170	*1945*	*1860*	*2020*	*2035*
	2120	*1370*	*1770*	*2150*	*1740*
	2285	*1730*	*1830*	*1620*	*2190*
	1325	*1780*		*1480*	*2415*
sum r 1	*20160*	*15450*	*17990*	*19225*	*20760*
Average	**2016**	**1545**	**1999**	**1923**	**2076**
R 2	*2375*	*1450*	*1970*	*2820*	*1590*

	2165	*1630*	*2020*	*2225*	*1965*
	1810	*1430*	*2080*	*2040*	*2185*
	2035	*1605*	*2150*	*2040*	*2200*
	2040	*1305*	*1910*	*1715*	*2105*
	1465	*2120*	*2120*		*2335*
	1915	*1355*	*1785*	*2790*	*2035*
	2030	*1480*	*1930*	*1355*	*1740*
	2105	*1100*	*1955*	*1765*	*2190*
	2175	*1350*	*2100*		*2415*
sum r 2	*20115*	*14825*	*20020*	*16750*	*20760*
Average	**2012**	**1483**	***2002***	***2094***	***2076***
R 3	*2030*	*1950*		*2430*	*1980*
		1400	*1485*	*2200*	*2000*
	1940	*1300*	*1930*	*2260*	*2200*
	1885	*1740*	*2070*	*1300*	*1850*
	1725	*1570*	*2070*	*1750*	
	1555	*1220*	*2340*	*1860*	*1700*
	2470	*1750*	*2040*	*2240*	*1605*
	2065	*1580*	*1975*	*1750*	*2240*
	1860		*1515*	*2210*	*1460*
	1935	*1725*	*2205*	*2200*	*1900*
sum r 3	*17465*	*14235*	*17630*	*20200*	*16935*
Average	**1941**	**1582**	**1959**	**2020**	**1882**
R 4		*1620*	*1975*	*1890*	*2345*
	2560	*1555*		*1685*	*2105*
	1840	*1810*	*2285*	*2025*	*2000*
	2045	*1585*	*2100*	*2470*	*2200*
	2140	*1685*	*2200*	*2100*	*1910*
	2225	*2060*	*2115*	*2250*	*2100*
	2230		*1920*	*2145*	*2340*
	1735	*1455*	*1850*	*1660*	*1870*
	1930	*1665*	*2120*	*1745*	*2050*
	2015	*1555*	*2200*	*1345*	*1650*
sum r 4	*18720*	*14990*	*18765*	*19315*	*20570*
Average	**2080**	**1666**	**2085**	**1932**	**2057**
Av. Of trt	**2012**	**1569**	**2011**	**1992**	**2023**

Table (7): Average daily feed intake / bird for different week.

(Week 1)

Replicate	1	2	3	4	5
r1	123	144	123	132	115
r2	147	116	128	121	119
r3	133	109	134	153	120
r4	135	120	127	128	113
average of trt	134	122	128	133	117

(Week 2)

Replicate	1	2	3	4	5
r1	249	226	195	252	299
r2	215	202	215	1930	172
r3	209	156	249	299	195
r4	257	221	195	242	264
average of trt	232	201	213	681	232

(Week 3)

Replicate	1	2	3	4	5
r1	304	339	226	312	275
r2	2912	202	2312	221	253
r3	260	328	322	371	346
r4	296	345	291	276	337
average of trt	943	303	788	295	303

(Week 4)

Replicate	1	2	3	4	5
r1	520	556	457	634	541
r2	535	479	567	503	585
r3	491	571	500	691	614
r4	656	345	614	608	671
average of trt	550	488	534	609	603

(Week 5)

Replicate	1	2	3	4	5
r1	903	801	807	883	951
r2	86	884	911	759	826
r3	491	768	704	860	656
r4	656	734	868	760	980
average of trt	534	797	822	815	853

(Week 6)

Replicate	1	2	3	4	5
r1	1056	825	1023	983	1169
r2	1104	800	1098	926	1102
r3	1065	710	1002	1130	955
r4	1009	873	969	931	953
average of trt	1058	802	1023	992	1044

Table (8): Percent of organs to live weight for 5 treatments at end 6 week.

(Treatment 1/ Control)

Wt. Gm	**1.00**		**2.00**		**3.00**		**4.00**	
	7 m	**2 f**	**10 m**	**8 f**	**4 m**	**1 f**	**2 m**	**5 f**
Live wt.	2100.00	1660.00	2110.00	1960.00	2120.00	1950.00	2430.00	2010.00
Carcass wt.	73.81	70.78	73.46	70.66	75.47	68.97	73.46	73.63
Total intestinal wt.	7.79	10.55	7.59	8.28	7.27	9.50	8.70	8.70
Wt. of gizzard	2.45	4.26	1.87	2.54	2.32	3.52	2.61	2.71
Wt. of heart	0.50	0.52	0.49	0.74	0.49	0.60	0.61	0.53
Wt. of liver	2.06	2.15	2.39	2.36	2.12	2.26	2.27	2.14
Wt. of cecum	1.06	1.27	0.75	1.22	0.40	0.66	1.07	0.64
Wt. l.i	0.24	0.24	0.21	0.13	0.17	0.15	0.20	0.51
Wt. s.i.	3.92	4.19	4.06	4.02	3.91	4.70	3.76	4.15
Proventricules	0.57	1.16	0.47	0.74	0.45	1.13	0.59	0.64
Neck	4.51	4.20	4.62	5.29	4.75	5.05	4.67	3.94
Wt. head	1.86	2.01	2.32	2.07	2.03	2.08	2.25	1.93

Wt. legs	3.98	3.81	7.58	3.99	4.00	3.59	3.85	4.00
Thighs wt.)	21.06	19.55	20.63	19.48	19.83	18.92	20.38	20.92
Wings wt.	6.79	8.13	7.72	8.11	7.17	7.22	7.20	7.76
Back wt.	13.49	13.15	13.73	13.39	13.73	14.10	14.83	15.11
Breast wt.	24.26	25.60	26.49	24.16	29.70	23.59	26.34	25.65
Spleen wt.	0.14	0.14	0.11	0.08	0.16	0.14	0.11	0.08
Wt. Esophagus	0.12	0.58	0.70	0.66	0.49	0.46	1.07	0.70

(Treatment 2)

Wt. Gm	**1.00**		**2.00**		**3.00**		**4.00**	
	4m	**7f**	**6m**	**4f**	**1 m**	**6 f**	**6 m**	**3 f**
Live wt.	2045.00	1690.00	1750.00	1625.00	1820.00	1690.00	1980.00	1725.00
Carcass wt.	73.10	73.37	77.43	67.07	68.68	74.26	72.22	72.46
Total intestinal wt.	7.70	7.79	8.05	8.07	10.35	9.12	8.60	11.58
Wt. of gizzard	2.54	2.85	2.60	2.92	27.70	2.79	1.70	3.39
Wt. of heart	0.67	0.73	0.84	0.79	0.71	0.79	0.62	0.62
Wt. of liver	2.54	2.72	2.72	2.12	2.72	2.62	2.13	2.24
Wt. of cecum	0.70	0.61	1.18	0.98	0.87	0.87	0.86	0.64
Wt. l.i	0.13	0.17	0.40	0.16	0.21	0.16	0.38	2.45
Wt. s.i.	3.82	3.63	3.34	3.54	5.42	4.72	4.70	4.67
Proventricules	0.53	0.33	0.48	0.46	0.72	0.51	0.42	0.67
Neck	4.66	4.40	4.08	4.87	5.38	4.64	4.85	4.14
Wt. head	2.19	2.22	2.01	1.69	2.12	2.39	1.95	18.37
Wt. legs	5.20	5.87	5.49	4.38	5.11	4.91	4.28	4.28
Thighs wt.	23.09	22	22.69	18.55	21.29	21.87	23.12	20.25
Wings wt.	7.95	8.17	8.30	8.40	7.84	8.96	7.93	8.23
Back wt.	12.79	13.49	15.42	13.16	10.99	14.92	10.18	13.04
Breast wt.	24.05	24.37	25.92	22.04	22.74	23.43	25.40	26.26
Spleen wt.	0.13	0.08	0.13	0.09	0.06	0.12	0.05	0.15
Wt. Esophagus	0.50	0.53	0.53	0.47	1.07	0.58	0.97	0.43

(Treatment 3)

Wt. Gm	1.00		2.00		3.00		4.00	
	5 m	4 f	9 m	6 f	8 m	7 f	10 m	3 f
Live wt.	2020.00	2160.00	1900.00	2010.00	1915.00	1935.00	2085.00	2200.00
Carcass wt.	72.28	71.53	73.42	72.39	71.54	63.82	72.66	72.95
Total intestinal wt.	7.54	10.24	7.81	11.03	8.54	12.65	8.82	12.31
Wt. of gizzard	1.77	3.29	2.21	4.73	2.72	3.10	2.59	3.53
Wt. of heart	0.57	0.58	0.58	0.61	0.55	0.40	0.58	0.61
Wt. of liver	2.70	2.01	2.07	2.29	2.23	1.82	2.11	1.98
Wt. of cecum	0.80	1.66	1.21	1.69	0.84	1.02	0.66	4.41
Wt. l.i	0.19	0.37	0.23	0.35	0.45	0.22	0.53	0.17
Wt. s.i.	4.04	4.20	3.69	3.68	4.12	4.87	4.34	3.59
proventricules	0.45	0.70	0.43	0.56	0.50	0.51	0.53	1.25
Neck	3.95	4.83	4.42	4.01	4.69	4.52	3.69	2.95
Wt. head	2.09	1.98	2.03	1.77	1.99	1.94	1.89	1.86
Wt. legs	4.34	4.13	4.58	4.07	4.41	4.13	4.43	4.39
Thighs wt.	19.01	20.32	16.81	19.7	22.79	21.97	23.74	21.36
Wings wt.	7.56	7.71	6.98	7.92	8.80	8.06	7.91	7.59
Back wt.	16.04	13.65	12.65	15.52	11.19	13.26	11.61	14.12
Breast wt.	25.46	24.81	24.21	25.00	23.93	24.05	25.46	25.68
Spleen wt.	0.22	0.13	0.10	0.20	0.10	0.16	0.14	0.16
Wt. Esophagus	0.73	0.72	0.36	0.58	0.42	3.44	0.53	0.61

(Treatment 4)

Wt. Gm	1.00		2.00		3.00		4.00	
	6 m	5 f	3 m	6 f	2 m	1 f	1 m	3 f
Live wt.	1950.00	2090.00	1970.00	2720.00	2200.00	1650.00	2180.00	2400.00
Carcass wt.	70.77	72.01	70.56	66.91	73.64	70.61	73.62	72.29
Total intestinal wt.	8.08	8.05	7.05	11.32	8.05	16.52	8.54	8.51
Wt. of gizzard	2.03	2.56	1.76	3.64	2.32	2.85	2.57	2.54
Wt. of heart	0.61	0.54	0.64	0.58	0.68	0.56	0.66	0.75
Wt. of liver	2.75	2.44	2.81	2.13	2.21	2.30	2.52	2.38
Wt. of cecum	0.87	0.84	0.95	1.07	0.95	0.78	0.66	0.73

Wt. l.i	0.27	0.11	0.26	0.17	1.27	0.22	0.16	0.19
Wt. s.i.	4.04	4.10	3.42	4.96	3.79	9.70	4.71	3.93
proventricules	0.43	0.60	3.42	0.90	0.38	0.73	0.55	0.58
Neck	4.42	4.38	3.99	4.74	5.39	5.99	5.39	4.36
Wt. head	2.10	1.82	2.18	1.76	2.03	1.98	2.10	1.79
Wt. legs	4.18	3.59	4.19	3.86	4.41	3.64	4.24	4.42
Thighs wt.	20.99	20.81	18.99	18.4	23.55	19.72	21.79	21.28
Wings wt.	8.15	7.60	7.57	6.51	7.50	8.00	7.50	7.47
Back wt.	11.39	14.15	13.41	13.38	12.36	14.62	15.02	13.75
Breast wt.	25.78	24.99	23.54	23.53	24.58	22.70	23.67	25.21
Spleen wt.	0.08	0.19	0.10	0.10	0.10	0.15	0.12	0.07
Wt. Esophagus	0.88	0.44	0.66	1.50	0.86	2.97	0.45	1.13

(Treatment 5)

Wt. Gm	**1.00**		**2.00**		**3.00**		**4.00**	
	6 m	**5 f**	**3 m**	**6 f**	**2 m**	**1 f**	**1 m**	**3 f**
Live wt.	2250.00	2035.00	2120.00	2100.00	1950.00	1900.00	2275.00	2100.00
Carcass wt.	68.44	73.22	72.17	80.24	75.90	74.21	71.65	66.43
Total intestinal wt.	7.71	7.89	8.29	8.79	6.91	8.11	9.46	7.39
Wt. of gizzard	2.10	2.87	2.07	3.20	2.53	2.60	2.61	2.39
Wt. of heart	0.43	0.45	0.68	0.57	0.58	0.72	0.59	0.53
Wt. of liver	1.90	2.13	2.39	2.11	2.10	2.37	2.31	2.07
Wt. of cecum	1.04	0.66	1.07	0.77	0.59	0.82	0.54	0.70
Wt. l.i	0.14	0.24	0.13	0.29	0.43	0.27	0.38	0.13
Wt. s.i.	4.16	3.79	4.48	4.01	3.05	4.03	4.69	3.49
proventricules	0.55	0.60	0.45	0.43	0.48	0.82	0.59	0.45
Neck	4.23	4.27	3.68	5.06	5.03	5.02	4.44	3.52
Wt. head	1.66	1.99	2.00	2.06	2.05	1.90	2.13	1.63
Wt. legs	3.72	4.32	4.62	4.68	3.96	3.92	4.44	3.59
Thighs wt.	20.26	20.85	20.32	23.45	19.33	21.25	20.82	18.67
Wings wt.	8.68	7.45	7.61	8.59	8.08	7.73	7.28	6.91
Back wt.	12.57	14.16	14.76	15.29	13.81	15.23	13.30	13.07
Breast wt.	23.75	26.77	25.30	27.69	28.88	24.60	25.25	26.76
Spleen wt.	0.08	0.06	0.09	0.11	0.09	0.09	0.11	0.08

الجهاز الهضمي في كل من الإناث و الذكور المستخدمة و كذلك على ملحقات الجهاز الهضمي من الغدد. لم يكن لأنزيم الفايتيز تأثير على قطع الذبائح المختلفة حيث تشابهت نسب هذه القطع للذكور و الإناث من الطيور في مجموعات التجربة المختلفة. وبينت التجربة أن أنزيم الفايتيز، عندما أضيف الى العلائق الفقيرة بالفسفور، قد أدى إلى زيادة معدلات الهضم لكل من المادة الجافة، الرماد الخام، و الألياف الخام (ADF, NDF)، كما أدى إلى نقص ($P<0.5$) معنوي في نسب كل مـــن الكالسيوم و الفسفور و الزنك في زرق الصيصان المغذاة على علائق فقيرة بالفسفور مما يدلل على زيادة الاستفادة من الفسفور في العلائق. و بينت النتائج أيضا أن محتوى العظم من الفسفور و الكالسيوم و الزنك لكل من الذكور و الإناث قد ازداد عندما أضيف الإنزيم إلى العلائق الفقيرة بالفسفور. هذا و يمكن الاستنتاج انه من الممكن توفير كمية لا يستهان بها من النفقات على مصادر الفسفور حيث من الممكن إضافة كميات اقل من هذه المصادر لدى استخدام أنزيم الفايتيز.

تأثير الفايتيز بنسب مختلفة على دجاج اللاحم وعلى مستوى الفوسفور في الجسم

إعداد الطالب

ربيع احسان أحمد صبحه

إشراف

أ.د. جمال ابوعمر

الملخص

تم إجراء هذه التجربة للتعرف على اثر استخدام أنزيم الفايتيز على الصفات الإنتاجية لدجاج اللحم من نوع كوب 500 ، و على معدلات استهلاك العلف و التحويل الغذائي و نسب التصافي، إضافة إلى صفات الذبائح ومعاملات الهضم ومستويات الكالسيوم والفسفور في عظم فخذ الدجاج. استخدم في التجربة التي استمرت 42 يوم 200 صوص لحم بعمر يوم واحد. و تم توزيع الصيصان على خمس مجموعات احتوت كل منها 40 صوصا، بينما قسمت كل مجموعة إلى أربع مككرات احتوت كل منها 10 صيصان. و قد كانت المجموعات كالتالي: المجموعة الأولى هي مجموعة الشاهد و التي تشابة العلائق التجارية المستخدمة في المزارع، بينما كانت المجموعة الثانية تحوي نسب اقل من الفسفور المقررة لصيصان اللحم، أما المجموعات الثلاث الأخرى فقد احتوت نسب من الفسفور مشابهة للمجموعة الثانية إلا إنه أضيف إليها أنزيم الفايتيز بمعدل 1000، 2000 و 3000 وحدة لكل كغم من العلف، على الترتيب. و قد تم عمل تجربة هضم في الأيام الثلاثة الأخيرة من التجربة حيث تم اخـــــذ اربع صيصان من كل من مكررات المجموعات، و تم ذبحها على عمر 42 يوما بعد تصويمها مدة 8 ساعات من اجل دراسة بعض خصائص الذبائح ومستوى الكالسيوم والفسفور في العظم. بينت النتائج أن للأنزيم المضاف تأثير معنوي ($P<0.5$) على معدلات الوزن عندما أضيف إلى العلائق الفقيرة بالفسفور ابتداء من الأسبوع الرابع، كما أنه أدى الى زيادة معنوية ($P<0.5$) في استهلاك العلف للصيصان المغذاة على العلائق الفقيرة بالفسفور أيضا. و كان للأنزيم نفس الأثر على معدلات التحويل الغذائي و نسب التصافي. إضافة إلى تأثيره المتباين على مكونات

جامعة النجاح الوطنية
عمادة كلية الدراسات العليا

تأثير الفايتيز بنسب مختلفة على دجاج اللاحم وعلى مستوى الفوسفور في الجسم

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قدمت هذه الأطروحة استكمالا لمتطلبات درجة الماجستير في الانتاج الحيواني بكلية الدراسات العليا في جامعة النجاح الوطنية في نابلس، فلسطين.

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