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Effects of Phytase and Dicalcium Phosphate Supplementation on Growth Performance of Broiler Chickens

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ABSTRACT

Phytate is an inactive form of phosphorus that is converted into an active form with the help of the phytase enzyme. This enzyme plays a major role in the digestion of protein/amino acids, energy metabolism, mineral storage, and bone development of chickens during the growth stage. Dicalcium phosphate (DCP) is an important compound among the minerals that has a ratio of active calcium and phosphorus effects of calcium and phosphorus on the growth of broilers, especially in the first stage of life, causing rapid growth. This experiment was conducted to study the comparative effect of supplementing phytase enzyme and DCP on the growth performance of broiler chickens in 28 days. All (150) one-day-old chickens were randomly divided into five equal groups, and each had 3 replicates. 30 birds in each group and (10) chicks in each replicate. The control (basal diet) and Treatment 1: 1000 IU/Kg phytase with starter fed (first 14 days), Treatment 2: 1000 IU/Kg phytase from the first day to the last day of the study, Treatment 3: 15 gr/Kg DCP with starter fed (first 14 days), and Treatment 4: 15 gr/Kg DCP from the first day to the last day of the study. The experiment showed that the T2 group gained 1010 g significantly ($P < 0.01$) more weight than all other groups. The feed intake was lower and had a significant ($P < 0.01$) food conversion ratio (FCR) as well. It can be concluded that the addition of 1000 IU/kg phytase enzyme in the feed of broiler chickens has efficient and significant results on their live body weight, weight gain, FCR, and feed intake.

Keywords: Broiler, DCP, Growth, Live Body Weight, Phytase, Weight Gain

INTRODUCTION

Poultry production in Afghanistan is increasing day by day. There has been an increase in the production of chickens in the country due to improved infrastructure, technology, and various research on chicken growth. Investment in the poultry sector has also increased over the past few years, resulting in increased production. but it has not met the need of consumers in Afghanistan. To meet this objective, various research studies have been conducted on the growth of broilers In the past few years, phytase enzyme has been used in the broiler feed to avoid the addition of inorganic phosphorus in the diet, because the use of phosphorus in the diet causes environmental pollution (Shahzad et al., 2013). This enzyme can make the relation between the phytate and phosphorus and increase the secretion of phosphorus (Kornegay et al., 1999). Phytate is an inactive form of phosphorus that is converted into an active form with the help of the phytase enzyme. Non-ruminant animals like chickens cannot utilise phosphorus in their diets due to a lack of phytase

enzymes (Shahzad et al., 2013). Phytase enzymes have six types; four types have fungal origin, and two types have bacterial origin. Fungal enzymes (Aspergillus A, Aspergillus R, Peniophora, and Aspergillus T) are commercially produced on a large scale for feed additives. Bacterial enzymes (E. coli phytase and Bacillus phytase) are produced on a small scale for use in a laboratory (Igbasana *et al*., 2000).

Aspergillus R is used more than the other enzymes in broiler feed; 50% to 60% of the phosphate requirement has been eliminated by the addition of this enzyme in poultry pig feeds (Jayaprakash et al., 2016). The phytase enzyme plays a major role in the digestion of protein/amino acids, energy metabolism, mineral storage, and bone development of chickens during the growth stage (Shahzad et al., 2013). Additional phytase enzyme in diets causes significant weight gain and increases the weight of the liver too in broiler chickens (Wang et al., 2013). The efficacy of supplemental microbial phytase enzyme is related to its rate of concentration, dietary calcium and phosphorus ratio, vitamin D_3, types of feed, age, and genotype of birds (Singh P.K., 2008). If given more (250 IU/kg) phytase enzyme in feed, it has a positive effect on broiler chicken growth performance (Assuena et al., 2009). 2000 IU/kg phytase enzyme supplementation in the diet of the broiler at the initial stage (0-14 days) has positive results on the growth and FCR of the broilers (Babatunde et al., 2019). Phytase is essential in protecting minerals in poultry diets, including 9% in protecting calcium, 10% in phosphorus, and up to 16% in zinc (Agustin Brenes et al., 2003).

Minerals that animals require extensively and that carry on important functions in the body; deficiency of them causes less production and various diseases. such as calcium, phosphorus, sodium, chlorine, sulphur, potassium, and magnesium. The addition of them is very important in the diet of chickens, especially because calcium and phosphorus play a greater role in the bone structure of the animal body than all other minerals (Kheiri and Rahman, 2006). DCP is an important compound among the minerals, which has a ratio of active calcium and phosphorus; therefore, it is used as a source of calcium and phosphorus in the diets of broiler chickens (Elnour and Ibrahim, 2003).

Calcium is found (98-99) % in bones and (1-2) % in plasma and other body fluids in broiler chickens (Dudek, 1997; Klasing, 1998; Siebrits, 1993). Calcium is necessary for muscle contraction, ovarian function, the structure of bones and teeth, blood clotting, nerve impulse transmission, heart rate regulation, and fluid balance within cells. Phosphorus also plays an important role in the formation of bones, the regeneration of cells and tissues, the structure of cell membranes, the structure of DNA and RNA, and the structure of energy sources such as ATP and ADP. (Pravina et al., 2013). If given (10 g of calcium and 4.5 g of phosphorus)/kg feed, broiler chickens diets have positive results on growth performance (Whitehead, 2002).

A comparative study was conducted between the DCP and monocalcium phosphate (MCP), which were added in different amounts with broiler feed. The results showed that (4.3) gr/kg DCP additive of broiler chicken feed in the first three weeks has positive effects on growth and feed intake. If after 21 days, the amount will have increased to (4.5) gr, the efficiency will be increased (Elnour and Ibrahim, 2003). Effects of calcium and phosphorus on the growth of broilers, especially in the first stage of life, cause rapid growth (James and Gillespie, 1984). The ratio of calcium and phosphorus is an essential factor for gaining high weight in chicken feed (Hulan et al., 1985, 1986). Phosphate digestion in poultry is related to the amount of calcium and phosphorus in the diet and their ratio (Günther and al-Masri, 1988; Al-Masri, 1995; Driver et al., 2005; Selle et al., 2009). In these articles, phosphorus in broilers' diets caused environmental pollution. To solve this problem in this research, DCP was used instead of phosphorus and then compared to phytase supplements. Phosphorus in the diet cannot meet the boiler's body needs; if calcium-containing contents are added to the diet, the need for bone mineralization will be met. but the expected results will not be obtained unless microbial phytase is used (Rousseau et al., 2012). The objective of the study is to investigate the effects of phytase and DCP supplementation in feed on the growth performance of broiler chickens to gain better production for meeting the consumers demand in the country.

MATERIALS AND METHODS

Study Area

The current study was carried out over the course of 28 days (4 weeks) at the local farm in Kabul, Afghanistan's Paghman district from 2021/06/09 to 2021/07/07.

Experimental Design

In this study, a completely randomized block design was employed to choose birds at random for each group. A total of (150) one-day-old broiler chickens were divided into five equal groups; four were treatment groups, and one was a control group. with three replicates per group (30 birds per treatment and 10 birds per repetition). The birds were fed a basic diet consisting of Starter feed for 14 days and finisher feed for 28 days. T1 and T2 groups received 1000 IU/kg of the phytase enzyme for 14 and 28 days, respectively, while T3 and T4 groups received 15 g/kg of DCP for 14 and 28 days, respectively. The control group was fed a baseline diet for 28 days.

Feed: Habib Feed was purchased from a local market as needed, which had good quality in the poultry industry in Afghanistan.

Statistical Analysis

The data obtained were analyzed by using SPSS one-way analysis of variance (ANOVA) post hoc test according to the method described by Values of $P < 0.05$ were considered significant.

RESULTS

The mean weights of the feed intake at the end of every week of all groups are presented in Table 1; the FCR of all groups at the end of every week is presented in Table 2; the mean weight gains of all groups at the end of every week are presented in Table 3; and the live body weights of all groups at the end of every week are presented in Table 4. The mean feed intake during the first two weeks of T1, T2, T3, and T4 groups was significantly ($P < 0.05$) less than that of the control group. In the 3rd week of the study, the T1 and T2 groups were significantly ($P < 0.01$) taking in less feed than the T3 and control groups, and the T2 group was also significantly ($P < 0.01$) taking in less feed than the T4 group. In the 4th week of the study, the T1, T2, and T4 groups were significantly ($P < 0.01$) taking in less feed than the T3 and control groups.

Table 1: Weights of Feed Intakes in all weeks

Treatment groups	Weeks				
	1st Week	2nd Week	3rd Week	4th Week	Total
T0	122.04±3.02^{a}	359.2±4.50^{a}	430.11±4.00^{a}	654.00±4.04^{a}	1565.35
T1	113.98±1.27^{b}	331.36±5.06^{b}	416 ±4.00^{bc}	628.89±6.00^{b}	1490.15
T2	115.9±1.00^{b}	332.88±4.73^{b}	411.96±5.00^{c}	627.28±5.00^{b}	1487.74
T3	112.96±1.74^{b}	333.87±3.61^{b}	429.8±5.00^{a}	644.00±4.00^{a}	1521.03
T4	116.4±2.40^{b}	324.28±5.57^{b}	426.7±5.00^{ab}	630.00±5.00^{b}	1496.38
Significant difference	*	**	**	**	
Means±SE of feed intake weights by the gram in all weeks					

with the control. During the 3rd week of the study, the T2 group had significance ($P < 0.01$) when compared with the T3 and control groups, but the T1 and T4 groups had no significance with all other groups. In the 4th week of the study, the T2 group had a significantly ($P < 0.01$) better FCR than all other groups.

Table 2: FCR in all weeks

Treatment Groups	Weeks				Total Mean
	1st Week	2nd Week	3rd Week	4th Week	
T0	1.36±0.074^{a}	1.71±0.030^{a}	1.77±0.064^{a}	1.72±0.032^{a}	1.7
T1	1.21±0.017^{b}	1.52±0.016^{b}	1.72±0.015^{ab}	1.67±0.028^{a}	1.61
T2	1.22±0.034^{b}	1.52±0.015^{b}	1.64±0.005^{b}	1.55±0.015^{b}	1.54
T3	1.24±0.025^{b}	1.59±0.010^{b}	1.75±0.047^{a}	1.70±0.050^{a}	1.65
T4	1.29±0.030^{ab}	1.54±0.051^{b}	1.70±0.01^{ab}	1.65±0.030^{a}	1.6
Significant difference	**	**	**	**	
Means±SE of FCR in all weeks					

significantly ($P < 0.05$) higher body weight than the control group. In the 3rd week of the study, the T2 and T4 groups had significantly ($P < 0.01$) gained higher body weight than all other groups. In the 4th week of the study, the T2 groups had significantly ($P < 0.01$) gained higher body weight than all other groups.

Table 3: Body Weight Weekly Gains at the end of every week

Treatment Groups	Weeks			
	1st Week	2nd Week	3rd Week	4th Week
T0	89 ±1.73^{b}	210.1±2.69^{b}	243±2.00^{b}	379.3±3.82^{b}
T1	94.2 ±0.76^{a}	218.3 ±1.5^{a}	246±2.64^{b}	376.3±7.93^{b}
T2	95.0 ±1.55^{a}	219.1 ±2.08^{a}	251.2±1.73^{a}	404.7±8.00^{a}
T3	91.1 ±2.00^{ab}	209.07±2.00^{b}	247.2±1.18^{b}	379.3±7.00^{b}
T4	91 ±1.32^{ab}	210.57±2.00^{b}	251±2.05^{a}	384.94±4.00^{b}
Significant difference	*	**	**	**
Means±SE of body weight weekly gains				

The mean live body weight of chicks during the first two weeks; T1 and T2 groups had significantly ($P<0.05$) gained higher body weight than the control group. In the 3rd week of the study, the T2 group had significantly ($P < 0.01$) gained higher body weight when compared to the control group. Similarly, at the 4th week of the study, T2 groups had significantly ($P < 0.01$) gained higher body weight than all other groups.

Table 4: Live Body Weight at the end of every

Treatment Groups	Age by Days			
	7days	14days	21days	28days
T0	130±0.52^{b}	340.3±2.98^{b}	583±5.44^{b}	962.3±11.59^{b}
T1	135.1 ± 1.17^{a}	353.2±5.36^{a}	595 ±6.01^{ab}	971.3±12.06^{b}
T2	136 ± 2.91^{a}	354.1±5.15^{a}	605.3±3.33^{a}	1010±9.16^{a}
T3	132±1.62^{ab}	341±1.80^{b}	587±4.26^{b}	966.3±11.02^{b}
T4	133.5±1.29^{ab}	342 ±2.40^{b}	593±4.29^{ab}	977.0±11.00^{b}
Significant difference	*	**	**	**

Means±SE of live body weight

DISCUSSION

The phytase enzyme plays a major role in the digestion of protein/amino acids, energy metabolism, mineral storage, and bone development of chickens during the growth stage (Shahzad et al., 2013). Shahzad et al. (2013) found that phytate is an inactive form of phosphorus that is converted into an active form with the help of the phytase enzyme. Non-ruminant animals like chickens cannot utilise phosphorus in their diets due to a lack of phytase enzymes. The result of the present study showed that 1000 IU/kg phyteze enzyme supplementation with 15 gr/kg DCP in broiler chicken diet had positive effects on growth performance, FCR, feed intake, and live body weight of broiler chicken. Similar results were obtained by Babatunde et al. (2019), who found that the phytase enzyme (2000 IU/kg) as a supplement in the diet of the broiler at the initial stage (0-14 days) has positive results on the growth and FCR of the broilers.

There are several studies indicating Assuena et al. (2009) and Whitehead (2002) that the supplementation of phytase enzyme more than (250 IU/kg) and dicalcium phosphate (10 gr of calcium and 4.5 gr of phosphorus)/kg had positive effects on the growth performance and FCR of broiler chicken. Wang et al. (2013) also discovered that supplementation of phytase enzyme in the diet of broiler chickens had significantly positive effects on the weight gain and liver weight. Our result also revealed that the supplementation of 1000 IU phytase enzyme and 15 g/kg of di-calcium phosphate during the 3rd and 4th weeks had significant effects on the growth performance and FCR of broiler chickens.

The present study found that supplementing broilers with 15 g/kg DCP during the 3rd and 4th weeks significantly improved their feed intake. A similar result was obtained by Elnour and Ibrahim (2003) in a comparative study between the DCP and monocalcium phosphate (MCP) (4.3) gr/kg DCP additives in broiler chicken feed during the 3rd week, which had positive effects on the feed intake of broilers. Shahzad et al. (2013) found that the phytase enzyme is used in the broiler feed to avoid the addition of inorganic phosphorus in the diet because the use of phosphorus in the diet causes environmental pollution. Kornegay *et al.* (1999) showed that this enzyme can change the relationship between phytate and phosphorus and increase the secretion of phosphorus. Wang et al. (2013) found that additional phytase enzymes in diets cause a significantly increased weight and increase the weight of the liver too in broiler chickens.

Hulan et al. (1985, 1986) showed that the ratio of calcium and phosphorus is an essential factor for gaining high weight in chicken feed. Singh P.K. (2008) found that the efficacy of supplemental microbial phytase enzyme is related to its rate of concentration, dietary calcium and phosphorus ratio, vitamin D_3, types of feed, age, and genotype of birds. James and Gillespie (1984) found that the effects of calcium and phosphorus on the growth of broilers, especially in the first stage of life, cause rapid growth.

CONCLUSION

It can be concluded that the addition of 1000 IU/kg phytase enzyme during the 3rd and 4th weeks in the feed of broiler chickens has efficient and significant results on their live body weight, weight gain, FCR, and feed intake. This suggests that broiler chickens could be raised to be more productive by using phytase enzyme as an effective supplement.

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AUTHORS CONTRIBUTIONS:

[Wahidyar Mohammad Yousof[1]] (Department of Animal Science, Paktika University, Paktika, Afghanistan): wrote the report, collected and analyzed data, and came up with the research proposal.

[Niazi Mir Hatem[2]] (Department of Animal Science, Nangarhar University, Nangarhar, Afghanistan): helped create the study, interpret the data, and make important changes to the publication.

[Ahmadi Mahboobullah[3]] (Department of Pre-Clinic, Afghanistan National Agricultural Sciences and Technology University, Kandahar, Afghanistan): supplied veterinary scientific knowledge, helped with study design, and helped with manuscript draughting and review.

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