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Effect of Dietary Phytase Supplementation on Growth Performance, Organ Weight and Tibia Ash of Broilers

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ABSTRACT This study was conducted to investigate the effects of dietary inclusion of phytase on the growth performance, organ weight, and tibia ash of broilers. A total of 1008 one-day-old Ross 308 broiler chicks (mixed gender) with body weight 42 ± 0.90 g (mean ± SD) were used in a trial for 32 d. Chicks were assigned to one of the two treatment diets. Each treatment consisted of 28 replicate cages, with 18 birds per cage. The dietary treatments were as follows: CON, basal diet; TRT1, basal diet + phytase 1,500 Fan Terminal Unit (FTU)/kg diet. Dietary inclusion of 1,500 FTU/kg phytase supplementation in broilers showed only slight improvements in daily feed intake (P=0.086) and feed conversion ratio (P=0.065) on day 9 compared with that in the control group. However, organ weights of the breast muscle, liver, spleen, kidney, and bursa of Fabricius were not affected by the dietary treatments. In addition, the dietary inclusion of 1,500 FTU/kg phytase supplementation in the broiler diet had no effect on tibia ash. The addition of 1,500 FTU/kg phytase in the basal diet of broilers did not have any adverse effect on growth performance, organ weight, and tibia ash, suggesting that phytase supplementation in broiler diets will exhibit comparable effects as that of corn-soybean meal-based diet.

(Key words: phytase, growth performance, organ weight, broiler)

INTRODUCTION

Plant-based feedstuffs widely derived from plant seeds become the predominant feed components in monogastric diets due to its anti-nutritional substances such as phytic acid. Phytate (myoinositol 1, 2, 3, 4, 5, 6-hexakis dihydrogen phosphate) stores 60~85 % of phosphorus (P) in plants, with corn and soybean meal diets typically containing 8.0~9.0 g of phytate per kilogram of feed (Cabahug et al., 1999). Phytate utilization and digestion in chicken is poor due to insufficient endogenous phytase activity, necessitating inorganic phosphate supplementation to meet the bird's phosphorus (P) requirement (Cowieson et al., 2006; Wendt and Rodehutscord, 2004). Boling et al. (2000) stated that feed phosphates represent a significant cost-effective element in chicken diets, with P being the third most expensive ingredient after energy and protein. Also, the anti-nutritive characteristics of phytate can cause insoluble complexes to form as a result of mineral chelation and nutrient binding, as well as an increase in endogenous losses, obstructing nutrient digestion, and negatively reducing avian performance (Selle et al., 2000; Cowieson et al., 2004; Woyengo and Nyachoti, 2013). Phytase is an enzyme that breaks down the bonds and hold the phosphate group of phytate together, by releasing P and other minerals (Cromwell and Coffey, 1991). Thereby phytase makes plant P available to animals, its inclusion in diets can lower the cost of P supplementation. The dietary inclusion of phytase supplementation for broilers has been extensively researched for a variety of reasons, including bone characteristics, growth performance, nutrient digestibility, and intestinal health (Cowieson et al., 2011; McCormick et al., 2017; Babatunde et al., 2019). However, other studies have found that phytase supplementation can help to modulate the intestinal microbiota by reducing harmful bacteria and boosting beneficial bacteria, which can improve nutritional digestibility, intestinal morphology, and bone in broiler chickens (Borda-Molina et al., 2016; Mancabelli et al., 2016). Although several studies have found that phytase has beneficial effects in poultry, more research is needed to achieve the production functions. Therefore, we attempted this study to evaluate the effect of phytase supplementation on growth performance, organ weight and tibia ash in broilers.

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MATERIALS AND METHODS

The experimental ethics were reviewed by Animal Care and Use Committee of Dankook University, at Cheonan, Chungcheongnam-do, South Korea (DK-1-2019).

1. Birds Husbandry, Experimental Design and Dietary Regimen

This trial was carried out for thirty-two days at Dankook University "Intensive Poultry Farm Unit" (Cheonan, Republic of Korea) with 1008 one day old Ross 308 broiler chicks (mixed gender). Chicks were assigned to one of two treatment diets at randomly (28 replicate cages per treatment, 18 birds per cage). The dietary treatments were as: CON-basal diet; TRT1 – basal diet + Phytase 1500 FTU/kg diet. All nutrients in diets were formulated to meet or exceed the recommendation of NRC (1994) for broiler chickens and fed in mash form (Table 1). The dietary phytase supplement (1,500 FTU/kg diet) used in this study was commercially obtained from GenoFocus Inc. (Daejeon, Republic of Korea). For the first three days, the trial room temperature was set up to of 33℃ and gradually dropped to reach 24℃ with a

Table 1. Feed composition of broiler (as fed-basis)

Item	Basal diet
Ingredients (%)	
Corn	43.63
Soybean meal	35.08
Corn gluten meal	13.00
Wheat bran	3.00
Soyoil	1.76
TCP	1.81
Limestone	0.94
Salt	0.36
Methionine (99%)	0.19
Lysine	0.03
Mineral mix[1]	0.10
Vitamin mix[2]	0.10
Total	100.00
Analyzed value	
Crude protein (%)	23.00
Ca (%)	1.10
P (%)	0.83
Available P (%)	0.54
Lys (%)	1.26
Met (%)	0.54
ME (kcal/kg)	3,200
FAT (%)	4.45
Fiber (%)	3.55
Ash (%)	6.76

[1] Provided per kg of complete diet: 37.5 mg Zn (as $ZnSO_4$); 37.5 mg Mn (as MnO_2); 37.5 mg Fe (as $FeSO_4 \cdot 7H_2O$); 3.75 mg Cu (as $CuSO_4 \cdot 5H_2O$); 0.83 mg I (as KI); and 0.23 mg Se (as $Na_2SeO_3 \cdot 5H_2O$).

[2] Provided per kg of complete diet: 15,000 IU of vitamin A, 3,750 IU of vitamin D_3, 37.5 IU of vitamin E, 2.55 mg of vitamin K_3, 3 mg of thiamin, 7.5 mg of rivoflavin, 4.5 mg of vitamin B_6, 24 ug of vitamin B_{12}, 51 mg of niacin, 1.5 mg of folic acid, 0.2 mg of biotin and 13.5 mg of Ca-pantothenate.

humidity of 60 percent, remains throughout the experiment.

2. Sampling and Chemical Analysis

The body weight (BW), average daily feed intake (ADFI), and feed conversion ratio (FCR) of chicks were measured on pen basis on days 9, 21, 32, and overall trail period. At end of the experiment, 112 birds (2 birds/cage, 56 birds/treatment) were killed by cervical dislocation. The abdominal fat, liver, spleen, bursa of fabricius, and breast muscle were carefully removed by the experts. The relative organs were weighed individually and estimated as mass BW. The respective samples were taken to the laboratory, and breast meat was separated for meat quality analysis.

Tibiae were deflated and cartilaginous caps were removed immediately after organ collection (36 birds/treatments) and kept in plastic bags at −20℃ to maintain wetness until analysis (Crenshaw, 1986). Frozen tibiae were thawed by leaving them in plastic bags at room temperature for 1 h. The plastic bags were opened only when the bone was being removed for testing. In order to obtain similar thawing times, bones were removed from the freezer at intervals and in small groups, depending on how fast the testing was going. Sheared tibiae pieces were collected, defatted and placed in electric heater drying oven at 500℃ for 5 h to get the ash. Finally, the ash was kept in conventional oven for dry matter determination.

3. Statistical Analysis

All data were statistically analyzed by *t*-test using SAS program (SAS Inst. Inc., Cary, NC). Results were considered significant at $P<0.05$ level and $P<0.10$ was considered as a trend.

RESULTS AND DISCUSSION

The enzyme phytase (myo-inositol hexaphosphate phosphohydrolase) promotes hydrolysis of the mineral phosphate of InsP6 from myo-inositol to InsP1 via InsP5. Phytases are present in plant, microorganism, and animal tissues (Greiner et al., 1997). The current research was aimed at evaluating the effect of phytase supplementation on growth performance, organ weight, and tibia ash in broilers. The effects of phytase supplementation on growth performance are shown in Table 2.

Table 2. The effect of Phytase supplementation on growth performance in brolier[1]

Items	CON	TRT1	SEM[2]	*P* value
d 1 to 9				
BWG (g)	148[b]	154[a]	2	1.000
ADFI (g)	176	181	2	0.086
FCR	1.175	1.177	0.009	0.065
d 9 to 21				
BWG (g)	628[ab]	614[b]	8	0.708
FI (g)	874	867	6	0.655
FCR	1.396	1.415	0.016	0.621
d 21 to 32				
BWG (g)	945	962	13	0.807
FI (g)	1,834	1,842	14	0.884
FCR	1.952	1.924	0.029	0.823
Overall				
BWG (g)	1,718	1,730	16	0.103
FI (g)	2,885	2,890	15	0.524
FCR	1.683	1.673	0.015	0.959

[1] Abbreviation: CON, Basal diet; TRT1, Basal diet + Phytase 1,500 FTU/kg diet.
[2] Standard error of means.
[a,b] Means in the same row with different superscripts differ ($P<0.05$).

Broilers fed 1500 FTU/kg phytase supplementation showed only slight improvements on ADFI and FCR at day 9. Similarly, Santos et al. (2005) reported that broilers fed diets contain phytase had lower feed intake and weight gain. In addition, Conte et al. (2003) stated 800 to 1,200 U/kg phytase supplement in broiler diet had no effect on their performance. However, Walters et al. (2019) demonstrate that the inclusion of increasing levels of phytase (3000 FTU/kg) had increased the feed consumption and BW throughout the study. According to Cowieson et al. (2006) report increasing phytase supplementation at logarithmic doses from 150 to 24,000 FTU/kg improved nutrient utilization, feed intake, and body weight (BW) in low-*P* diets.

Calcium (Ca) and Phosphorous (P) are the two primary minerals that make up the inorganic matrix of bone (Ali, 1992; Rath et al., 1999). Besides, bone status is widely utilized to the measure of mineral adequacy. Such bone mineralization impacts on bone strength and poor mineralization has been linked to an increased risk of fractures (Reichmann and Connor, 1977; Blake and Fogelman, 2002). Weak bones shatter during processing may resulted with inferior meat quality. In addition, weak legs sometimes result in lower feed intake, reducing weight gain as well as egg quality and quantity (Rowland et al., 1967; Orban et al., 1999). Tibia bone ash has long been regarded as a suitable measure for assessing phytase efficiency in broiler mineral use and deposition (Tang et al., 2012; Lalpanmawia et al., 2014). The tibia ash of broilers fed phytase supplement is presented in Table 3. The dietary inclusion of 1500 FTU/kg Phytase supplementation had no significant effect on tibia ash in broilers chickens. According to Sebastian et al. (1996) the improvement of the ash percentage in the tibia may imply an increase in bone mineralization and to increase the mineral availability released by phytase from the phytate-mineral complexes. Similarly, Lan et al. (2012) reported that male broilers fed with low-P diets (0.21 % avP) had decreased tibia bone ash, Ca, and P content. In addition, Panda et al. (2007) noted a decline in tibia ash concentration as dietary non-phytate phosphorus (nPP) levels were reduced in 21-day-old broilers. The maximum tibia ash, P, and Ca content was obtained with phytase supplied at super-dose concentrations, with significant improvements in ash and P content beyond that of ordinary dosages due to the possible liberation of higher amounts of minerals.

The determination of poultry meat quality become a complicated concept since it depends on consumer pre-

Table 3. The effect of phytase supplementation on tibia ash in broilers[1]

Items (%)	CON	TRT1	SEM[2]	*P* value
d 32				
Tibia ash	39.76	39.83	2.44	1.000

[1] Abbreviation: CON, basal diet; TRT1, basal diet + phytase 1,500 FTU/kg diet.
[2] Standard error of means.

Table 4. The effect of phytase supplementation on organ weight in broilers[1]

Items	CON	TRT1	SEM[2]	*P* value
Relative organ weight (%)				
Breast muscle	9.77	10.04	0.20	0.077
Liver	3.05	3.66	0.39	0.892
Spleen	0.09	0.11	0.01	0.702
Kidney	0.81	0.85	0.07	0.727
Bursa of fabricius	0.22	0.16	0.02	0.700

[1] Abbreviation: CON, basal diet; TRT1, basal diet + phytase 1,500 FTU/kg diet.
[2] Standard error of means.

ferences (Ishamri and Joo, 2017). The result of Phytase supplementation on organ weight are shown in Table 4. Organ weight of breast muscle, liver, spleen, kidney, and bursa of fabricius did not affect by the inclusion of phytase supplementation in broiler diet. Previously, Akyurke et al. (2011) found that the inclusion of phytase to low-P diet of corn-soybean meal did not enhance the weight of heart, liver and spleen. Similarly, Attia et al. (2006) stated that diet supplemented phytase (500 FTU/kg) to alter the available P and Ca % showed the comparable results. Also, Akyurke et al. (2009) discovered broilers fed diet supplemented with 0.25 % (NPP) phytase could improve the broilers heart weight.

SUMMARY

The current study will be the base for further research. The dietary inclusion of phytase supplement at 1500 FTU/kg in the diet of broiler had a no positive effect on the growth performance, organ weight and tibia ash in broilers. On other hand, further research is need for various standards of dietary phytase to understand the mechanism that underlies with the effect of phytase on broiler performance.

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