Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.7, No.10, 2017

The Efficacy of Microbial Phytase on Growth Performance, Phosphorus Utilization and Cost-benefit Analysis of Broiler Chicks

Daramola Olajumoke[1,2] and Fasuyi Ayodeji[2]

[1]Department of Agricultural Technology, Federal Polytechnic, Ado-Ekiti, Ekiti-State

[2]Department of Animal Production and Health Sciences, Ekiti State University, Ado-Ekiti,

Abstract

A four-week feeding trial was carried out to investigate the effect of exogenous phytase on growth performance, phosphorus utilization and cost analysis of broiler chicks. Five iso-nitrogenous and iso-caloric diets were compounded. The reference diet (diet containing both groundnut cake and soybean meal as plant protein and fish meal as animal protein source without phytase supplementation), diet 2 had groundnut cake based non-phytase diet, diet 3 had groundnut cake based phytase diet, diet 4 had soybean plant based non- phytase diet and diet 5 had soybean plant based phytase diet. 240 day-old broiler chicks were randomly assigned to the diets in a completely randomized design. Feed and water were provided *ad-libitum*. Each diet was allocated to 48 broiler chicks which were further divided into four replicates of 12 birds each. The feed intake, weight gain, feed conversion ratio and protein efficiency ratio of the birds were not significantly ($p>0.05$) influenced by the experimental diets. The final liveweight of birds on reference diet, diets 3and 5 (diets supplemented with phytase) however, higher ($p<0.05$) than the birds on phytase free diets. The phosphorus utilization of broiler chicks revealed a significant ($p<0.05$) increase in apparent phosphorus digestibility of birds on diets 3 and 5 at 74.68±2.31% and 72.73±2.55%, respectively over other plant protein based diets without phytase supplementation. The cost analysis of broiler chicks revealed that birds on phytase supplemented diet had a lower cost of feed per kg weight gain than the birds that were not phytase supplemented. Results show that phytase supplementation in broiler chicks diets had significantly favourable effects on growth parameters, enhanced utilization of feed which improved the nutrient digestibility of phosphorus and the cost per kg weight gain were highly reduced with phytase inclusion.

Keywords: Broiler chicks, phytase, growth performance, phosphorus, cost analysis

1. Introduction

Phytase, the mixed salt of phytic acid (myo-inositol 1,2,3,4,5,6- hexakis di-hydrogen phosphate is a ubiquitous component of plant-sourced feed ingredients which accounts for approximately) two-thirds of the total phosphorus found in plant-based diets (Ravindran *et al*.,1995).

Fifty to eight-five percent of phosphorus stored in cereal grain is bound in phytic acid and its salts (Tran and Skiba, 2005). Therefore, a considerable amount of phosphorus in poultry diets is in form of phytate phosphorus (PP) with negligible availability (Selle and Ravindran, 2007). This is because poultry have limited ability to use PP.

Phytase, a digestive enzyme catalysing the release of phosphorus from the phytate complex, is not in sufficient amount (Applegate *et al*., 2003). The low release of PP in the gut leads to the need for greater dietary supplementation with inorganic phosphorus to meet the bird's requirement for phosphorus and elevated levels of phytate phosphorus being excreted in manure.

Phosphorus is an important mineral because it plays a major role in many body functions and in mineral deposition in the skeleton together with calcium. Phosphorus in poultry manure can cause environmental

problems such as surface water eutrophication. Phytate can also bind to other nutrients and digestive enzymes leading to lower nutrient digestibility and increased nutrient excretion in manure (Lenis and Jongbloed, 1999).

Inorganic phosphorus is an expensive mineral and a finite resource. Supplementation with commercially available exogenous phytase enzyme has significantly increased utilization of phytate-phosphorus in poultry. (Baxter *et al.*, 2003; Angel *et al.*, 2005b).

The study was designed to determine the growth performance, phosphorus utilization of broiler and cost analysis of broiler chicks fed with or without exogenous phytase.

2. MATERIALS AND METHODS

2.1 Experimental Materials

A commercial phytase (Ronozyme-P) was purchased from Lagos. It is a granulated phytase produced from P*eniophora lycii* by submerge fermentation of a genetically modified *Aspergillus oryzae* micro-orgganism. The enzyme has a minimum activity of 250 FTU/KG. The inclusion rate was 0.1g/kg for this study. The day-old broiler chicks were purchased from a reputable hatchery at Ibadan, Nigeria.

2.2 Experimental Diets

Five iso-nitrogenous and iso-caloric broiler chicks diets were formulated with feed ingredients in Table 1. Diet 1 was the reference diet with no phytase supplementation. The protein sources in the reference diet were from both plant and animal origins. Diets 2 and 3 were duplicate diets with 0.1g/kg enzyme supplementation only in diet 3. Diets 4 and 5 were also duplicate diets with 0.1g/kg enzyme supplementation only in diet 5. Diets 2 and 3 had groundnut cake as the major plant protein ingredient while diets 4 and 5 had soybean meal as the major plant protein ingredient. All diets were supplemented with feed grade methionine, lysine and vitamin/mineral premix.

Table 1: Composition of experimental diets ($g100g^{-1}$) for broiler chicks (0-28days)

	Diets				
	1	2	3	4	5
		Phytase inclusion			
Ingredients	Reference diet	-	+	-	+
Maize	45.00	45.00	45.00	45.00	45.00
Groundnut cake	15.00	40.00	40.00	0.00	0.00
Soyabean	25.00	0.00	0.00	40.00	40.00
Wheat offal	8.70	10.70	10.70	10.70	10.70
Fishmeal (72% CP)	2.00	0.00	0.00	0.00	0.00
Bone meal	2.50	2.50	2.50	2.50	2.50
Oyster shell	0.50	0.50	0.50	0.50	0.50
NaCl	0.50	0.50	0.50	0.50	0.50
Methionine	0.15	0.15	0.15	0.15	0.15
Lysine	0.15	0.15	0.15	0.15	0.15
Premix	0.50	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00
Calculated composition					
Crude protein ($g100g^{-1}$)	24.00	23.72	23.72	23.32	23.32
Crude fibre ($g100g^{-1}$)	4.32	3.81	3.81	4.89	4.89
Metabolisable energy (Kcal/kg)	2777.21	2719.69	2719.69	2759.69	2759.69
Analysed composition					
Crude protein (g/100g)	24.23	23.51	23.51	23.53	23.53
Crude fibre (g/100g)	5.30	5.51	5.52	5.67	5.64

Negative sign (-) means no phytase inclusion; positive sign (+) means phytase inclusion at 250 FTU/g minimum activity inclusion rate of phytase in diets

2.3 Bird Husbandry and Experimental Design

Two hundred and forty (240) day old unsexed chicks of commercial broiler strain (Anak 2000) were obtained from a reputable hatchery for this study. The chicks were brooded and fed experimental diets right from day one. All necessary routine veterinary care was observed. There were five experimental treatments with four replicates per treatment and twelve chicks were allotted per replicate amounting to 48 chicks per treatment.

Feed and water were given to the chicks *ad-libitum* throughout the period of the experiment (28days). The daily feed consumption in g/day was determined on daily basis by substracting the weight of the left over feed from the weight (g) of the initially offered. The daily feed consumption in g/day was calculated and was divided by the average daily weight gain to obtain the feed conversion ratio for the chicks on the five experimental diets. The protein efficiency ratio was calculated as the ratio of weight gain to the total protein consumed.

2.4 Mineral Content Determination

Five days to the end of feeding trial, the records of the faeces as well as the corresponding feed intake for the period were collected. The faeces were oven-dried and analysed for phosphorus determination. Phosphorus was determined by the vanado-molybdate method (AOAC, 2010). The proximate composition of the experimental diets and faecal samples were determined by the method of AOAC (2010). Phosphorus retained was calculated as the algebraic difference between the phosphorus in feed and faecal phosphorus (on dry matter basis) for the period of five days towards the close of the feeding trial.

2.5 Cost-Benefit Analysis

The cost analysis was computed based on the prevailing market prices of the feed ingredients. The cost of labour, housing and medication which were common to all the treatments were not included in the analysis. The cost of each experimental diet, cost of feed consumed per bird, the cost of feed per weight gain on each dietary treatment were calculated making use of the unit cost of each ingredient used in the diet formulation.

2.6 Statistical Analysis

Data collected in these study were subjected to analysis of variance. Duncan's Multiple Range Test of one way Anova was used to analyse the mean differences of the same parameters.

3.0 Results

Table 2 shows that the final liveweight of birds on reference diet was significantly ($p<0.05$) different from the other final liveweight of birds fed the experimental diets. The final liveweight of birds on diets 3 and 5 were similar ($p>0.05$) but significantly higher ($p<0.05$) than birds on diets 2 and 4 which were also similar ($p>0.05$).There was no significant ($p>0.05$) weight gain in the experimental birds. However, there were slight increase in the weight gain of birds on phytase supplemented diets. The feed intake, feed conversion ratio and protein efficiency ratio were similar ($p>0.05$) for all the experimental birds.

Table 2: Performance characteristics of broiler chicks fed diets with or without exogenous phytase supplementation (0-28day)

	Diets				
	1	2	3	4	5
			Phytase Inclusion		
Parameters	Reference diet	-	+	-	+
Initial liveweight (g)	40.35±1.25	40.79±1.36	39.98±2.18	40.79±1.15	40.50±2.10
Final liveweight(g)	962.00±3.30[a]	908.16±2.42[c]	930.64±1.51[b]	910.01±2.04[c]	936.75±2.14[b]
Feed intake (g/b/d)	66.02±2.46	65.47±2.35	65.53±2.68	65.36±2.71	65.86 ±2.09
Weight gain (g/b/d)	32.92±1.50	30.98±2.04	31.81±1.82	31.05±1.56	32.01±1.49
Feed Conversion Ratio (FCR)	2.01± 1.01	2.11±1.04	2.06±1.61	2.10±2.02	2.06±2.41
Protein Efficiency Ratio (PER)	1.36±1.51	1.32±2.21	1.35 ±2.71	1.32±2.11	1.36±2.41

Means with different superscript in the same horizontal row differ significantly (P< 0.05) Negative sign (-) means no phytase inclusion; positive sign (+) phytase inclusion at 250 FTU /g minimum activity inclusion rate of phytase in diets

Table 3 shows that the faecal phosphorus ranged from 0.20±0.01g/100g in diet 3 to 0.27±1.05g/100g in diet 4. Birds on diets 3 and 5 had the highest phosphorus retention when compared with birds on other diets. The highest value of phosphorus retention was recorded for birds on diet 3 at 0.59±0.01g/100g while the lowest value of phosphorus retention was recorded for birds on reference diet at 0.49±0.21g/100g. The apparent phosphorus digestibility of birds on diets 3 and 5 were similar ($p>0.05$) and higher ($p<0.05$) than birds on reference diet, diets 2 and 4.

Table 3:Phosphorus utilization of broiler chicks fed diets with or without phytase supplementation (0-28day)

	Diets				
	1	2	3	4	5
		Phytase Inclusion			
Parameters	Reference diet	-	+	-	+
Phosphorus intake (g/100g)	0.74±0.01	0.78±0.01	0.79±0.01	0.78±0.01	0.77±0.01
Faecal phosphorus(g/100g)	0.25±0.01	0.26±0.01	0.20±0.01	0.27±1.05	0.21±0.01
Phosphorus retention(g/100g)	0.49±0.21	0.52±0.11	0.59±0.01	0.51±1.01	0.56±0.02
Apparent phosphorus digestibility(%)	66.22±2.00^{b}	66.67±2.01^{b}	74.68±2.31^{a}	65.38±0.72^{b}	72.73±2.55^{a}

Means with different superscript in the same horizontal row differ significantly (P< 0.05)Negative sign (-) means no phytase inclusion; positive sign (+) phytase inclusion at 250 FTU /g minimum activity inclusion rate of phytase in diets

Table 4 shows the cost analysis of broiler chicks fed diets with or without exogenous phytase supplementation. The cost of feed per kg was highest for birds on reference diet at #89.62 and lowest for birds on diet 2 at #77.02. The highest cost of feed consumed per bird was highest for birds on reference diet at # 112.03 and lowest for birds on diet 2 at #98.59. Diet 3 had the lowest cost of feed per kg weight gain at #89.60 while the highest cost of feed per kg weight gain was recorded for birds on reference diet at #96.57.

Table 4: Cost analysis of broiler chicks fed with diets with or without exogenous phytase supplementation (0-28day) .

	Diets				
	1	2	3	4	5
		Phytase Inclusion			
Parameters	Reference diet	-	+	-	+
Average total weight gain (Kg)	1.16	1.07	1.12	1.05	1.12
Average total feed intake (Kg)	1.25	1.28	1.27	1.23	1.25
Cost of feed (₦/tonne)	89,622.80	77,019.20	79,019.20	80,631.20	82,631.20
Cost of feed (₦/kg)	89.62	77.02	79.02	80.63	82.63
Cost of feed consumed /bird (₦)	112.03	98.59	100.36	99.17	103.29
Cost of feed/Kg weight gain	96.57	92.14	89.60	94.45	92.22

4.0 Discussion

The initial weights of the experimental birds were uniform therefore any differences in the outcome of parameters investigated were as a result of the treatments imposed. In this study, apart from the reference diets, the final live-weight and consequently the weight gain values for chicks fed diets supplemented with phytase were higher than other diets without phytase inclusion. The result agreed with the report of Ojewole *et al*. (2003) that supplementing diets with phytase always give a better result than other diets that were not supplemented with phytase. The consistent higher weight gain in broiler chicks on phytase supplemented diets over the birds on phytase free diets could only imply that benefit were derived from the inclusion of phytase in broiler finisher diets. The result conformed with the report of Bedford (2000) that benefits have been derived from phytase supplementation in poultry diets and such benefits are improvement in nutrient digestibility and reduction in the variation of nutrient quality of feed ingredients when fed diets with phytase. The feed conversion ratio obtained were ($p>0.05$) similar. However, the feed conversion ratio obtained indicate that diets with phytase inclusion are more efficiently utilized by the birds than the diets without phytase inclusion.This result agreed with the previous study of Aureli *et al*.(2011) where the addition of phytase at 2000FTU/kg led to a significant improvement in FCR. The result obtained in this present study disagreed with the report of Sebastian *et al*. (1997) and Zhang *et al*. (1999) that phytase supplementation did not improve feed conversion ratio. The protein efficiency ratio is an important protein evaluation index which gives an insight into the relationship between the bodyweight gain and the actual protein intake. Even though the operative protein efficiency ratio (PER) values were similar for all experimental birds on all treatments, there were clear indications of higher protein efficiency ratio values for birds on the reference diet of animal and plant protein origins and also for phytase supplemented diets. Pollution of the environment with phosphorus excretion is a major argument for improving
Phosphorus utilization and limiting phosphorus excretion by poultry birds (Cromwell and coffey, 1991). The phosphorus intake, phosphorus retention and apparent phosphorus digestibility of birds as shown in this study indicated that phytase was effective in improving the bioavaliabilities of phytate-phosphorus in broiler chicks diets because the apparent phosphorus digestibility of birds placed on diets with phytase inclusion were better than those birds fed diets without phytase inclusion which suggested that the addition of phytase to diets permitted hydrolysis of phytate, reduction in manure and helps to correct possible environmental problems as reported by (Sazzad et al., 1995).
Recently, most popular animal protein ingredients such as fish meal has been claimed to be adulterated with materials like sand, saw dust, fish bone, fish scales, heavy bacterial loads. Among vegetable sources, soybean meal and groundnut cake are comparatively expensive but available throughout the year. Their nutritive value especially as protein supplements are acceptable and superior in most cases when compared with other vegetable protein sources. In this study, the cost per kg weight gain were highly reduced with phytase inclusion. This resulted in higher financial benefit for birds on diets 3 and 5 at 250FTU/g. Economic evaluation of enzyme supplementation showed that supplementing diet with phytase at 250 FTU/g level increased the cost of the diet with appreciable improvement in feed conversion ratio. Since the ultimate objective of any commercial poultry farmer is to maximize his profit, the use of phytase will facilitate a better FCR and translate into a better economic marginal gain per broiler bird. However, the results agreed with the result of Ojewole et al.(2003) that it costs more to feed a bird on phytase supplemented diets than those on phytase free diets. This results obtained in this study was not in conformity with the report of Ren et al.(1999) who found that phytase supplementation in broiler diet reduced feed cost and made broiler production profitable. Phytase supplementation in broiler chicks enhanced feed utilization and cost per kg weight gain were highly reduced with phytase inclusion.

References

Angel, R., Saylor, W.W, Dhandu, A.S., Powers, W. & Applegate, T.J (2005b). Effects of dietary phosphorus, phytase and 25-hydroxycholecalciferol on performance of broiler chickens grown in floor pens. Poult Sci. 84: 1031-1044.

AOAC (2010) .Official of Analysis. 16th edition Association of Official Chemist Washington D.C

Applegate, T.J., Angel, R.& Classen, H.L (2003). Effect of dietary calcium, 25-hydroxycholecalciferol and bird strain on small intestinal phytase activity in broiler chickens. Poult. Sci 82:1140-1148

Baxter, C.A., Joern, B.C, Ragland, D., Sands,J.S & Adeola, O. (2003). Phytase high available phosphorus corn and storage effect on phosphorus levels in pig excreta. J.Environ.Qual.32:1481-1489.

Bedford, M.R & Schulze, h. (1998) Exogenous enzymes for pigs and poultry Nutri. Res.Rev.

11:91-114

Cromwell, G.L & Coffey, R.D (1991). Phosphorus. A key essential nutrient, yet a possible major pollutant. Its central role in animal nutrition. Pages 133-145. In T.P Lysons ed. Biotechnology in the feed industry. Alltech Technical Publications, Nicholasville, Kentucky.

Lenis, N.P & Jongbloed, A.W (1999). New technologies in low pollution swine diet: Diet manipulation and use of synthetic acids, phytase and phase feeding for reduction of nitrogen and phosphorus excretion and ammonia emission Review. Asian-australas. J.Anim. Sci. 12: 305-327.

Ojewole, G.S, Nwachukwu, E.N, Abaseiekong, S.F, Akinmutimi, A.H & Oluwafisayo, O.A (2003). Economics and bio-efficacy of ronozyme-p as subtitude for bonemeal in female turkey poults ration. Proc. 28th Ann , NSAP conf. IB pp 197-200.

Ravindran, V., Bryden, W.L& Kornegay, E.T (1995). Phytin occurrence, bioavailability and implications in poultry nutrition. Poultry and Avian Biology Reviews 6: 125-143.

Sazzad, M.H., Givisiez, P.E.N & Silva, C.G (1995). Effect of dietary protein, phosphorus and phytase on performance and phosphorus utilization of broiler chicks. Poult. Sci. 74 (suppl.1): 109 (Abstract).

Sebastian, S., Touchburn, S.P., Chavez, E.R & Lague, P.C (1997) . Apparent digestibility of protein and amino acids in broiler chickens fed a corn soybean meal diet supplemented with microbial phytase. Journal of Poultry Sci. 76: 1760-1769.

Selle, P.H& Ravindran, V.(2007). Microbial phytase in poultry nutrition. Animal Feed Science and Technology, 135: 1-41.

Zhang, K., Mika, M., Swiatkiewkz, S., Koreleski, J. & Piironen, J. (2011). Effects of phytase on laying performance, egg shell quality and phosphorus and calcium balance in laying hens fed phosphorus deficient maize-soybmeal diets. Poult. Sci. TBC: 1-6