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Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

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Effect of Different Non-Phytate Phosphorus Levels and Phytase Sources on Performance in Broiler Chicks

A. Karimi
Animal Science Department, Faculty of Agriculture, Kurdistan University, Sanandaj, Kurdistan, Iran

Abstract: Interest in the use of low phosphorus diets through inclusion of phytase in monogastric diets has risen due to environmental concerns. This study was carried out to investigate the effects of formulating diets varying in non-phytate phosphorus (NPP) levels and phytase sources on performance in broiler chicks. Ross® straight-run broiler chicks (n=576) were allocated to six dietary treatments, each replicated three times (32 chicks per pen) in a completely randomized design in a 3×2 factorial arrangements. Three dietary phases were employed, a starter (0-20d), grower (21-40d) and finisher (41-51d). The dietary treatments consisted of three NPP levels (0.45, 0.38, and 0.31% during starter period and 0.43, 0.36, and 0.29% during grower and finisher periods) with 500 F.T.U per kg of either sources of phytase, Natuphos® or Ronozyme P®. Measurements included body weight (BW), daily gain (DG), feed intake (FI) and feed conversion ratio (FCR). The results of this experiment showed that the chicks fed diet containing lower NPP levels had significantly lower body weight at 40 and 50d; lower daily gain during 21-40d; and higher feed conversion ratio during 21-40d period. The broiler performance was not affected by either source of phytase or the interaction between phytase source and NPP levels.

Key words: Phytase, performance, broiler, Natuphos, Ronozyme P

Introduction

It is well known that the major phosphorus content of foodstuffs of plant origin such as corn and soybean meal is in the form of phytate, which has low availability to monogastric animals, such as poultry and pigs (Simons *et al*., 1990; NRC, 1994; Summers, 1997; Bedford, 2000; Lesson and Summers, 2001). Phytic acid not only reduces phosphorus availability for poultry, but also reduces the availability of other nutrients in poultry diets (Ravindran *et al*., 2001; Sebastian *et al*., 1996a,b; Ravindran *et al*., 1999a,b; Punna *et al*., 2001; Lan *et al*., 2002; Shirley and Edwards, 2003).

Poor utilization of phytate P by monogastric poses several problems for producers and the environment: 1) It introduces the need to add inorganic P supplementation to diets 2) It results in the excretion of large amounts of P in the manure, 3) reduces the availability of other nutrients in the diets and as a result reduces the precision with which the nutrient requirements of chicks can be met (NRC, 1994; Summers, 1997; Waldroup, 1999; Bedford, 2000; Lesson and Summers, 2001).

During recent years, several alternative methods for reducing the aforementioned negative impacts of phytate P on the environment and poultry performance have been devised. Such strategies include the use of low phytate grains such as corn and barley (Jang *et al*., 2003; Ceylan *et al*., 2003), phase feeding and feeding birds closer to their nonphytin P(NPP) requirements (N.R.C, 1994; Summers, 1997; Um and Paik, 1999; Waldroup, 1999; Yan *et al*., 2001; Keshavarz, 2003a,b; Dhandu and Angel, 2003) and microbial phytase supplementation of rations fed to ducks (Orban *et al*., 1999), turkey poults (Yi *et al*., 1996a), layers (Gordon and Roland, 1998; Punna and Roland, 1999; Um and Paik, 1999; Jalal and Scheideler, 2001; Sohail and Roland, 2002; Keshavarz, 2003a,b; Snow *et al*., 2003; Ceylan *et al*., 2003) and broilers (Simons *et al*., 1990; Sebastian *et al*., 1996a, b; Qian *et al*., 1996; Yi *et al*., 1996a,b; Ravindran *et al*., 1999a,b; Sohail and Roland, 1999; Yan *et al*., 2001; Boling-Frankenbach *et al*., 2001; Punna and Roland, 2001; Ravindran *et al*., 2001; Viveros *et al*., 2002; Lan *et al*., 2002; Applegate *et al*., 2003; Yan *et al*., 2003; Shirley and Edwards, 2003).

Supplementation of poultry diets with phytase has proven to be an effective and realistic method for enhancing the digestibility of phytic acid in monogastric animals. Supplementation of broiler diets with microbial phytase not only enhances broiler performance on low P rations (Simons *et al*., 1990; Sohail and Roland, 1999; Yan *et al*., 2001; Ravindran *et al*., 2001; Viveros *et al*., 2002; Lan *et al*., 2002; Shirley and Edwards, 2003), but also increases the availability of phytate P, Zn, Ca, Mg, Cu (Simons *et al*., 1990; Sebastian *et al*., 1996a,b; Qian *et al*., 1996; Punna and Roland, 2001; Viveros *et al*., 2002; Lan *et al*., 2002), AME (Ravindran *et al*., 1999a, b; Ravindran *et al*., 2001; Lan *et al*., 2002; Shirley and Edwards, 2003) and a number of amino acids (Ravindran *et al*., 2001; Adeola and Sands, 2003). However the degree to which phytase influences the digestibility of these nutrients, particularly energy and amino acids, is still under debate, with the result that it

Table 1: Composition (%) and calculated analysis of basal diets

	Finisher			Grower			Starter		
Phytase[1] (FTU/kg diet)	500	500	500	500	500	500	500	500	500
Ingredients	%								
Corn grain	57.83	58.17	58.50	61.70	62.04	62.34	66.97	67.41	67.85
SBM (44 % Cp)	34.91	34.85	34.78	31.25	31.19	31.12	26.58	26.38	26.18
Fish meal (63 % Cp)	2.50	2.50	2.50	2.00	2.00	2.00	1.23	1.17	1.31
Corn oil	1.27	1.16	1.05	1.53	1.42	1.31	1.44	1.59	1.29
$CaCO_3$	1.13	1.35	1.57	1.08	1.30	1.51	1.27	1.05	1.48
D.C.P	1.33	0.96	0.58	1.32	0.95	0.58	1.10	1.48	0.71
Oyster shell	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
Common Salt	0.30	0.30	0.30	0.28	0.28	0.28	0.30	0.30	0.29
Mineral premix[2]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin Premix[3]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
DL. Methionine	0.17	0.17	0.17	0.17	0.17	0.17	0.20	0.20	0.20
L-Lysine -HCL	0.05	0.06	0.06	0.15	0.15	0.15	0.18	0.18	0.18
Calculated dietary nutrient content									
ME(Kcal\kg)	2900	2900	2900	2962	2962	2962	3010	3010	3010
CP (%)	22	22	22	20.5	20.5	20.5	18.4	18.4	18.4
Ca (%)	0.95	0.95	0.95	0.9	0.9	0.9	0.88	0.88	0.88
T.P (%)	0.7	0.63	0.56	0.67	0.60	0.53	0.60	0.67	0.60
NPP (%)	0.45	0.38	0.31	0.43	0.36	0.29	0.36	0.43	0.36

[1]From either sources: Natuphos(10000 F.T.U. phytase activity/gr.) or Ronozyme P(2500 F.T.U. phytase activity/gr. [2]Supplied per Kg: Vit. A , 7200 mg; Vit. D_3, 1600mg; Vit. E, 14400mg; Menadion, 800 mg; Thiamine, 720 mg; Riboflavin, 2640 mg; Niacin, 12000 mg; Pyridoxin, 1200 mg; Vit B_{12}, 6 mg; D-Pantothenic acid ,4000 mg; Folic acid, 400 mg; Biotin ,40 mg; Choline chloride, 100000mg; Antioxidant, 40000 mg. [3]Supplied per Kg: Manganese, 40000 mg; Zinc ,33880 mg; Iron, 20000 mg; Copper , 4000 mg; Iodine, 400 mg; Choline chloride, 100000 mg.

is difficult to predict the response of chicks to phytase supplementation (Kornegay, 1999; Ravindran *et al.*, 1999a,b; Bedford, 2000; Kornegay, 2001; Maenz, 2001; Adeola and Sands, 2003).

Simons *et al.* (1990), in a study on broilers, showed that growth rate and feed conversion on the low-P diets containing microbial phytase were comparable to or even better than those obtained on control diets. Sohail and Roland (1999) observed in corn soybean based diets fed to four to six wk-old male broilers, that phytase significantly increased BW at lower NPP levels but not at the higher NPP level. Similar results have been reported by most other researchers (Sebastian *et al.*, 1996a,b; Qian *et al.*, 1996; Edwards *et al.*, 1999; Viveros *et al.*, 2002; Lan *et al.*, 2002; Shirley and Edwards, 2003) where the response to phytase was highest at lowest NPP levels.

The objectives of the present experiment were to investigate the influence of different NPP levels with two different sources of phytase on performance in broiler chicks.

Materials and Methods

The present study was an intervention study carried out at the Animal Science Department of Kurdistan University, Kurdistan, IRAN. Five hundred and seventy six day-old commercial broiler chicks (Ross®) were purchased from a local chick supplier and randomly assigned to six dietary treatments. There were three replicate pens of thirty-two straight-run chicks per dietary treatment. The chicks were housed in floor pens (1.2×1.5m) containing wood shavings throughout the experiment. Lights were on continuously for the first day posthatching, after which a 23L: 1D lighting schedule was maintained for the duration of the experiment. Temperature was maintained between 32°C and 34°C at the beginning of the rearing period and were gradually decreased every 2 to 3 d to 22°C at the end of rearing period. Chicks were provided free access to feed and water during the experimental period. Care and management of the chicks were in accordance with commercial guidelines.

Dietary treatments: The corn-soybean meal-based starter, grower and finisher diets were formulated to meet or exceeded the requirements (NRC, 1994) for all nutrients, with the exception of NPP (Table 1). Experimental diets were formulated to contain different NPP levels (0.45, 0.38, and 0.31 % during starter period and 0.43, 0.36, and 0.29% during grower and finisher periods) with 500 F.T.U from either sources of phytase, Natuphos® or Ronozyme P®.

Table 2: The effect of non-phytate phosphorus levels and phytase source on broiler performance

		Phytase Source		NPP level[1]		
		Ronozyme P	Natuphos	High	Medium	Low
Body weight(gr.)	20d	513.0	511.4	511.6	524.7	500.2
	40d	1651.1	1674.6	1614.5[b]	1749.3[a]	1624.8[b]
	50d	2197.6	2221.4	2149.0[b]	2287.1[a]	2192.5[ab]
Daily gain(gr.)	0-20d	23.5	23.4	23.4	24.1	22.9
	21-40d	54.2	55.4	52.5[b]	58.3[a]	53.6[b]
	41-50d	68.3	68.4	66.8	67.2	71.0
	0-50d	43.9	44.4	42.9	45.7	43.8
Feed intake(gr.d-1)	0-20d	36.5	38.5	36.6	38.6	37.4
	21-40d	112.8	113.2	114.4	113.1	111.6
	41-50d	170.9	167.6	163.6	169.7	174.5
	0-50d	90.9	91.4	90.4	91.7	91.38
FCR(gr.gr-1)	0-20d	1.56	1.65	1.57	1.61	1.65
	21-40d	2.10	2.05	2.18[a]	1.94[b]	2.09[ab]
	41-50d	2.51	2.47	2.46	2.54	2.47
	0-50d	2.07	2.06	2.11[a]	2.01[b]	2.09[ab]

[a-b]Mean values within a row and under each main effects with no common superscripts differ significantly (P<0.05).

[1]Low, Medium, high: 0.45, 0.38 and 0.31% in starter, and 0.43, 0.36 and 0.29% in grower and finisher periods.

Measurements: The experiment was conducted for 51 days. Birds were weighed as a group on arrival. At 20, 40 and 51 days of age, all birds were weighed by pen. Then feed intake was recorded at the same points in time for determination of feed conversion. Mortality was recorded daily and feed consumption data were corrected for body weight of mortality. Average body weight, daily gain, and feed to gain ratio (FCR) were determined for each period and for the overall experiment.

Statistical analysis: Data were analyzed according to General linear model (GLM) procedure of SAS (SAS institute, 1991) as a CRD experiment. Significant differences among treatments were determined at P<0.05 by Duncan's new multiple range test.

Results and Discussion

During the experimental period mortality was within acceptable levels (less than 2 %) and was not related to dietary treatments. The influence of different dietary treatments on broiler performance during starter, grower and finisher growth periods were summarized in Table 2.

During the starter period, average body weight, daily gain ,feed intake and feed conversion ratio were not significantly influenced by different dietary NPP levels (P<0.05). Through grower period, the average body weight (40d) , daily gain, and FCR of broiler chicks (21-40d) were significantly affected by NPP level (P<0.05), in which that chicks fed with diet containing 0.36% NPP had higher BW and average daily gain, and lower FCR values compared with chicks fed diets containing 0.43% or 0.29% NPP levels. The results of this experiment also indicated that the average body weight (50d) of broiler chicks fed marginally deficient NPP diets (0.29%) was significantly (P<0.05) lower than BW of chicks fed diets containing adequate NPP levels (0.43-0.36%). Other performance criteria were not affected by NPP levels during this period.

Over the whole experimental period (0-50d), the average chicks daily gain, feed intake and feed conversion ratio were not either significantly influenced by dietary NPP level or phytase sources. According to the results, phytase sources had not significant effect on broiler performance (P<0.05). There was no significant interaction (P>0.05) between dietary NPP levels and phytase source.

The fact that reduced NPP levels did not adversely affect broiler performances during the starter period suggests that even the 0.31% NPP diet was not severely deficient in phosphorus during this phase. This is in agreement with the findings of Waldroup (1999). Low NPP diets typically result in reduced gain and intake and perhaps a mildly adverse effect on FCR, with performance being restored on addition of phytase (Simons *et al.,* 1990; Sohail and Roland, 1999; Yan *et al.,* 2001; Punna and Roland, 2001; Ravindran *et al.,* 2001; Lan *et al.,* 2002; Viveros *et al.,* 2002; Yan *et al.,* 2003; Shirley and Edwards, 2003).

Live weight at 40d of age was influenced by dietary NPP level, indicating that the low NPP diets fed during this period were in fact deficient. Data from the literature is equivocal during this phase of growth, with some papers suggesting lower levels of NPP are required to constrain growth (Sohail and Roland, 1999; Dhandu and Angel, 2003; Waldroup, 1999) and others suggesting these levels are already deficient (NRC, 1994; Leske and Coon, 2002; Viveros *et al.,* 2002).

Lack of significant difference between two source of phytase during this experiment , could be partially explained by the fact that the NPP levels of the diets were marginally deficient ,not severely (Simons *et al.,* 1990; Waldroup *et al.,* 1999).

In conclusion, the results of the present experiment demonstrate that the effect of feeding these marginally NPP deficient diets becomes most evident after 21d of age, and under the circumstances presented here, The broiler performance was not affected by phytase source and dietary NPP levels.

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