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Diet supplementation with phytase on performance of broiler chickens

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ABSTRACT - The assay was carried out to determine the effect of phytase supplementation on performance of broilers from 1 to 21 and 1 to 40 days of age. Twelve hundred and fifty male broilers (Ross) were distributed in a randomized experimental design, with five treatments, 10 repetitions and 25 birds per experimental unit. The treatments consisted of evaluating the phytase supplementation in diets with reductions in nutritional levels, compared with the positive control. The nutrient contents in negative controls one and two were reduced progressively and these diets were supplemented with phytase levels of 250 and 500 ftu/kg of the diet, respectively. Two diets were formulated: pre-starter/starter, 1-21 days, and growth/finishing, from 21 to 40 days). In both phases, with the phytase supplementation in diets that had their nutritional levels reduced (negative control one + 250 ftu and negative control two + 500 ftu), feed intake, weight gain and feed conversion of the birds were similar to the positive control. In the period from 1 to 40 days of age, with the diets supplemented with phytase, the productive efficiency index of the birds was similar to that of the positive control group. Supplementation with 250 ftu/kg and 500 ftu/kg phytase in diets with reduced nutritional levels improved broiler performance, resulting in parameters similar to those shown by broilers fed with the diet with normal levels of nutrients.

Key Words: diet, productive efficiency index, weight gain

Introduction

Feedstuffs of plant origin are the main components of diets for broilers. However, they may present anti-nutritional factors, such as the phytic acid. The molecule of phytic acid contains approximately 28.2% phosphorus (P) (Kornegay, 2001) and has anti-nutritional property for making P unavailable to birds, in addition to complexing with other nutrients. Typically, it is considered that only 30% of the P of plants is actually available for the birds (NRC, 1994). According to Rostagno (2005), the bioavailability of the P in the corn is 33%, and, for the soybean meal, it is 32%.

Phytase is an enzyme that acts in the bonds of the phosphate group of phytate, releasing P and other minerals that are part of this molecule (Cromwell & Coffey, 1991). This way, besides increasing P availability, the use of phytase also improves the availability of other minerals, such as magnesium, manganese and copper. Thus, its use in diets for broilers may provide positive responses on the digestibility of feeds and broiler performance, having a direct effect on productive efficiency.

As phytase acts making plant P available to animals, its utilization in the diets can also reduce the cost of supplementation with P. Besides, it can reduce the environmental impact caused by the poultry activities, for the available P, added to the excess of inorganic P in the diets, ends up eliminated in the excreta of birds.

Research has shown that the performance of broilers fed with different levels of inclusion of phytase and low levels of available P in the diets can improve with the addition of the enzyme (Dilger et al., 2004; Santos et al., 2005; Fukayama et al., 2008). However, other researchers did not observe beneficial effect on broiler performance with the addition of phytase in the diets (Lima et al., 2002; Assuena et al., 2007).

Therefore, the objective of this research was to evaluate the effect of supplementation of the phytase enzyme on the performance of broilers.

Material and Methods

Twelve hundred and fifty broiler chicks of the Ross strain, from one to 40 days of age with initial average weight of 43 grams were used. Birds were distributed in a completely randomized design, with three treatments and 10 repetitions of 25 birds per experimental unit. For formation of experimental

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units, chicks were weighed individually, and grouped by weight range so that all the plots presented similar average weight.

The management of drinkers, troughs, curtains and birds followed the recommendations of the strain manual, with water and diet supplied *ad libitum* throughout the experimental period. The program of continuous lighting (24 hours of natural light + artificial light) was adopted during all the period. Artificial heating of chicks was done through 250-W/box infrared lamp with adjustable height, set to provide the most comfort possible to birds.

Diets were formulated according to recommendations by Rostagno et al. (2005). The phytase utilized was Fitase Quantum® (Syngenta Animal Nutrition). For the formulation of diets, increase in the bioavailability of metabolizable energy, crude protein, digestible lysine, calcium and available phosphorus obtained with phytase supplementation was also considered (Table 1). This way, the contents of these nutrients were reduced progressively in the negative control groups 1 and 2, and the phytase levels of 250 and 500 uft/kg of diet were also added to the diet, respectively.

Diets were comprised of: positive control (diet formulated according to recommendations by Rostagno et al., 2005); negative control 1 (diet formulated with reduction in the nutritional levels, considering the increases in the bioavailability of the nutrients if there were supplementation of 250 uft); negative control (diet formulated with reduction of nutritional levels, considering the increases in the bioavailability of nutrients if there were supplementation of 50 uft); negative control + 350 uft; and negative control 2 + 500 uft (Tables 2 and 3). Two diets were formulated for the experimental period: pre-starter/ starter diet (1-21 days) and growing/finishing diet (21-40 days).

Birds and diets were weighed on the 21st and 40th days of age. In these periods, feed intake, weight gain and feed conversion ratio were evaluated. Mortality rate was also recorded for correction of performance data and for calculation of viability. From these data, the Productive Efficiency Index (PEI) was calculated. In order to do so, the following formula was utilized:

$PEI = (WG \times V) / (SA \times FC) \times 100$

where: WG = average weight gain of the plot, kg; V = viability, %; SA = age at slaughter, days; FC = feed conversion.

Statistical evaluations were done through analysis of variance with comparison of means by the Student-Newman-Keulls (SNK) test at 0.05 probability level, utilizing the software SAEG (Sistema para Análises Estatísticas, version 9.1).

Table 1 - Fitase Quantum® nutritional matrix according to inclusion in the diet*

	250 uft/kg in the diet (level 1)	500 uft/kg in the diet (level 2)
Crude protein, %	0.12	0.36
Calcium, %	0.077	0.1
Phosphorus, %	0.1	0.13
Metabolizable energy, kcal	26	45
Digestible lysine, %	0.003	0.010

* Values according to the manufacturer.

Table 2 - Composition of experimental diets in the period from 1 to 21 days of age

	Positive control	Negative control 1	Negative control 2
Corn	56.362	58.195	59.671
45% Soybean meal	36.853	36.256	35.459
Oil	2.783	1.931	1.341
Dicalcium phosphate	1.852	1.309	1.148
Limestone	0.909	1.057	1.103
Salt	0.502	0.502	0.501
DL-methionine	0.240	0.239	0.238
L-lysine	0.143	0.153	0.166
L-threonine	0.031	0.033	0.037
Vitamin mix[2]	0.100	0.100	0.100
Mineral mix[1]	0.050	0.050	0.050
Choline chloride	0.100	0.100	0.100
Anticoccidial[4]	0.055	0.055	0.055
BHT[3]	0.010	0.010	0.010
Total	100.000	100.000	100.000
ME kcal/kg	3.000	2.974	2.955
ME kcal/kg DM	3.436	3.410	3.393
Crude protein, %	21.50	21.38	21.14
Calcium, %	0.908	0.831	0.808
Available phosphorus, %	0.454	0.354	0.324
Available arginine, %	1.382	1.370	1.349
Total glycine + serine, %	1.963	1.951	1.928
Digestible isoleucine, %	0.854	0.847	0.836
Digestible lysine, %	1.170	1.167	1.160
Digestible met + cys, %	0.831	0.829	0.824
Digestible methionine, %	0.540	0.538	0.535
Digestible threonine, %	0.761	0.759	0.754
Digestible tryptophan, %	0.242	0.238	0.234
Digestible valine, %	0.908	0.903	0.893

[1] Mineral mix (kg of product): iron - 80 g; copper - 10 g; cobalt - 2 g; manganese - 80 g; zinc - 50 g; iodine - 1 g; and excipient q.s. - 500 g.
[2] Vitamin mix (kg of product): vitamin supplement containing: vit. A - 10,000,000 U.I.; vit. D_3 - 2,000,000 U.I.; vit. E - 30,000 U.I.; vit. B_1 - 2.0 g; vit. B_2 - 6.0 g; vit. B_6 - 4.0 g; vit. B_{12} - 0.015 g; pantothenic acid - 12.0 g; biotin - 0.1 g; vit. K_3 - 3.0 g; folic acid - 1.0 g; nicotinic acid - 50.0 g; selenium - 250.0 mg; and excipient q.s. - 1,000 g.
[3] Antioxidant (butylated hydroxytoluene).
[4] Anticoccidial (12% salinomycin).
ME - metabolizable energy; DM - dry matter; met + cys - methionine + cystine.

Table 3 - Composition of experimental diets in the period from 21 to 40 days

	Positive control	Negative control 1	Negative control 2
Corn	60.651	62.484	63.972
45% Soybean meal	31.503	30.906	30.107
Oil	4.231	3.379	2.789
Dicalcium phosphate	1.615	1.072	0.912
Limestone	0.832	0.980	1.027
Salt	0.465	0.464	0.464
DL-Methionine	0.210	0.209	0.208
L-lysine	0.152	0.163	0.176
L-Threonine	0.025	0.028	0.031
Vitamin mix[2]	0.100	0.100	0.100
Mineral mix[1]	0.050	0.050	0.050
Choline chloride	0.100	0.100	0.100
Anticoccidial[4]	0.055	0.055	0.055
BHT[3]	0.010	0.010	0.010
Total	100.000	100.000	100.000
ME kcal/kg	3.150	3.124	3.105
ME kcal/kg DM	3.608	3.582	3.565
Crude protein, %	19.41	19.29	19.05
Calcium, %	0.809	0.732	0.709
Available phosphorus, %	0.404	0.304	0.274
Available arginine, %	1.226	1.214	1.194
Total glycine + serine, %	1.768	1.757	1.734
Digestible isoleucine, %	0.763	0.756	0.744
Digestible lysine, %	1.050	1.047	1.040
Digestible met + cys, %	0.756	0.754	0.749
Digestible methionine, %	0.486	0.484	0.481
Digestible threonine, %	0.683	0.681	0.676
Digestible tryptophan, %	0.213	0.211	0.207
Digestible valine, %	0.820	0.815	0.805

[1] Mineral mix (kg of product): iron - 80 g; copper - 10 g; cobalt - 2 g; manganese - 80 g; zinc - 50 g; iodine - 1 g; and excipient q.s. - 500 g.
[2] Vitamin mix (kg of product): vitamin supplement containing: vit. A - 10,000,000 U.I.; vit. D_3 - 2,000,000 U.I.; vit. E - 30,000 U.I.; vit. B_1 - 2.0 g; vit. B_2 - 6.0 g; vit. B_6 - 4.0 g; vit. B_{12} - 0.015 g; pantothenic acid - 12.0 g; biotin - 0.1 g; vit. K_3 - 3.0 g; folic acid - 1.0 g; nicotinic acid - 50.0 g; selenium - 250.0 mg; and excipient q.s. - 1,000 g.
[3] Antioxidant (butylated hydroxytoluene).
[4] Anticoccidial (12% salinomycin).
ME - metabolizable energy; DM - dry matter; met + cys - methionine + cystine.

Results and Discussion

In both experimental stages, diets with reduction in nutritional levels (negative controls 1 and 2) resulted in inferior values (P<0.05) for birds feed intake (Tables 4 and 5). However, with supplementation of phytase to the diets that had their nutritional levels reduced (negative control 1 + 250 uft and negative control 2 + 500 uft), birds feed intake was similar to that in positive control (P<0.05). In the stage from 1 to 21 days, the increasing feed intake of negative control 1 + 250 uft and of negative control 2 + 500 uft was 3.32 and 6.01%, when compared to birds of negative controls 1 and 2, respectively. In the stage from 1 to 40 days, the increase in feed intake was of 1.02 and 4.53% with regard to negative controls 1 and 2, respectively.

In diets with reduction in the nutritional levels, deficiency of P causes reduction in feed intake (Sebastian et al., 1996; Viveiros et al., 2002). However, the addition of phytase in proper levels generates rupture of the P-phytic acid complex, releasing this mineral to be absorbed, avoiding the reducing effect of its deficiency on feed intake.

In both experimental periods, birds of negative control groups 1 and 2 presented weight gain smaller than those of the positive control (P<0.05). However, birds of negative control 1 + 250 uft and negative control 2 + 500 uft presented weight gain similar to those from the positive control (P<0.05). In the period from 1 to 21 days, the improvement in weight gain of birds of negative control 1 + 250 uft and negative control 2 + 500 uft was 6.43 and 10.92%, when compared to negative control groups 1 and 2, respectively. In the period

Table 4 - Effect of addition of phytase in the diets on feed intake (FI), weight gain (WG) and feed conversion (FC) of broilers in the period from 1 to 21 days of age

	Positive control	Negative control 1	Negative control 2	Negative control 1 + 250 uft	Negative control 2 + 500 uft	CV %	P value
FI (g)	1208.7a	1159.7b	1158.9b	1198.2a	1228.6a	3.4	<0.001
WG (g)	834.5a	767.0b	751.7b	816.3a	833.8a	3.1	<0.001
FC	1.449a	1.513bc	1.542c	1.468ab	1.474ab	3.0	<0.001

Means followed by different letters on the same row differ (P<0.05) by SNK test.
CV - coefficient of variation.

Table 5 - Effect of addition of phytase in the diets on feed intake (FI), weight gain (WG) and feed conversion (FC) of broilers in the period from 1 to 40 days of age

	Positive control	Negative control 1	Negative control 2	Negative control 1 + 250 uft	Negative control 2 + 500 uft	CV %	P value
FI (g)	4586.6a	4421.5bc	4323.9c	4466.4ab	4519.6ab	2.8	<0.001
WG (g)	2625.1a	2493.2b	2413.6c	2562.0a	2607.9a	2.9	<0.001
FC	1.747a	1.774ab	1.793b	1.743ab	1.733a	2.4	<0.001
PEI	361.6a	338.4b	324.4c	353.6a	362.3a	4.5	<0.001

Means followed by different letters on the same row differ (P<0.05) by the SNK test.
CV - coefficient of variation; PEI - productive efficiency index.

from 1 to 40 days, the increase in weight gain was 2.76 and 8.05% in relation to negative control groups 1 and 2, respectively.

Similarly, Santos et al. (2005) observed that feed intake and weight gain of broilers fed diets with nutritional levels reduced without addition of phytase were inferior than those from the positive control group. But, when diets were supplemented with phytase, birds presented feed intake and weight gain similar to those of the positive control. Conte (2003) observed that supplementation with phytase (800 to 1,200 U/kg) in diets with 0.18% Pd provided broiler chicks of 1 to 21 days of age with performance similar to those of birds which consumed the diet with normal level of such nutrient (0.45%). Lan et al. (2002) supplemented diets deficient in Pd (0.24% in the starter phase and 0.232% in the growth phase) with 0, 250, 500, 750 and 1,000 uft phytase/kg in the diet and observed that in the total period of the experiment, supplementation with 250 uft phytase/kg of the diet was enough for increasing birds weight gain in 14.8%. Thus, the utilization of phytase in diets of minimum cost can be an alternative for obtaining better profitability in broiler production.

It was observed that, for the period from 1 to 21 days, birds of negative control groups 1 and 2 also presented decrease in feed conversion, in relation to those from the positive control group ($P<0.05$). Comparing feed converstion of birds of both negative control 1 and negative control 1 + 250 uft, no statistical difference was observed ($P>0.05$). However, feed conversion of birds of negative control group 2 was significantly inferior ($P<0.05$) when compared with that of birds of negative control group 2 + 500 uft. Supplementation with phytase at 500 uft/kg in the diet of negative control group 2 provided improvement of 4.41% and same feed conversion in relation to birds of positive control group. For the whole rearing period, feed conversion of birds of negative control group 2 was statistically inferior ($P<0.05$) than those of positive control and negative control 2 + 500 uft.

Dilger et al. (2004) and Lan et al. (2002) evaluated the performance of broilers fed diets containing different levels of the enzyme phytase and low levels of Pd and also observed that the addition of this enzyme provided better performance to birds, when compared with those which received diets without the inclusion of the enzyme. Fukayama et al. (2008) observed that the addition of phytase in all the levels utilized (500, 700 and 1,000 uft/kg of the diet) improved the performance of 1- to 20-day old broilers. Moreover, among the levels studied, that of 750 uft/kg of diet enabled maximum performance of birds, in addition to characteristics of bone mineralization and digestibility of nutrients.

Nevertheless, Lima et al. (2002) worked with broilers fed diets supplemented with two levels of the enzyme phytase and verified that there was no improvement in birds at the starter and growth phases. Assuena et al. (2007) also did not observe benefit from supplementation with phytase in diets for broilers.

According to Sebastian et al. (1996), the improvement in the development of birds fed diets supplemented with phytase can be explained by four main factors: the release of the minerals present in the phytate-mineral complex; the utilization of inositol (final product of the dephosphorization of the phytic acid) by animals; increase in the digestibility of the starch and increase in protein availability. According to Ravindran et al. (2001), it is also possible that there is indirect effect of supplementation with phytase on the energy available for the birds. This effect occurs by means of the improvement in the nutrient digestibility, hindering the reaction of saponification between the lipids and the minerals of the phytate-mineral complex.

The viability of birds for the period from 1 to 40 days of age was not statistically different between treatments. The average viability for the period was of 96%.

Following the trend of the performance parameters, the productive efficiency index was lower ($P<0.05$) for birds of negative control groups 1 and 2. However, when the diets with reduced nutritional levels were supplemented with 250 and 500 uft phytase, the productive efficiency index values were similar ($P<0.05$) to those of the positive control group.

Notwithstanding, Laurentiz et al. (2005) studied the supplementation with phytase in diets with different P levels on the performance of broilers and observed that reduction in the levels of Pd in the diet provided lower values of productive efficiency index when there was supplementation with phytase.

Conclusions

In the periods from 1 to 21 and from 1 to 40 days of age, reduction in the nutritional levels of the diets leads to lower weight gain and worse feed conversion of birds. Supplementation with 250 uft/kg and 500 uft/kg phytase in diets with reduction of nutritional levels improves bird performance, providing productive performance similar to that presented by birds fed diets with regular levels of nutrients.

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