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MINERAL Writes

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Calcium to total phosphorus ratio and nutrient specifications on phytase efficacy

Phytase supplementation has been the subject matter of research in poultry science for many years. Many benefits of supplementation have been identified. Researchers are now turning their efforts to identifying more specific causes and effects, key nutrient relationships and specific mechanisms of nutrient transport and absorption. As we understand more of these variables in phytase supplementation, broiler performance will be able to be strategically managed for maximum results through nutrition.

Phytase not only benefits diets low in phosphorus and calcium. Current research also shows supplementation adds benefit in diets formulated with adequate concentrations of phosphorus (Watson et al., 2006). Higher concentrations of phytase (>1,000 FTU/kg) also benefits the growth performance response of birds.

Phytase efficacy is influenced by the calcium to total phosphorus ratio in the diet. In low phosphorus diets, phytase reduces the ratio by increasing the amount of total P available. More research is yet to be conducted on the efficacy of phytase on nutrient adequate diets and the subsequent effect on the calcium to total phosphorus ratio (Walk et. al, 2013).

Oluski and Fru-Nji (2014) recently published the results of a two-part study looking at how the use of nutrient matrix values for phytase influences its efficacy on growth performance and tibia bone mineralization. The researchers specifically also designed the experiment to evaluate the results as influenced by varying dietary calcium to total phosphorus ratios.

The Experiment

In this study, 576 one-day old birds were used for a 14 day experiment. During the first seven days, the birds were grouped together and fed a standard diet formulated to meet NRC broiler nutrient requirements. From day 7-21, the birds were weighed and divided into treatment groups of 48 birds each. The groups were further divided into two levels of nutrient specifications, 2 levels of calcium to total phosphorus ratios and three levels of phytase supplementation for the 14 day period. On the 21st day, the birds and feed were weighed, birds were euthanized and tibia bones were

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Table 1. Ingredient composition of the experimental basal diets (1-4)

	1	2	3	4
	Ca:tP[1] (2:1)		Ca:tP[1] (2.5:1)	
Item	Positive[2]	Negative [2]	Positive[2]	Negative [2]
Corn	482.6	477.4	466.6	499.4
Wheat	--	50.0	--	--
Soybean meal	397.5	382.5	400.5	394.5
Soybean oil	58.0	40.0	60.0	45.0
Corn starch	15.0	15.0	15.0	15.0
Dicalcium phosphate	17.5	9.0	17.5	10.0
Calcium carbonate	17.0	15.5	28.0	24.0
Titanium dioxide	0.5	0.5	0.5	0.5
L-Lysine-HCl	1.0	0.4	1.0	0.7
DL-Methionine	2.8	1.9	2.8	2.8
Threonine	0.6	0.3	0.6	0.6
Vitamin-mineral premix[3]	2.5	2.5	2.5	2.5
Salt	5.0	5.0	5.0	5.0
Phytase premix[4]	To 1,000	To 1,000	To 1,000	To 1,000
Total	1,000	1,000	1,000	1,000

[1] Ca:tP (total P) based on analyzed chemical composition.

[2] Control (Phytase matrix).

[3] Supplied the following per kilogram of diet vitamin A, 5,484 IU; vitamin D_3, 2,643 ICU; vitamin E, 11 IU; menadione sodium bisulfate, 4.38 mg; riboflavin, 5.49 mg; D-pantothenic acid, 11mg; niacin 44.1 mg; choline chloride, 771mg; vitamin $B_{12,}$ 13.2 µg; biotin, 55.2 µg, thiamine mononitrate, 2.2 mg; folic acid, 990 µg; pyridoxine hydrochloride, 3.3 mg; I 1.11 mg; Mn 66.06; Cu, 4.44 mg; Fe 44.1 mg; Zn 44.1 mg; Se 300 µg.

[4] Phytase premix containing 200 phytase units (FYT)/g replaced corn starch to provide 1,000 or 2,000 FYT/kg.

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collected from each bird for examination.

The nutrient specification levels included one set of diets formulated to meet all the nutrient requirements for the broilers (a positive control, PC) and one set formulated to be deficient in phosphorus, calcium, crude protein, amino acids and energy, (a negative control, NC, Table 1). The matrix values of the phytase supplementation were used to reduce the nutrient values in the NC diets relative to the PC diets. The reductions were based on the expected release of nutrients and energy from the phytase supplementation.

The calcium to total phosphorus ratios (Ca:tP) used in the experiment were narrow at 2:1 and wide at 2.5:1. The three levels of phytase supplementation were 0, 1,000 and 2,000 phytase units (FYT)/kg.

Findings

Overall, the effects of the nutrient matrix (PC vs. NC), Ca:tP, and phytase supplementation significantly affected growth performance responses, except for the gain:feed (G:F) ratio which only showed significantly effects from the phytase supplementation.

On the NC diets, weight gain and feed intake were lower when compared to the PC diets. The same was true for wide Ca:tP compared to narrow Ca:tP for weight gain and feed intake. Matrix x Ca:tP ratio interactions were not significant for growth performance responses. Weight gain was significantly influenced by the interaction of matrix x phytase supplementation and Ca:tP x phytase supplementation.

On the PC diets, broiler weight gain increased due to phytase supplementation at 2,000 FYT/kg relative to the control diet. On the NC diets, the weight gain due to phytase supplementation was dramatic with 1,000 FYT/kg and only marginally at 2,000 FYT/kg compared to the control diet at 0 FYT/kg. The weight gain was also greater at 1,000 FYT/kg phytase supplementation on the NC diets with a narrow Ca:tP (2:1) compared to the control diet and no further increase was observed at 2,000 FYT/kg supplementation. The wide Ca:tP (2.5:1) produced a stepwise increase in weight gain with increasing phytase supplementation.

Bone mineralization responses were lower on NC diets compared to the PC diets. The two-way interactions of the experiment variables were only significant for certain nutrients. Tibia P was influenced by Ca:tP x Phytase supplementation. Tibia K and Zn were influenced by matrix x phytase supplementation. The narrow Ca:tP diets increased tibia P when supplemented with 1,000 FYT/kg relative to the control diet. No further response at 2,000 FYT/kg was observed. Each increasing level of phytase supplementation in the diets formulated for a wide Ca:tP increased tibia P concentrations. One other significant effect was that tibia K concentrations were lower in NC diets supplemented with phytase.

Based on nutrient content only, the nonsupplemented PC diets demonstrated greater growth performance responses than the NC diets did, since the PC diets were formulated to meet nutritional requirements and the NC diets were formulated to be limiting in nutrients. Manipulating the diet for increased growth performance is limited by the available nutrients.

For weight gain, the NC diets with above average supplementation levels (2,000 FYT/kg) were 68% greater than the PC diets at the same level of supplementation. In the NC diets, the supplementation level of 1,000 FYT/kg reversed negative weight gain effects. The higher supplementation rate then only improved weight gain marginally. Phytase supplementation is necessary to promote weight gain in limited diets, but the highest rate is not always what is needed. This finding emphasizes the importance of managing phytase supplementation for the greatest economic impact.

Given the effect on weight gain as a result of the phytase supplementation, the authors put three inferences forward as explanations. First, since the PC diet was formulated to meet nutrient requirements, there was “less room” for the additional nutrients freed by phytase to be needed or utilized for weight gain. Second, at the highest level of supplementation (2,000 FYT/kg,), on the

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PC diets, the significant weight gain may be a result of additional benefits of phytase supplementation beyond phosphorus release. (The higher supplementation is above established requirements, but has been reported to provide a greater response, Coweieson et al., 2011). The third inference is based on the degree of response to the supplementation. At 2,000 FYT/kg, the weight gain was much higher on PC diets than on NC diets. At 1,000 FYT/kg, the weight gain was the same. This leads the authors to put forth the idea that more study is needed to identify other factors that may hinder phytase efficacy in limiting diets.

Phytase supplementation influenced bone mineralization independently of nutrient content (matrix). In this study, weight gain and bone mineralization did not respond in identical ways to the dietary manipulation (NC vs. PC). The authors hypothesize that this is because bone development is more dependent on P and Ca supplies than weight gain.

The authors of this study came to two conclusions. One was that 1,000 FYT/kg of phytase is enough to offset the conditions that depress weight gain in limiting diets in this experiment. The second conclusion is that the higher levels of supplementation show more benefit when the Ca:tP are wider to achieve that offsetting effect.

What this means for the industry

This study looked at how the Ca:tP and nutrient content (or matrix) interact and those would effect how phytase supplementation effects growth performance and bone mineralization.

Higher phytase supplementation levels can be beneficial even in diets that are formulated to meet nutrient requirement, especially if the Ca:tP is wide. There is a limit to P uptake in the digestive tract, and the benefit may not be from the available P freed by phytase, but by the extraphosphoric effects of the supplementation. In diets with a narrow Ca:tP, the higher supplementation levels may contribute to nutrient imbalances and not contribute to the optimal growth hope from phytase supplementation.

It is important to review many different factors in diet formulations when determining phytase supplementation levels. Based on this study, limiting diets with narrow Ca:tP would show the best response to phytase supplementation levels. High phytase supplementation levels are more effective on diets with full nutrient specifications and a wider Ca:tP.

This level of close attention to the diet will help producers achieve desired growth performance and weight gain results in the most economical means possible.

Information for this article taken from:

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The Staff at ILC Resources wish you a Happy Holidays and Best Wishes for a Successful 2016!