ilc resources

MINERAL Writes

3rd QUARTER 2015

In this issue:
A. Progressive phytase regimens in broilers
B. Organic and inorganic mineral digestibility and retention in pigs

CALCIUM

Feed-grade calcium products are available in a wide variety of particle sizes, from liquid suspendable products to large particle products for laying hen diets.

DICALCIUM PHOSPHATE

Both 18.5% and 21% phosphorus products are available.

SODIUM BENTONITE

Bentonite products are available in a wide variety of particle sizes suitable for any purpose.

All products are available in both bag and bulk.

Todd M. Owens, M.S., P.A.S.
Director of Nutrition and Technical Services
ILC Resources
3301 106th Circle
Urbandale, Iowa 50322-3740
(515) 243-8106
Fax (515) 244-3200
1-800-247-2133
www.ilcresources.com
toddo@ilcresources.com

Using Progressive Phytase Regimens for Broiler Performance and Yields

Phytase is traditionally supplemented into broiler diets between 300 and 600 phytase units (FTU)/kg. This supplementation releases phosphorus (P) from phytate in feed ingredients. The obvious benefit is the increase in available nutrients. Another benefit, when phytase is added to corn-soybean meal based diets, the production costs are reduced, leg abnormalities are minimized and bird growth may be enhanced. To break down the phytate, in the absence of phytase, broilers hypersecrete pepsin and hydrochloric acid to improve digestibility and then in turn secrete sodium bicarbonate ($NaHCO_3$) and mucin, a gel-like secretion, to protect the intestinal tract lining (Cowieson, et al., 2004).

Supplementing diets with phytase improves growth performance and digestibility responses. Increasing the supplementation rate does not continue to increase these responses, and diminishing returns become apparent. For example, feed consumption in young birds (one to 14 d) can be less than 15% of the total feed consumed. Increased supplementation during this time at higher levels and then in lesser concentrations in later production phases would make sense. The benefits of the extra phosphorus during the starter phase, are the limiting factor to overall increased growth performance. Increasing phytase supplementation may be worth considering again after about 25 d of age. This is about the time bird growth reaches the linear portion of the growth curve. Since improvements in performance and growth with phytase is not a one-to-one relationship, the feasibility of supplementing needs to be balanced with the cost of phytase and the feed costs. Varying concentration rates, dependent on broiler age might be an economically, feasible option worth pursuing.

Experiment

Gehring et al., (2014) recently conducted an experiment to determine the effects of a fluctuating phytase supplementation regimen during the first 35 days of growth in male broilers. Specifically, the regimen stepped-up phytase supplementation in the grower or finisher phase from 500 to 1,500 FTU/kg and stepped down the supplementation (1,500 to 500 FTU/kg) in the grower or finisher phase.

The experiment was based on eight treatment diets: 1) a positive control (PC), 2) a negative control (NC) plus six treatment diets consisting of the NC diet with varying phytase additions. The PC diet was formulated to have adequate Ca and nonphytate P. The NC diet contained a reduced concentration of Ca and nonphytate P (by 0.14 and 0.13% respectively). Additionally, the sodium in the NC diet was reduced by 0.03%. The remaining six treatments were based on the NC diet with varying phytase additions. Diets 3-5 contained 500 FTU/kg phytase supplemented to the NC diet in the starter phase and then either continued through the experiment (diet 3), increased to 1,500 FTU/kg starting at the beginning of the finisher (diet 4) or grower (diet 5) phases. Diets 6-8 were also based on the NC diet, except that the starter phase was supplemented with 1,500 FTU/kg in the starter phase and continued at that level through the experiment (diet 6), or decreased to 500 FTU/kg in the finisher (diet 7) or grower (diet 8) phases. Table 1 shows the analyzed phytase concentrations of the diets.

Continued on p. 2

Continued from p. 1

Table 1. Analyzed phytase concentrations of the experimental diets provided to broilers from 1 to 35 d of age

	Dietary treatment[1]	Phytase (phytase units/kg)		
		Starter	Grower	Finisher
PC	Positive Control	---	<50	<50
NC	Negative Control	---	<50	<50
3	500, 500, then 500	---	519	581
4	500, 500, then 1,500	185	505	1,371
5	500, 1,500 then 1,500	---	1,600	1,280
6	1,500, 1,500 then 1,500	---	1,220	1,320
7	1,500, 1,500 then 500	---	1,290	370
8	1,500, 500 then 500	---	480	467

[1] Phytase units per kilogram of feed during the starter, grower, and finisher phases, respectively.

Findings

Growth rates were reduced in birds fed the NC diet at 14, 28 and 35 d. Birds on diets supplemented with 1,500 FTU/kg of phytase displayed greater feed intake and body weight gain over the birds fed 500 FTU/kg. The phytase supplemented diets (500 or 1,500 FTU/kg) had higher body weight gain than birds fed the positive control diet. On 1,500 FTU/kg, feed intake and body weight gain were higher but the feed conversion rate was lower at 14 d than the positive control diets as well.

At 28 d of age, birds supplemented with 1,500 FTU/kg phytase during the starter period continued higher body weight and body weight gains over the PC diet. The trend was obvious on the diets supplemented with 500 FTU/kg. This was most closely tied to feed intake, especially when the phytase was increased from 500-1,500 FTU/kg phytase (treatment 5). The only difference in feed conversion rate after the grower period was between the PC and NC diets.

The effects of the changing phytase supplementation were also analyzed at 35 d. Broiler growth did not change significantly regardless of when the supplementation rates changed. Body weight gain was 2.5% higher in broilers fed diets with 1,500 FTU/kg of phytase from 1-35 d compared to broilers fed 500 FTU/kg of phytase. Broilers fed 500 FTU/kg of phytase from 1-35 d and those fed increased phytase supplementation after the starter phase (500, 1,500 and 1,500 FTU/kg) did not differ in their growth rates. The broilers fed the progressive phytase diets consumed more feed, (an average of 96 g/bird) which resulted in higher feed conversion rates. Additionally feed conversion rates were higher in birds fed reduced phytase supplemented diets (1,500 FTU/kg in the starter and grower diets and 500 FTU/kg in the finisher phases) compared to the birds fed a continuous 1,500 FTU/kg phytase (diet 6).

What this means for the industry

Feed conversion rates changed in this experiment depending on the phytase concentrations. Gehring, et al., (2014) suggest that this may occur because of the physiological state or microbiota levels as a result of the previous phytase concentration fed. The effects of phytase supplementation last after the feeding stops (Pirgozliev, 2009). Angel, et al. (2002) determined that phytase indirectly affects cecal microbiota through the reduced concentrations of phytate and the resulting antinutrient effects. Since nutrients are not escaping digestion, it is logical that growth and feed conversion rates are going to be affected. In the current experiment, this was demonstrated on the treatments when the phytase concentration increased after the starter phase or decreased after the grower phase. Timing is critical, large swings in supplemental phytase concentrations can negatively influence feed conversion rates when fed at the wrong time in the production phases.

Since a positive effect on growth rates, feed conversion rates and nutrient availability is well established, it makes sense to feed higher concentrations of phytase over the entire life cycle of broilers. The economics of doing this would be determined by market prices and the efficacy of feeding phytase.

Information for this article taken from:

Angel , R., N.M. Tamin, T.J. Applegate, A.S. Dhandu, and L.E. Ellestad. 2002. Phytic acid chemistry: Influence on phytin-phosphorus availability and phytase efficacy *J. Appl. Poult. Res.* 11:471-480.

Cowieson, A.M., T. Acamovic, and M.R. Bedford. 2004. The effects of phytase and phytic acid on the loss of endogenous amino acids and minerals from broiler chickens. *Br. Poult. Sci.* 45:101-108.

Gehring, C.K., M.R. Bedford and W.A. Dozier, III. 2014. Effects of step-up and step-down phytase regimens on performance and processing yields of male broilers from 1-35d of age. *J. Appl. Poult. R.* 23: 252-259.

Pirgozliev, V., T. Acamovic, and M.R. Bedford. 2009. Previous exposure to dietary phytase reduces the endogenous energy losses from precision-fed chickens. *Br. Poult. Sci.* 50: 598-605.

Organic and Inorganic Nutrient Digestibility of Minerals and Retention in Pigs

Microminerals are important in swine diets for growth, reproduction and development of the immune system. Often these nutrients are delivered as supplements in the diet. If the source of the nutrients is a supplement, at higher than required levels, they are often excreted, passing right through the system. When the nutrients are fed at the correct levels, there is reduced excretion and a more economical feeding strategy is developed.

Excretion of minerals is an issue of ongoing concern in the industry. The source, organic or inorganic microminerals, makes a difference. Organic microminerals have been found to reduce the excretion in several studies (Veum et al., 2004, Burkett et al., 2009, and Jollif and Mahan, 2012). Specific microminerals of interest are zinc, copper, manganese and iron. As an inorganic supplement, they are often delivered in the diet as inorganic salts such as oxides or sulfates. Organic microminerals may be more bioavailable than inorganic minerals in pig diets (Creech et al., 2004).

Liu et al., (2014) conducted an experiment to determine if the digestibility and retention of organic minerals in pig diets are greater than inorganic mineral digestibility and retention. This study also tested the digestibility of those microminerals (organic and inorganic) to determine if it is influenced by the base of the diets (high-phytate, corn-soybean meal or low-phytate, corn grits).

The Experiment

Two groups of 24 barrows each were divided and fed six treatment diets (four barrows/diet). The experiment used 48 barrows. Three diets had a base of corn grits, soy protein, sorghum and corn oil. The other three diets had a base of corn and soybean meal. Three micromineral premixes were used as variables in the experiment. They were a basal micromineral premix (BMM), an inorganic micromineral premix (IMM) and an organic micromineral premix (OMM). The micromineral premixes were each contained in one the treatment diets. The BMM premix did not contain supplemental Zn, Cu, Mn or Fe. The IMM contained Zn, Cu, Mn and Fe from inorganic sources. The OMM contained Zn, Cu, Mn and Fe from organic sources. In order to meet current nutrient requirements, vitamins and all other nutrients, except those identified as variables, were used in all diets (NRC, 2012). The ingredient compositions of the corn grits diet and the corn-soybean meal diet, on an as-fed basis, are listed in Table 1. Chemical compositions of the experimental diets are listed in Table 2.

All pigs were fed the corn grits diet with the BMM for a two week period before the experiment. Pigs were then assigned to the six experimental diets. At the time of the transition, the average weight of the pigs was 40.2 ± 6.2 kg. Pigs were provided feed at three times the estimated requirement for maintenance energy on a daily basis for each diet. Experimental diets were provided for 12 days. The first five days served as an adaptation period to the diet.

Findings

The calcium concentrations in the three corn grits diets were 0.55 to 0.56% compared to the 0.61% concentration in the corn-soybean meal diets.

Overall, fecal excretion, nutrient absorption, and calcium and phosphorus retention was greater in pigs fed the high-phytate, corn-soybean meal diets than in pigs fed the low-phytate corn grits diets.

Both the inorganic and organic microminerals reduced the fecal excretion of calcium and phosphorus compared to feeding the BMM premix. Mineral absorption, retention, digestibility and the retention rate of calcium and phosphorus were increased when fed IMM or OMM compared to feeding the BMM premix. Between the IMM and OMM, the digestibility and retention of phosphorus was increased in pigs fed OMM.

On the high-phytate meal diets, the addition of OMM reduced the fecal excretion

Table 1. Composition of diets, as-fed basis

Item	Corn grits diet (Low-phytate)	Corn-soybean meal diet (High-phytate)
Ingredient, %		
Corn	--	74.93
Soybean meal	--	22.63
Corn grits	64.37	--
Soy protein concentrate	10.00	--
Sorghum	20.00	--
Corn oil	2.60	--
Dicalcium phosphate	0.78	0.82
Calcium Carbonate	0.95	0.89
Salt	0.40	0.40
L-Lys HCl	0.40	0.08
MHA	0.09	--
L-Thr	0.05	--
L-Trp	0.01	--
Micromineral premix	0.15	0.15
Vitamin premix	0.10	0.10
Calculated nutrient composition		
ME, kcal/kg	3,331	3,331
SID Lys %	0.83	0.83
SID Met+Cys, %	0.49	0.52
SID Thr, %	0.53	0.54
SID Trp, %	0.15	0.17

Continued on p. 4

Continued from p. 3

Table 2. Chemical composition of experimental diets

	Corn grits diet			Corn-soybean meal diets		
Item	BMM	IMM	OMM	BMM	IMM	OMM
DM, %	91.69	91.25	91.52	89.94	90.01	90.04
Ash, %	2.21	2.16	2.52	3.93	3.97	3.97
CP, %	12.64	13.26	14.17	16.47	16.16	16.20
AEE, %	2.95	2.86	3.31	2.76	2.60	2.57
Crude Fiber, %	0.53	0.56	0.52	2.07	1.92	1.98
Zn, mg/kg	10.23	44.34	51.15	19.84	56.60	60.24
Cu, mg/kg	3.88	59.89	60.06	4.21	62.87	64.31
Mn, mg/kg	10.55	27.77	28.47	12.73	32.23	32.77
Fe, mg/kg	97	187	197	103	201	207
Ca, %	0.55	0.56	0.55	0.61	0.61	0.61
Total P, %	0.35	0.35	0.35	0.49	0.49	0.48
Phytic acid, %	0.48	0.41	0.43	0.87	0.81	0.79
Phytate P, %	0.14	0.12	0.12	0.25	0.23	0.22
Nonphytate P, %	0.21	0.23	0.23	0.24	0.26	0.27

of phosphorus. Phosphorus absorption, retention, digestibility and retention rate was increased with OMM compared to the IMM in high-phytate diets. This same trend was not found in the low-phytate diets.

Apparent digestibility of microminerals does not increase when the animal's intake is reduced. The concentration of the mineral in the intestinal tract does not influence the percent absorbed or the percent excreted.

In this experiment, calcium absorption, retention and digestibility were not influenced by the source of the microminerals (inorganic or organic). The concentrations of the minerals in the diet may influence calcium retention and digestibility more than the type of minerals being supplemented in the diet. In this experiment, the apparent digestibility of calcium in corn-soybean diets with OMM or IMM was 62-70%. The corn-soybean meal diet without supplementation was only 56.8%. The authors hypothesize that the low levels of copper and zinc in the diet without supplementation impaired how efficiently the calcium was absorbed. On the corn grits diets, calcium retention and apparent digestibility were increased and the authors hypothesize that this is a result of feeding the low-phytic acid.

Phosphorus excretion was decreased when OMM was added to the corn-soybean meal diets. Nutrient absorption and digestibility were increased on this diet. The authors point to these observations to explain that OMM supplementation may improve the efficiency of P absorption, because OMM may reduce complexes between P and other minerals. This reduction may increase the absorption of P in the intestine.

What this means for the industry.

Micromineral supplementation is an important component of diet formulation. The amount to be supplemented needs to meet requirements, with caution given to not exceeding the requirements and result in nutrient excretion. In addition, the organic micromineral supplementation increases the P digestibility but not Ca digestibility when added to corn-soybean meal diets. Organic microminerals may also reduce the fecal excretion of microminerals and P compared to inorganic mineral supplementation.

Organic micromineral supplementation may be a better option for nutrient absorption, retention, digestibility and retention rate of certain nutrients. The organic supplementation positively influences those same measures of P in high-phytate, corn-soybean diets compared to low-phytate, corn grits diets. The digestibility of Ca is not influenced by the type of (organic or inorganic) supplementation.

Information for this article taken from:

Burkett, J.L., K.J. Stalder, W.J. Powers, K. Bregendahl, J.L. Pierce, T.J. Baas, T. Bailey, and B.L. Shafer. 2009. Effect of inorganic and organic trace mineral supplementation on the performance, carcass characteristics, and fecal mineral excretion of phase-fed, grow-finish swine. *Asian-Australasian Journal of Animal Sciences.* 22:1279-1287.

Creech, B.L., J.W. Spears, W.L. Flowers, G.M. Hill, K.E. Lloyd, T.A. Armstrong and T.E. Engle. 2004. Effect of dietary trace mineral supplementation and source (inorganic vs. chelated) on performance, mineral status, and fecal mineral excretion in pigs from weaning through finishing. *Journal of Animal Science.* 82:2140-2147.

Jolliff, J.S. and D.C. Mahan. 2012. Effect of dietary insulin and phytase on mineral digestibility and tissue retention in weanling and growing swine. *Journal of Animal Science*. 90:3012-3022.

Liu, Y., Y.L. Ma, J.M. Zhao, M. Vazquez-Anon, and H.H. Stein. 2014. Digestibility and retention of zinc, copper, manganese, iron, calcium, and phosphorus in pigs fed diets containing inorganic and organic minerals. *Journal of Animal Science.* 92:3407-3415.

NRC. 2012. Nutrient requirements of swine. 11th rev. ed. *National Academy Press.* Washington, D.C.

Tran, G. and D. Sauvant. 2004. Chemical data and nutritional value. In: Tables of composition and nutritional value of feed materials. 2nd ed. Wageningen Academic Publishers, Wageningen, The Netherlands. P. 17-24.

Veum, T.L., M.S. Carlson, C.W. Wu, D.W. Bollinger and M.R. Ellersieck. 2004. Copper Proteinate in weanling pig diets for enhancing growth performance and reducing fecal copper excretion compared with copper sulfate. *Journal of Animal Science.* 82:1062-1070.