IOWA
LIMESTONE
COMPANY

MINERAL
WRITES

SECOND QUARTER, 2000

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.

POTASSIUM
Iowa Limestone Company has both potassium chloride (KCl) and potassium magnesium sulfate (K/Mg/S) available.

All products are available in both bag and bulk.

The Effect of Phytase Supplementation on Swine and Poultry

Phosphorus availability to animals from plant sources, such as corn and soybean meal, is limited to 30-40 percent. Availability is low because much of the plant's phosphorus is in the form of phytates (Myoinositol hexaphosphates). Phytases are a group of enzymes that catalyze the stepwise removal of inorganic orthophosphate from phytic acid.

Phosphorus (P) is present in the form of phytic acid as a complex of cations (Ca, Mg, Zn and K) and/or proteins. Swine and poultry diets generally contain large amounts of unavailable phytate P which is not efficiently utilized and is excreted in the feces.

Monogastric animals lack the ability to produce sufficient amounts of endogenous phytase in the gastrointestinal tract to hydrolyze the phytate molecule and release the inorganic P. Thus supplementation of feed with inorganic sources of P is necessary to satisfy dietary requirements.

Recent advances in recombinant DNA technology have made it possible to commercially synthesize phytase enzymes that can then be added to the feed.

Phytase in Poultry Diets

Much of the original work with phytase enzymes was conducted with broilers, as we tend to formulate diets closer to the true requirement with broilers than we do with other species. Some of the key layer trials have been conducted by van der Klis, Roland and co-workers.

The efficacy of microbial phytase in laying hen diets was tested by van der Klis et al. (1997) using a phytase preparation from a genetically modified *Aspergillus niger* fungi strain. Three separate experiments measured ideal absorption of P as an indication of phytase efficacy and monitored the impact of supplementation on production parameters

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Effect of Phytase Supplementation

continued

(egg production, laying rate, feed intake, feed conversion and egg weight).

These data indicate that P absorption increased considerably — from 22 percent (control diet) to 50 percent in laying hens — by supplementing microbial phytase to the diet. No difference in production performance was seen in phytase-supplemented hens comparable to hens receiving inorganic P supplementation from monocalcium phosphate.

Significant differences in production parameters between supplemented and unsupplemented diets were observed by Gordon and Roland (1997) in feeding five levels of nonphytate P (0.1 - 0.5 percent) and two levels of phytase (0 and 300 U/kg feed). When not supplemented with phytase, the nonphytate P diet at 0.1 percent decreased egg production by 8.1 percent over the trial period (21 to 38 weeks), relative to other unsupplemented diets of 0.2 - 0.5 percent nonphytate P.

Gordon and Roland also reported a 5.8 percent decrease in feed consumption and lighter body weights in hens fed only 0.1 percent nonphytate P without enzyme supplementation. These hens also exhibited inferior bone strength and bone quality, an elevation in mortality, and a decrease in egg weight and egg specific gravity. Supplementation of 0.1 percent nonphytate P with phytase completely corrected these adverse effects with increases in egg production, egg weights, egg specific gravity, feed consumption and body weights, as well as a drop in mortality.

The key point is that the performance of hens consuming 0.1 percent nonphytate P with phytase performed as well as hens fed diets containing higher levels of nonphytate P without phytase.

Roland also observed that hens fed 0.1 percent nonphytate P with phytase supplementation excreted 25 percent less P than those consuming the same diet without phytase (3.71 and 4.98 mg/g, respectively). This reduction in P excretion indicates important environmental benefits can be associated with phytase supplementation.

Phytase in Swine Diets

Over the past decade European and U.S. swine researchers have extensively studied the inclusion of phytase in swine diets to evaluate its effectiveness in grow/finish pigs under experimental conditions. Their studies suggest potential environmental benefits through the reduction in fecal P excretion by 30 to 40% (Cromwell et al., 1993). Improvement in nutrient utilization also is reported.

Cromwell and co-workers evaluated the efficacy of recombinant *Aspergillus niger,* derived microbial phytase, using graded levels of phytase in combination with different levels of supplemental P in corn-soybean meal based diets. They studied from 0% to .15% added P. The diets containing no supplemental P (Dicalcium Phosphate) responded positively in a linear manner to level of phytase added to the diet, with regards to animal performance. The diets containing supplemental P elicited better performance than the phytase-supplemented diets, with exception of the diet containing no supplemental P or phytase. This

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Phosphorus Fundamentals-Part 2

Deficiency and Body Storage

A phosphorus (P) deficiency primarily effects the skeleton. Low dietary P levels in the diet of growing animals results in rickets, and in adults the affliction is referred to as osteomalacia. In both cases the bones become soft and possibly deformed due to the failure of the calcification process of the cartilaginous matrix. As the deficiency progresses it manifests itself in the deprivation of appetite and growth retardation. Animals also may suffer from PICA, an abnormal behavior in which the animal chews on wood, pipes and other inappropriate materials.

With reference to cattle grazing low P forages, large improvements in fertility and calf weaning weights were shown with supplemental P. This response is similar in most species suffering from P deficiency.

The skeleton provides a large pool of P that can be drawn upon during periods of inadequate P intake in mature animals. Because

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U.S. Feed Survey

The October, 1999 issue of *Feed Management* contained the annual survey of feed use by the major classes of livestock in the United States. The estimated feed tonnage for 1998 declined compared to 1997. This decline was attribued to a reduction in feeder pigs, beef replacements, grain-fed beef, dairy heifers and turkeys.

The feed potential for swine accounted for 26 percent of the total demand; dairy, 21.8 percent; broilers, 19.4 percent; beef, 18 percent; layers, 8 percent; turkeys, 5.6 percent; and the balance was divided among several other species. These estimates are the amount of complete feed needed for feeding the various species; they are calculated from animal inventories and expressed on a complete feed basis.

Species	Number (000)	Estimated Feed Consumption (000 tons)
Pigs	104,98	136,323
Sows	12,058	6,210
Beef Cows	33,885	3,050
Grain Fed Cattle	20,909	26,532
Milk Cows	9,199	31,267
Replacement Heifers	8,071	4,501
Layers	311,870	13,099
Broilers	7,934,280	31,737
Turkeys	283,503	9,214
Sheep	10,080	1,033
Catfish	—	562

Lobo, Philip. 1999. Feed Management. 50(8): 6-17

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suggests that the animal needs some source of supplemental P to maximize performance. However, the authors noted a decrease in fecal P excretion with the diets not containing added P.

Harper et al. conducted several experiments assessing the effectiveness of microbial phytase in low P and adequate P corn-soybean meal based diets. Feeding low P diets (.4 / .35% total P in growing and finishing diets, respectively) without supplemental phytase resulted in an overall 18% reduction in average daily gain (P< .05), 15% reduction in average daily feed intake (P< .05) and 3% poorer feed efficiency, compared to the control diet that contained adequate P. The addition of two levels (250 and 500 U/kg of diet) of phytase to the low-P diets restored the performance parameters within 96% of the adequate P diet. The overall apparent digestibility of P was linearly improved (P< .01) with the addition of 250 and 500 units of phytase/kg to the low P diets, which translates into a 21.5% decrease in fecal excretion. However, Ca and dry matter digestibles calculated in these studies were not affected by phytase supplementation or P level.

Conclusion

The efficacy of commercially available phytase has been demonstrated in numerous studies in the last decade. This product has been shown to be most effective in poultry diets, where Ca and P levels are highest. In swine diets it appears to be the most effective in the late growing and finishing period. Supplementation of phytase in low P diets appears to elicit performance similar to that of diets adequate in P without supplemental of phytase. Thus, decreasing the amount of P excreted eases some environmental concerns without compromising animal performance to a great extent.

However, limitations of phytase exist. The product is a protein enzyme and is denatured by the heat of normal processing during pelleting. Its effectiveness in diets that are pelleted at normal processing temperatures are in question. Phytase application post-pelleting is recommended by manufacturers, but systems to apply the phytase post-pelleting are extremely expensive and may affect pellet quality.

Phosphorus Fundamentals - Part 2
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of this reserve, one cannot measure a P deficiency in a short period of time. Deleterious effects on performance, while not quickly recognizable in animals in feeding situations, will be visible sooner in animals with a daily performance measure, such as layer hens and dairy cows.

Skeletal reserves of P can be replenished when the animal is consuming adequate amounts of P.

ILC

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