Surviving the High Cost of Phosphorus for Swine and Poultry: New Phytase Enzymes Offer Significant Cost Savings and Additional Benefits

This document is a general summary of the
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New phytase enzymes are saving swine and poultry producers more money than ever and offering additional benefits, including decreased phosphorus excretion rates, and improved gain/feed ratios (in swine), while also maintaining growth rates and bone mineralization. The total cost savings compared to using traditional inorganic supplemental phosphorus is over $5.50 per ton of feed consumed. With the price of feed-grade phosphorus supplements for animal nutrition increasing over 400% in the last few years, and with further price increases expected in the future, these new phytase enzymes are needed more than ever to provide some financial relief, while also offering other benefits.

Swine and poultry have required phosphorus supplements in their diets for many years, so the rapidly increasing cost of these feed components is having a dramatic and negative impact on the price of feed for the producer, and will ultimately affect the price of pork, poultry and egg products to the consumer. The effect is significantly worse for the producer and the feed manufacturer, who simply can't increase their prices enough to cover their increasing feed and raw material costs respectively. Thus, today's swine, poultry and egg producers, as well as the feed manufacturers are both watching their profit margins dwindle with no end in site.

However, there are solutions readily available to help producers and feed manufacturers reel in this skyrocketing cost of feed and retain their profit margins. In addition, some of these solutions even have other significant benefits to offer. To better understand this situation, it is important to understand how the problem developed, what has been done about it in the past, where the problem is heading, and what all the options are for solving it.

The Dietary Phosphorus Story - A Brief Overview

Animals require phosphorus in their diets to achieve proper skeletal growth rates and bone mineralization. However, much of the phosphorus contained in common feedstuffs (cereals and oilseed meals) is highly unavailable, meaning the animal's digestive tract is unable to digest and absorb it. The phosphorus is bound in the form of phytic acid, which is largely indigestible by

monogastric (single-stomached) animals, such as swine and poultry, due to the lack of an endogenous phytase enzyme that breaks down this acid and releases the phosphorus. In the past, this situation has been remedied in various ways, including adding a supplemental phosphorus, adding a phytase enzyme, or adding a combination of both to their diets.

Traditionally, the major source of supplemental phosphorus has been the following three inorganic phosphate products.

- Dicalcium Phosphate (Dical) is used predominantly in swine and poultry layer diets.
- Defluorinated Rock Phosphate (Defluor) is used predominantly in poultry broiler diets.
- Mono-Dicalcium Phosphate (Monocal) is used predominantly in ruminant diets (cattle, sheep, etc.) and in mineral and vitamin-mineral premixes.

In the U.S., dical, defluor, and monocal have maintained roughly a 40%, 30%, 30% market share, respectively. Swine, and particularly poultry, are the biggest users of these supplemental phosphorus products, with poultry accounting for over 50% of their total usage.

The Rapidly Increasing Cost of Phosphorus

Historically, these inorganic phosphorus products, dical, defluor and monocal, have met the demand for supplemental phosphorus cost-effectively, so other options had not been aggressively pursued. In recent years, however, their costs have increased dramatically. As an example, the cost of monocal has increased from approximately US$200 per ton just a few years ago to more than US$900 per ton today. Considering the staggering amounts of these products that are used by today's producers, this type of cost increase is now forcing everyone to look for more cost-efficient solutions.

There are a couple primary reasons for the price increases related to these inorganic supplemental phosphorus products. One reason is clearly the increased demand for the phosphates used as fertilizers, specifically to supply the new demand for corn used in the production of ethanol. Corn production requires twice the amount of phosphorus than soybeans, wheat and some other crops, so as more fields are being used for corn to supply the growing ethanol market, more phosphorus is being channeled into higher margin fertilizers, rather than being used for feed. Thus, the reduced phosphorus supply remaining for feed production has increased in price as one would expect based on the elementary concepts of supply and demand.

Another reason for the dramatic price increase of inorganic supplemental phosphorus rests on the supply side. Sulfuric acid is an indispensable ingredient in the manufacture of these phosphates, and its price has skyrocketed 2,000% in the last year. Sulfur, which is later processed into sulfuric acid, is a by-product of the oil and gas discovery and refining industries, where little new activity has occurred in recent years. With a total of 46 tons of sulfur required to produce 100 tons of monocal, it is easy to see how the increasing cost of this material has a dramatic effect on the price of phosphorus.

Phytase Enzymes Put to the Test

As stated previously, the needed phosphorus for swine and poultry is obtained by adding inorganic supplemental phosphorus, a phytase enzyme, or a combination of both to their diets. Using microbial phytase enzymes in animal diets allows the animal to unlock the phosphorus bound in the phytic acid of common feedstuffs, and increases the bioavailability of that phosphorus. This natural process reduces the need for inorganic supplemental phosphorus.

Commercially-produced phytase enzymes have been used in monogastric nutrition for approximately 15 years. Originally, these enzymes were produced from a fungus. Some newer phytase enzymes took a novel approach, and are derived from an *E. coli* bacteria strain isolated from the gut of pigs.

There has been a great deal of research conducted on the efficiency and effectiveness of phytase enzymes since the early 90's, so their benefits are well known, but as these products continue to advance, more research is continually needed. Recently, the renowned animal nutrition scientist David H. Baker, Ph.D. from the University of Illinois, led a research project that compared various phytase enzyme products.

A key factor in analyzing these enzyme products is the amount of phosphorus they release from the feed (making it bioavailable to the animal). The amount of bioavailable phosphorus released from the feed is measured in percentages and is compared to the amount of the enzyme used, which is measured in phytase units (FTU) per kg of feed. According to the NRC (National Research Council, 1994, 1998), the amount of bioavailable phosphorus required for animals ranges from 0.60% to 0.25% in poultry diets (broiler chickens, turkeys, laying hens) and from 0.55% to 0.15% in swine diets.

Dr. Baker's research with swine and broiler chickens fed corn-soybean meal diets at inclusion rates of 1,000 phytase units per kg of feed concluded that one of the newer *E. coli* derived products,

OptiPhos™, released the most bioavailable phosphorus, at a level of 0.20%. This compares to the release of 0.07% (broiler chickens) and 0.11% (swine) for one of the other leading phytase products (also at 1,000 FTU per kg of feed).

Dr. Baker's research also showed that some of the other phytase products could attain the goal of releasing 0.20% phosphorus, but it required the use of much more enzyme. In broiler chickens, one of the leading fungal-based enzymes required more than 5,000 FTU to reach the 0.20% level. However, another fungal-based enzyme could not attain 0.20% even at a level of 10,000 FTU (it only achieved a 0.15% release). Although not part of Dr. Baker's study, another leading *E. coli* derived phytase product has been reported to release approximately only 0.14% in both swine and broiler chickens (at 1,000 FTU per kg).

Calculating the Cost Savings of a Phytase Enzyme

Based on the highest phosphorus release levels concluded in Dr. Baker's research (0.20% by the OptiPhos product at 1,000 FTU per kg), 22 lbs of dicalcium phosphate can be replaced per ton of complete feed. With dicalcium phosphate at US$900 per ton, this equates to an initial supplemental phosphate cost reduction of nearly $10.00 per ton of feed. In this situation, swine producers could completely eliminate the dietary supplementation of inorganic phosphate to corn-soybean meal diets beginning in the early finishing period. The efficacy of this product in poultry is also very high. Additional research at the University of Illinois concluded that an inclusion level as low as 150 FTU per kg of feed was sufficient to completely eliminate the need for inorganic supplemental phosphorus in second-cycle laying hens.

In calculating the total cost savings of using phytase enzymes, the reduction or elimination of purchasing inorganic supplemental phosphorus is certainly a major factor, but some other factors need to be considered. First, the enzyme product itself obviously has a cost associated with it. Second, more limestone needs to be added to the phytase-focused diet (to replace the calcium lost with the phosphorus supplement) and more corn needs to be used to add weight. When all of these factors are considered, the total cost savings in switching from using inorganic phosphorus to phytase enzymes (using Optiphos for this example) is over $5.50 / ton of feed. This represents a very substantial overall cost savings.

With the United States swine market consuming more than 46 million tons of complete feed per year, and the US poultry market consuming more than 70 million tons of complete feed per year, a savings of $5.50 / ton equates to a potential savings of nearly US$640,000,000 in the US alone.

Additional Benefits of Phytase Enzymes

In addition to significantly reducing feed costs, one of the big benefits of using phytase enzymes is the dramatic reduction in phosphorus excretion rates (by 69% in some situations and relative to inorganic phosphorus controls). This is due to the phosphorus in the feed being broken down and used by the animal, rather than being excreted. This is a much better solution for the environment and can eliminate potential fines or legal actions aimed at producers as the mandates on controlling phosphorus excretions become more strict.

Phytase enzymes can also improve gain/feed ratios (in swine), while they maintain traditional growth rates and bone mineralization. Lastly, many enzymes on the market today are specifically designed for ease-of-use and are temperature stable for surviving the pelletizing and other processes.

Conclusions

For swine and poultry producers, surviving the increasing cost of phosphorus has become a significant problem. Some of the new phytase enzymes are solving this problem by creating a total cost savings of over $5.50 per ton of feed consumed (using Optiphos for this example). In addition, a top performing phytase enzyme like OptiPhos, when used in varying concentrations for pigs in the 50-280 lbs range, can allow for a total replacement of all inorganic supplemental phosphorus, while maintaining growth rates and bone mineralization, improving feed efficiency, and substantially reducing phosphorus excretions. These benefits, combined with the significant cost savings, make these new phytase enzymes easy to embrace, as they appear to be the clear choice for the future of swine and poultry diets.