Livestock Feed Supplement Developed At Cornell Helps Reduce Phosphate Pollution

Cornell University

In the 1990s, while he was working on his Ph.D. in animal science, Xingen Lei learned that phosphorus pollution from livestock is a huge problem. When he came to Cornell University, Ithaca, N.Y., as a professor in the Department of Animal Science, his first project was to develop an enzyme that could be used as a feed supplement to alleviate this problem. His research resulted in OptiPhos, a feed supplement that can reduce phosphorus pollution from pigs and poultry by as much as 50 percent.

Necessary Nutrient

As animals grow, they need phosphorus for bone and muscle development, and to help them use the energy in their diet. Much of the phosphorus in a typical corn-soy-based diet for livestock occurs as phytic acid. Livestock with simple stomachs, such as pigs and chickens, cannot digest the phytic acid, so it is excreted.

Pigs, chickens and other simple-stomach livestock animals need to receive supplementary phosphorus in the form of inorganic phosphates, which their digestive systems easily absorb. For pigs, the cost of this phosphate supplementation is currently $2 to $4 per animal during its growth cycle, the third most costly component of the animal's feed. Inorganic phosphate is obtained from mines and is a nonrenewable resource. The depletion of this resource has resulted in an increase in price per ton of phosphate from $200 or $300 to $1,000 in recent years.

Even though animals need the phosphate supplements, the phosphorous they excrete causes phosphorous pollution, taking a toll on the environment. While pig and chicken manure can be used to fertilize crops, the high level of phosphorus in the manure limits how much manure can be spread on a field. In livestock-raising areas, water runoff from farms washes much excreted phosphorus into neighboring waterways, lakes and ponds. This promotes eutrophication—excessive growth of aquatic plants that deplete the oxygen concentration in the water, often killing fish and other organisms.

Fortunately, through research in the U.S. and abroad, phytase enzymes are now available as feed supplements to help animals break down the phytic acid in their feed into usable phosphate. "Phytases are a group of enzymes," says Lei. There are different versions, but they all do the same job: breaking down the phytic acid. "It's like cars. There are different models, different engines, different colors, but they all do the same thing—get you from here to there."

Phytase Developments

The first phytase supplements, developed in Europe in the early 1990s, showed promise but did not act effectively in the conditions present in an animal's stomach. To be effective, a phytase supplement needs to do its work in the presence of stomach acid and digestive enzymes. And the phytase needs to work fast. Food doesn't stay in the animal's stomach for very long; an hour to an hour and a half in pigs, and less in poultry, is all the time the phytase has to do its job.

> *Lei and his students found a strain of E. coli bacteria that produces a phytase enzyme resistant to the digestive enzymes and acid in the stomach. Also, it works quickly enough to convert a significant amount of phytic acid to useful phosphate while food is in an animal's stomach.*

After isolating the gene responsible for making phytase, Lei expressed it in yeast to produce the phytase in quantity, and improved the enzyme's stability. Then, he published a paper based on animal studies of the enzyme's performance.

Partnership

Lei's work attracted the attention of Frank Ruch, president of Protein Scientific, Inc., a Portland, Maine, company specializing in nutritional products for humans and animals. Protein Scientific and JBS United, a Sheridan, Ind. animal feed company, formed a joint venture, Phytex LLC, to license the technology from Cornell and further develop it. In 2001 Cornell granted Phytex an exclusive license for the development and production of the phytase enzyme.

Phytex performed further development of the enzyme and transferred it to large-scale production. The company has also worked with academic
laboratories in the U.S. and abroad to improve the yield. In 2005, Phytex completed a 3-year Food and Drug Administration approval process for OptiPhos.

Meanwhile, “the cost of the enzyme went down, and the cost of phosphate went up,” says Ruch. It became cost effective to substitute animal feed with more and more phytase enzyme in place of inorganic phosphate, enabling farmers to raise pigs on a diet with very little inorganic phosphate supplementation.

The OptiPhos technology transfer program has involved patents in three main areas, says Alice Li, a senior technology commercialization and liaison officer at the Cornell Center for Technology Enterprise and Commercialization. One family of patents covers bacteria phytase enzyme. Another covers improved versions of bacteria phytase that have been developed. Other patents cover methods of phytase production.

Continuing research includes applications in the poultry industry with turkeys, chickens, and ducks, as well as work with swine to investigate substitution of greater amounts of enzyme for more and more of the inorganic phosphate supplements. Additional work at Cornell has included improving the enzyme’s resistance to the heat and moisture encountered during the pelleting process.

Within the phytase research programs, Lei has had “the opportunity to teach students that technology can make a real impact—research is not just about writing papers,” he says. And he has been pleased with the experience of working with commercialization partner, Phytex. “There is a great role for university professors and industry to work together as a team.”

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