ilc resources

MINERAL WRITES

FIRST QUARTER 2006

### 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

ILC Resources has both potassium chloride (KCl) and potassium magnesium sulfate (K/Mg/S) available.

All products are available in both bag and bulk.

# Introduction

As follow-up to the last issue of *Mineral Writes*, these two recent articles may further unlock understanding of mineral interactions.

The first study involves hypocalcemia (milk fever) in dairy cows. It reviews the complexities of dietary cation-anion differences in predicting milk fever as well as interactions among key mineral components of calcium, phosphorus and magnesium. It was reported in the February, 2006, edition of the *Journal of Dairy Science* (JDS 89:669-684) and titled ***"Hypocalcemia in Dairy Cows: Meta-analysis and Dietary Cation Anion Difference Theory Revisited."*** Meta-analysis refers to a quantitative analysis of previous studies. This in-depth examination of many studies was conducted by a team of Australian bovine researchers, in Camden, Australia.

The second study was broiler research conducted at Louisiana State University at Baton Rouge. This was reported in the March 2006, issue of the *Journal of Poultry Science* (JPS 85:493-497) and titled ***"The Effects of Phytase on Growth Performance and Intestinal Transit Time of Broilers Fed Nutritionally Adequate Diets and Diets Deficient in Calcium and Phosphorus."***

Here's an overview of the articles and follow-up with some interpretive suggestions. For more complete information, please obtain the texts as referenced above or contact ILC Resources for further detail.

For additional information contact
**Richard H Bristol, MS**
ILC Resources Director of Nutrition and Technical Services

ILC Resources
500 New York Avenue • Des Moines, Iowa 50313
(515) 243-8106
Fax (515) 244-3200 • 1-800-247-2133
www.ilcresources.com
richardb@ilcresources.com

# Hypocalcemia in Dairy Cows: Established Dynamics Revisited

An article published in the February, *2006, Journal of Dairy Science* (JDS 89:669-684) reported results of an Australian group's evaluation of previous research on dietary dynamics in precalving dairy cow nutrition affecting milk fever. Their meta-analysis, *the quantitative analysis of previous studies,* on hypocalcemia research provided a means to analyze collective data from numerous studies for insight on dietary influences of incidence of milk fever. They evaluated data from more than 35 papers involving 137 individual research trials observing over 2,545 calvings. The aim of this study was two-fold. First, precalving DCAD (*dietary cation-anion difference)* equations were reviewed to determine which provides the best estimate of milk fever risk. Secondly, the study clarified the roles dietary *calcium, magnesium and phosphorus* play in prepartum nutrition to influence the incidence of milk fever.

While both aims of this study merit consideration, *calcium, magnesium and phosphorus* interactions are the primary focus of this synopsis. For more complete coverage of findings, see the actual journal article.

Prepartum dietary *calcium's* role in the development of milk fever may exacerbate the condition or may help prevent its occurrence. This study indicated that increasing dietary *dry matter* (DM) concentrations of Ca from 0.5 to 0.6% before parturition may increase milk fever risk by upwards of 40%. The data showed that further escalation of dietary Ca to 1.0% (*e.g. high alfalfa feeding and mineral supplementation)* could increase milk fever risk by over 300%.

The study also showed a strong association between higher concentrations of *magnesium* (Mg) in the diet and a lower incidence of milk fever. For example, an increase in magnesium concentration from 0.3 to 0.4% of diet DM, with other variables maintained, would result in over a 60% decrease in milk fever risk. This realization strongly suggests the need for testing feedstuffs to be fed precalving and knowing interactive levels of key minerals. For instance, high potassium (K) increases milk fever incidence by creating a negative effect on magnesium absorption. Some roughage tends to run high in K and thus, may hinder magnesium utilization leading to higher milk fever risk. Magnesium plays important roles physiologically. Protein synthesis and enzyme-regulated energy metabolism are two key functions. Further, magnesium plays a role in parathyroid hormone release leading to synthesizing vitamin D, vital for Ca absorption and utilization. Calcium mobilization rates at parturition (calving) are slower in prepartum diets low in magnesium.

Increasing *phosphorus* (P) concentration in prepartum diets can also increase risk of milk fever. This study reported that a dietary increase in P from 0.3 to 0.4% DM increases risk of milk fever by as much as nearly 20%. Metabolically, increasing dietary P prepartum can inhibit vitamin D production sufficiently to cause hypocalcemia, leading to higher incidence of milk fever. In cattle, prepartum diets high in P can have a negative impact on Ca homeostasis (equilibrium).

Important inferences may be drawn from this study. Predictably, lower milk fever risks exist with lower dietary calcium levels (< 0.5%) fed during the dry period, perhaps especially 2-3 weeks pre-freshening. Higher magnesium levels in prepartum diets appear to be beneficial in lowering milk fever incidence. Prepartum diets with elevated P levels may increase milk fever risk too. Transition diets high in grain to meet mounting energy demands could push P intake to levels increasing milk fever risks.

Close attention to determining key mineral levels in late *dry period* diets is vital for preparing the dairy cow for parturition and successful lactation. In particular there exist important interrelationships among Ca, Mg and P that have major influence on that success or possible failure.

# Effects of Phytase on Growth & Intestinal Transit Time of Broilers Fed Diets Adequate or Deficient in Ca & P

Louisiana State University researchers conducted a study (March, 2006, *Journal of Poultry Science*) to examine the influence phytase had on performance factors in broiler chicks. Their objective was to evaluate the effects of phytase on growth performance and intestinal transit time in nutritionally adequate diets as well as diets deficient in *calcium* (Ca) and *non-phytate phosphorus* (nPP).

Fundamentally, phytate is a compound that contains bound P and other minerals, including Ca, and is found in most plants, counting corn and soybeans. Corn and soybean meal comprise a substantial portion of poultry diets. Thus, much of the P in these diets is unavailable. Phytase is an enzyme that hydrolyses the release of P from the phytate molecule.

Measuring performance one would expect that deficiencies in Ca and P would result in reduced performance. The LSU scientist reconfirmed this known phenomena but with additional findings. *Average daily gain* (ADG), *average daily feed intake* (ADFI), and *gain: feed* (G:F) were decreased by dietary deficiencies of Ca and nPP. Phytase increased ADG and ADFI of chicks fed the Ca- and nPP-deficient diet as well as chicks fed the nutritionally adequate diet. Further, bone parameters (*tibia and toe ash percentages*) were decreased in chicks fed the Ca- and nPP-deficient diet. Phytase increased those bone parameter percentages in chicks fed both the Ca- and nPP-deficient diet as well as the nutritionally adequate diet. Thus, performance was enhanced by dietary phytase addition along with improved bone ash percentages.

Additional investigation by the LSU research team revealed phytase also influenced ingesta passage rates through the GI tract measured as transit time. Their experiments demonstrated that transit time was faster in chicks fed the phytase-added diet. Previous research has revealed that transit time of ingesta through the intestinal tract is affected by several factors, including age of bird, temperature, *viscosity* of diet, and *enzyme supplementation. Viscosity* is an internal property of a fluid that offers resistance to flow. Low viscous ingesta would appear runnier and would flow through the intestinal tract faster than a thicker, high-viscous fluid. Thus, a high-viscous diet prolongs feed passage time which decreases feed intake simply due to capacity constraint. Research has shown that enzymes in poultry diets do result in differences in viscosities of the ingesta and transit time through the digestive tract. It may well be that phytase enzyme changes the ingesta viscosity resulting in reduced intestinal transit time. Less transit time allows for increased feed intake which further allows for improved growth performance.

The researchers noted a decrease in transit time in chicks fed diets with added phytase, which could provide the explanation for improved performance. The results of their study suggest that the increase in ADG in chicks fed diets containing phytase was due to an increase in feed intake, regardless of the adequacy of the diet in Ca and nPP.

Interpretation of this study would suggest two key benefits. One, adding phytase to diets unlocks key nutrients, predominantly P, bound by the phytate complex in grains and soybean meal diets. This allows for better nutrient availability and reduces the need for additional supplementation which would potentially increase nutrient excretions. Such excretions detrimentally affect the environment as well as raise feed costs. Second, reducing intestinal transit time by feeding phytase might allow for more feed intake and result in greater growth performance, regardless of the adequacy of the diet.

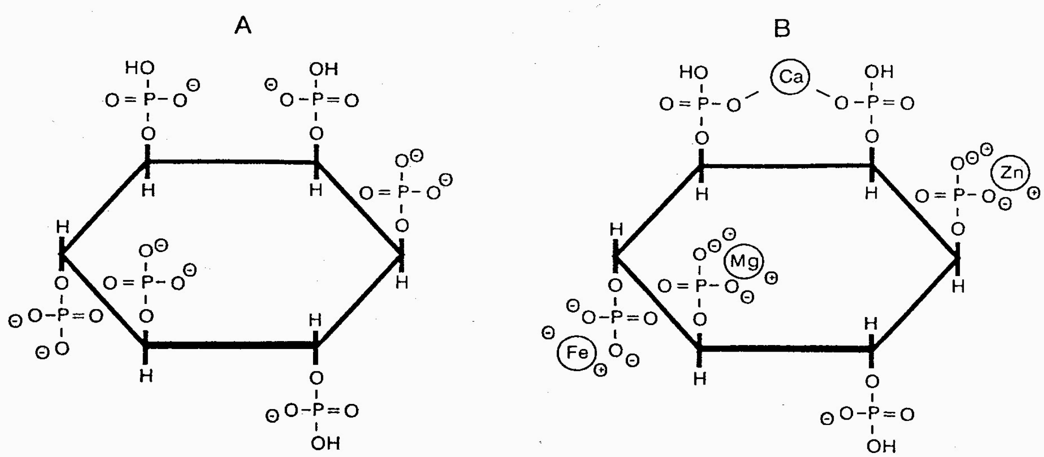
# What is Phytate?

Phytate (phytic acid) is an organic compound that ís abundant in plant cells. Phytate stores phosphate and other mineral nutrients for utilization during seed germination and seedling growth.When present as mixed complexes with minerals (K+, Mg2+, Ca2+, Fe2+, Zn2+) it is known as phytin, (phytic acid chelate).

Up to 80% of total seed phosphorus is stored in phytin. Although phytate is found in large quantities in seeds, it is also present in other plant tissues. The potential of phytate to form very stable complexes with minerals and proteins confers upon this molecule its notorious antinutritional\properties. Monogastric animals lack the hydrolytic enzymesin their digestive tracts needed to break this down. Therefore, the high concentrations of phytate in food grains and phytate's ability to chelate mineral cations compromise mineral absorption. Undigested phytate in animal waste also contributes to eutrophication and environmental phosphorus pollution.

The degradation of phytate is achieved by a group of enzymes called phytases. Phytases are used to reduce the level of phosphate pollution in areas of intensive animal production. Addition of adequate amounts of microbial phytases in animal feed improves the utilization of phosphate from phytate. This allows for a reduction in inorganic phosphate supplementation in the diets of simple-stomached animals. As a result, the fecal phosphate excretion of these animals may be reduced by up to 50 percent. Finally, phytases can improve the nutritional value of plant-based ingredients (especially grains) by increasing the availability of the minerals chelated in phytin.

## Structure of Phytic Acid (A) and Phytic Acid Chelate (B)




**Phytate is an organic compound that's abundant in plant cells. It provides for the storage of phosphorus for utilization during seed germination and seedling growth.**

**Phytin is the result of mixing phytate complexes with minerals (K+, Mg2+, Ca2+, Fe2+, Zn2+).**