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MINERAL WRITES

THIRD QUARTER 2003

An Update: Distillers Dried Grains with Solubles (DDGS)

Since the last edition of *Mineral Writes,* several significant points have come to our attention that advance our understanding of the use of DDGS in livestock diets, especially non-ruminants (swine and poultry). Acknowledgement is gratefully expressed to John Goihl, AGRI-NUTRITION SERVICES, Shakopee, Minnesota, for his expertise.

In the previous article, DDGS was inadvertently cast in an unfavorable light as to its use in non-ruminant diets. Although unintentional, the implication was there nonetheless.

During the past five years, Goihl has analyzed many samples of DDGS from various ethanol plants in the upper Midwest. Much of the historical inconsistencies in nutrient analyses and digestibilities with DDGS have been minimized by today's methods of ethanol production.

As ethanol production uses approximately two-thirds of the corn kernel (starch content), this process increases the nutrient densities of the remaining nutrients. The remaining third of the corn has a much denser nutrient profile. The analysis of DDGS is approximately three times the nutrient analysis of corn.

The previous article stated that DDGS competes with protein ingredients, when in fact it primarily competes with *corn* plus *soybean meal* and *inorganic phosphorus*. Thus, comparing DDGS to other protein ingredients on a cost per unit of protein may be applicable to ruminants, but isn't suggested for non-ruminants.

Goihl states "the addition of 200 lb. of DDGS/ton of complete feed replaces approximately 177 lbs. of corn, 20 lbs. of 44% soybean meal and 6 lbs. of 18.5% dicalcium phosphate." This results in needing to provide additional calcium carbonate to balance calcium needs (3.0-3.5 lbs./ton).

Further, the energy level of the DDGS from the new ethanol plants is much higher than reported in the old nutrient data. Metabolizable energy values are approximately 1500 Kcal/lb., not 1275 Kcal/lb. as previously reported.

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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.

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Solubility

Questions about the meaning and significance of the term "solubility" have arisen. Certainly, answers about the "solubility" of ILC Resources' calcium carbonate products are important for poultry layer operations, but an understanding of the concept of solubility may be useful with other species as well.

The nutrients required by the body first must be dissolved before they can be absorbed by the body and used. Solubility is a term that describes the quality or condition of being soluble. More specifically, it is the "amount of a substance that can be dissolved in a given amount of solvent." A solvent, in chemistry terms, is a substance, usually a liquid, capable of dissolving another substance. Putting these definitions together and applying them to the feeding of calcium carbonate ($CaCO_3$) to livestock and poultry, we are saying that "solubility" refers to the amount of calcium (Ca) that can be dissolved in a given amount of digestive liquid (i.e., hydrochloric acid in the stomach). This dissolution of $CaCO_3$ makes calcium available for absorption and subsequent utilization to meet the variety of requirements necessary for life's functions. These functions include such processes as skeletal development and maintenance, muscle contractions, nerve impulses, milk production, enzyme activation, and eggshell formation.

The solubility of nutrients is determined by the molecular properties of the nutrients. There are three main factors affecting solubility: (1) temperature, (2) nature of the *solute* (substance being dissolved) or the nature of the *solvent* (liquid substance capable of dissolving another substance), and (3) pressure. Since body temperature sets the first factor and calcium solubility does not involve the effect of pressure as in the case of gases, we will confine our look to the second factor.

The nature of the solute, calcium carbonate, is of primary importance. The solvent is weak hydrochloric acid (HCl) present in the stomach. By definition then, solubility of $CaCO_3$ is the amount that can be dissolved in a given amount of HCl. Bear in mind that this number is a *relative* term. It also depends greatly on the properties of the $CaCO_3$ being measured. Surface area exposure is the main determinant. Smaller particulate limestone would have greater surface area exposed per given weight, so fine ground calcium carbonate would have a high *solubility*. Conversely, large particle sized $CaCO_3$ with reduced surface area exposure per the same given weight has a low *solubility*. Hardness of limestone rock plus particular structure of a given limestone source also influence solubility.

One would think that high solubility calcium carbonate would have more Ca available for absorption and then utilization by the body. While in essence this is true, certain functions may prove this wrong. In the case of eggshell production, timing of available calcium is critical. Highly soluble Ca will likely pass through the GI (gastrointestinal) tract too quickly and may not be available for absorption at the time when peak eggshell formation is taking place, usually during nighttime non-feeding hours. Therefore, it is more important to use a source of calcium that will be available on a slower, more metered basis to insure availability during times of peak shell production. When fed to laying hens, large particle sized $CaCO_3$ is deposited in the gizzard and is slowly "dissolved," making Ca available to the bird for shell production during non-feeding hours.

Thus, rate of passage becomes an important factor for absorption in addition to the amount of a nutrient that is dissolved and available for absorbance. Finely ground $CaCO_3$ is highly soluble, but large quantities of the dissolved Ca could pass through the digestive tract of laying hens unabsorbed, before helping in shell formation. However, highly soluble, smaller particle $CaCO_3$ is helpful for other body functions, not only in poultry but other species as well.

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Solubility *continued*

Singling out the laying hen again, adequate calcium in her diet must be provided to meet requirements for a variety of body functions, even though eggshell production creates the most critical demand for great amounts of calcium. Just to meet normal body functions, the laying hen needs about 1.25% Ca in her diet. To meet the additional Ca demands for eggshell formation, she needs twice that amount by mobilizing calcium from bones and/or by ingesting additional amounts of dietary calcium. In this scenario, the solubility of additional dietary calcium will be very important. Dr. Craig Coon, poultry scientist at University of Arkansas, provides some interesting information concerning the effects solubility of calcium has not only on eggshell production but calcium and phosphorus status in the bones. His research indicates that high soluble calcium (small particulate $CaCO_3$) causes a large loss in phosphorus excretion compared to large particle low soluble $CaCO_3$. Further, besides helping do a better job with the calcium and phosphorus utilization for the hens, improving performance, etc. the low soluble calcium carbonate minimizes the amount of calcium (and phosphurus) that has to be pulled from the bone to take care of the hen's calcium demand for eggshell production. Thus, there is less phosphorus that is lost in the urine (excreta) because when Ca is pulled from bones, P comes with it and is usually lost in urine. The bird will need Ca especially during periods of peak eggshell production. A large particle sized, slowly dissolved source of calcium will address that need. Incorporating *Shell & Bone Builder* or a blend into layer diets that have lower solubility values fits this need. Historical research by Dr. Coon, while at Minnesota in the early '90s, determined that $CaCO_3$ with solubility percentages between 11-14% was suggestive as ideal for proper eggshell production. Recommendations based on solubility values are more reliable than just particle size. Our own laboratory testing continues to verify that "like particle size" products (e.g. *Shell & Bone Builder*) do vary in their solubility values from plant to plant, based on differences in the basic limestone being processed at each location.

How is solubility determined? The laboratory test for solubility adds 2 grams of $CaCO_3$ to 100 ml (milliliters) of dilute HCl in a beaker that is oscillating in a heated water bath at 107 degrees Fahrenheit for ten minutes. The pH (measurement of acidity) of the HCl solution is determined prior to adding $CaCO_3$, and then measured again after 10 minutes. Reacting $CaCO_3$ with HCl raises the pH (neutralizing effect) of the solution. How much that pH is raised equates to how much calcium carbonate is dissolved in the acid solution. This is a relative measurement of how much free calcium is available for absorption in a given time period. High percent solubility means greater calcium available in its free state for absorption. Low percent solubility means lesser calcium available in its free state for absorption in the same time frame. Although dissolution is a necessary step for nutrients to be absorbed, absorbance depends on more than just solubility of the nutrients. Rate of passage is part of the issue. What body functions need calcium and when it is needed play a major role as to how soluble calcium carbonate needs to be in the diet.

ILC Resources' large particulate granular products (e.g., *Shell & Bone Builder* or *Shell & Bone Builder Blend*) run 10-15% *solubility.* Our finely ground products (e.g., *Unical-P or Unical-UF*), on the other extreme, run 25-27% *solubility.* For instance, it is not so much that 12% solubility means specifically one thing versus maybe 26% solubility. It is rather, relative to each other, high solubility $CaCO_3$ dissolves *exponentially* quicker than low solubility $CaCO_3$. For certain body functions, we need to have calcium available for absorption in abundance and quickly upon ingesting. For other functions, such as eggshell production, we need a slower "metered" source of calcium available for absorption. "Solubility" gives us part of the equation and provides a guide to make decisions on formulating diets.

Glucosamine/Chondroitin: Alternative therapy or foo-foo?

Arthritis in humans or pets occurs so frequently that the likelihood of experiencing this malady is high, depending largely on age given reasonable longevity. One of the curious contradictions in life is that rigorous activity and exercise tend to hasten this problem.

Drug therapy resulting in symptomatic relief has been the historical approach, but often with less than satisfactory results. "Relief" does not eliminate the underlying disease. Whether nonsteroidal anti-inflammatory drugs or disease-modifying antirheumatic drugs, relief from pain is mostly the extent of their effectiveness. Besides, all too often they are not well tolerated by the user. Failure to provide long-term benefits has prompted a search for more effective treatments which both control pain and slow down or reverse progression of the disease. Biochemical and pharmacological data combined with animal and human studies demonstrate that *glucosamine* and *chondroitin* are capable of satisfying these criteria.

Glucosamine stimulates biosynthesis of components needed in the structural formation of joints. Chondroitin provides additional components for the formation of a healthy joint matrix. Either singly or in combination, glucosamine and/or chondroitin supplementation has been an extremely popular treatment of degenerative joint disease. A number of studies dating from the early 1980s demonstrate that oral glucosamine decreases pain and improves mobility in osteoarthritis without side effects.

Like humans, aging animals experience such maladies as stiffness of joints and other effects of arthritis. Many "companion animal" feed companies are now offering senior product line feeds containing glucosamine and chondroitin.

Why are we discussing this topic in *Mineral Writes*? The feed industry — along with animal agriculture in general — is so intertwined with other disciplines of society that much interdependence has emerged. Tyson Foods, "mega-giant" in the human food industry, had its origins feeding poultry in Arkansas. That company has expanded in many directions, including recent endeavors to market cartilage products that will deliver a natural source of glucosamine and chondroitin sulfate. The trade press tells us that "These ingredient products will be marketed to manufacturers of human supplements as well as to suppliers of companion animal foods and supplements."

An Update *continued*

Also, fiber content was stated as a possible hindrance. Swine nutritionists are looking upon fiber from DDGS as a positive, instead of a negative in swine diets.

From ILC Resources' perspective, an increase in DDGS fed to non-ruminants increases the need for additional calcium carbonate; i.e., approximately 3.5 lbs./ton for each 200 lbs./ton of DDGS used in complete swine feeds.

Goihl is well recognized for his expertise as a swine nutritionist. We appreciate his experience and insight in the use of DDGS in non-ruminant diets. For additional information on current research with DDGS, refer to Web Site www.ddgs.umn.edu.

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