IOWA
LIMESTONE
COMPANY

MINERAL
WRITES

FOURTH 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.

ILC

Limestone particle size: What's the right one to use?

The answer depends upon the species that you are feeding and the finished products manufactured in your facility.

Overview

In general, increasing the fineness of grind of limestone increases the surface area available for digestion in the animal. It has been suggested that for some species of animals the particle size must be sufficient enough to allow for optimum retention time, therefore maximizing calcium availability. This is evident for laying hens, where it is commonplace to include large particle size limestone in the diet.

A large variety of calcium sources are available for application in the feed industry. However, the most common source of supplemental calcium is some form of limestone. According to the American Association of Feed Control Officials (AAFCO), a limestone source that is high in calcium (38 - 40%) is referred to as calcium carbonate. A 33 - 37% calcium limestone is called ground limestone. However, this name bears no reference to its particle size. Dolomitic limestone is 20 - 23% calcium and contains at least 10% magnesium. The most common calcium source is usually calcium carbonate.

Selection of feed-grade limestone as a nutrient source in the animal diet is inclusive of such factors as mixing characteristics, compatibility with other ingredients, application, and quality and consistency of the supplemental calcium source. These selection criteria used by the feed manufacturer have resulted in a consistent improvement in feed-grade products by calcium suppliers. The most notable refinements relate to the development of numerous powder or granular products. Feed-grade limestone products are currently available with a particle size range from <30 to 3,100 microns.

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Calcium Metabolism

Calcium (Ca) is generally consumed in the form of calcium carbonate, calcium phosphates, oxalate in legumes and as phytates in grain. Calcium absorption occurs in the small intestine, primarily in the duodenum. The two mechanisms involved in its absorption are: 1) Active transport, is saturable, which requires metabolic energy (ATP), and 2) simple diffusion.

Ninety-nine percent of the Ca absorbed is located in the skeletal matrix. Coupled with phosphate, it forms hydroxyapatite crystals, which provide the inorganic structural component of the skeleton. Hydroxyapatite crystals fill the interspaces in the porous protein matrix to make bones rigid. In addition to its primary structural role, the bone also serves as a reservoir for ions such as Ca, phosphate, sodium and magnesium. Bone is a dynamic tissue always in a state of remodeling. At equilibrium, there is balance between new bone formation and bone resorption. Thus, calcium levels in the production animal's diets should not be overlooked.

Approximately 1% skeletal Ca is freely exchangeable and another 1% is found in the membranes surrounding the bones. This constitutes the available pool of Ca for the animal to draw from. Total circulatory Ca is found in three major forms: 1) physiologically active unbound ionized Ca; 2) Ca complexed with organic acids; and 3) protein-bound Ca. Ionized Ca is maintained within very narrow limits, alterations as small as 1% call into play mechanisms to restore baseline values. These mechanisms involve the skeleton, which may be drawn upon or into which excess may be deposited and excreted through the kidneys or via the intestine as bile salts.

Because Ca is involved in virtually all phases of metabolism, concentrations of ionized Ca in extracellular fluids must be closely regulated. Three hormones regulate Ca concentrations: parathyroid hormone (PTH), 1,25 dihydroxycholecalciferol (the biologically active form of vitamin D), and thyroid calcitonin.

PTH raises serum ionized Ca by direct actions on the kidney and bone and indirect effects on gastrointestinal absorption of Ca as regulated by calcitrol. Calcitrol stimulates absorption of Ca across the small intestine wall via Ca transport proteins requiring ATP. It promotes the mineralization of bone and is similar to PTH in that it mobilizes skeletal mineral and decreases Ca excretion through the kidney. Conversely, calcitrol lowers serum Ca primarily by slowing down bone mineralization, thus a myriad of biochemical, metabolic pathways and physiological processes. The following functions require the Ca ion either as a cofactor, regulator or activator:

- Ca plays an important role in the **contraction of muscle**. Changing Ca levels in skeletal, cardiac and smooth muscles act as a switch converting muscle to and from a contractile state. If serum Ca is not maintained within limits, tetany, muscle twitching and cramps (hypocalcemia), or muscular weakness (hypercalcemia) can occur.
- The **blood clotting** mechanism proves Ca to be an essential factor. The importance of Ca is reflected in that most anticoagulants bind mainly Ca.
- **Nerve impulse transmission** requires Ca to control nerve excitability. Reduced Ca concentration produces increased excitability of pre- and postganglionic nerve fibers. However, higher than normal Ca concentrations produce the opposite effect on the nerve fibers.
- **Secretion regulation** is impacted by Ca. Several mediators, including Ca, regulate the gastric acid secretion by the parietal cells. Pancreatic secretions contain Ca, which help neutralize acids in the digesta entering the small intestine. Additionally, it stabilizes pancreatic and salivary amylase, which are the most important enzymes in starch digestion.
- **Control of several hormonal actions** require Ca as a component of the messenger mechanism. These chemical messengers are transported via the

blood to target organs. They attach at receptor cites and change the rate and/or extent of a wide variety of functions. Once the hormone has attached to its prospective receptor cite, it stimulates the CA-dependent regulatory proteins that trigger a cascade of reactions.

In addition, several other crucial body functions require Ca to support life, such as membrane integrity, plasma membrane transport, enzyme reactions and the release of neurotransmitters.

Plasma Ca concentrations are regulated by the level of excretions and absorption. Circulating levels represent as equilibrium between the amounts absorbed, utilized, stored and excreted. When this balance is upset, metabolic disorders occur. Ca deficiency (hypocalcemia) causes tetany, milk fever and other related muscle and neurological disorders. These symptoms occur most commonly as a result of vitamin D deficiency, hypoparathyroidism, or renal insufficiency, but Ca level also can be the cause. When plasma Ca levels fall below normal, the body mobilizes Ca from the skeleton to restore homeostatic conditions. This can result in bone abnormalities in the young (rickets) and mature (osteomalacia).

Generally, Ca toxicity is fairly rare, due to the fact that if Ca is in excess it is simply not absorbed. However, failure of absorption mechanisms, vitamin D intoxication and hyperparathyroidism can lead to renal stone

Particle size *continued from page 1*

Species Differences

Diversity in particle size was not entirely shaped by the required formulation characteristics. Matching the characteristics associated with the particle size to the nutrient needs of the animal is key to optimizing animal production. Development of species-specific products has been an area of great focus by calcium suppliers.

It has been demonstrated that feed-grade limestone products of different particle sizes are equally effective in supplying calcium and influencing animal performance and digestion in swine and ruminant animals. Studies evaluating limestone particle size differences in swine, however, show a slight improvement in daily gain when the animals consume a medium particle size (approx. 300 microns) calcium source. In the case of laying hens, large particles (1,400 - 5,600 microns) of limestone appear to be more effective than smaller granulations in producing eggs with acceptable shell strength.

Facility Differences

When evaluating the proper particle size of limestone for your manufacturing facility, you should consider what end product you are producing. A liquid feed manufacturer requires the finest grind source that can be acquired. Iowa Limestone Company's finest product — Unical UF — is less than 30 microns (325-mesh) and is produced specifically as a suspendible calcium source for liquid feed. Not many facilities want to handle Unical UF in a general line feed mill.

Most general line feed manufacturers use our finest free flowing granular product, Unical S. It has an average particle size of less than 285 microns and is an excellent choice for producing complete mixed feeds, supplements and pelleted feeds. As noted above, Unical S is within the particle size range to promote optimal animal performance.

If your primary need is for a calcium ingredient for base mixes, Unical L is generally regarded as the product of choice. It approximates the particle size of most dicalcium phosphate products and is a very clean and flowable ingredient, producing base mixes that have excellent eye appeal and calcium availability.

Our Fre Flo is a granular blend of various particle sizes. This product was designed to be used in the production of most feed products. Its range of particle sizes makes it an excellent carrier, blending well with products possessing many different particle sizes.

Iowa Limestone Company can blend our wide variety of products to produce a product tailored to your individual specifications.

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Limestone Production: A lot more complicated than you think

Visitors to our production facility are always amazed at the capital, energy and manpower required to produce a high quality, feed-grade calcium. The process is complicated, energy intensive and strenuous. Here's how we produce the highest quality product possible.

We start by removing the overburdern, 40 to 50 feet of soil above the limestone ledge. This can involve 350,000 to 400,000 cubic yards of topsoil and clay. The removed material is "recycled." It's used in the reclamation of an area where limestone has already been extracted. Our reclamation projects yield a fertile pastoral environment, which is then ready to be put back into crop production.

We then core drill along the quarry wall, removing cores representing the rock strata. Explosives placed in the holes created then are detonated, bringing down the quarry wall for further processing. Samples from the stone removed in the blast are taken and tested for purity.

We then begin reducing the size of the stone we will process. Large pieces of quarry stone are loaded onto our "pit trucks" and hauled to the primary crusher. The stone is reduced to 4-inch pieces and screened to remove any quarry impurities. The 4-inch stone travels via a conveyor belt to a stockpile where it is allowed to air dry.

The air-dried material is than conveyed into our production plant where it is further processed and screened. The material that is too large to pass through the screen is reduced in size via a hammer mill and then re-screened. Material that passes through the screen goes directly to a gas dryer. The high temperature dryer removes nearly all the moisture, yielding a product that is less than .05% moisture.

Once it is heat dried the material is sent through a series of screens and air separators. This process allows us to size our products to exact specifications. Each product is sampled for further analysis in our on-site laboratory. Precision-sized material is then conveyed to our holding bins to cool and soon be loaded for rail or truck delivery.

Our on-site laboratory is the hub of our quality assurance program. All products from each shift are analyzed for both Ca content and particle size. This assures us that we are meeting our stringent quality specifications and exceeding our customers' expectations for quality and consistency. Lab analysis helps us locate any problems in the screening process and could identify the root of any problems that might arise.

Iowa Limestone Company provides 10 base calcium carbonate products ranging from a 325-mesh material (approx. 18 microns) used in suspension feed to a 7-mesh material (approx. 3100 microns) used in laying hen diets. We can blend to almost any specification requested by the customer.

Quality products are the result of quality systems, managed by quality-conscious people. The bottom line is our people. Quality is a part of our culture, and is the common thread that runs though everything we do.

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