ilc resources

MINERAL Writes

First QUARTER 2011

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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Mineral Supplementation Affects Performance While Grazing Winter Wheat Pastures

In warmer winter regions, stocker cattle commonly graze on winter wheat pastures. *Free-choice* mineral supplementation is a widely accepted practice to optimize growth during this time. However, relative economics may suggest cutting costs by foregoing mineral supplementation, saving that expense. A recent study came out of Oklahoma which soundly showed the fallacy of this decision.

Reported in the *Proceedings, Western Section, American Society of Animal Science (March 2011)* is a study titled **EFFECT OF MINERAL SUPPLEMENTATION ON THE PERFORMANCE OF STOCKER CATTLE GRAZING WINTER-WHEAT PASTURE**. The study was conducted in Northwest Oklahoma (USDA, Agriculture Research Service – Woodward, OK). Previous research in Oklahoma indicated improved performance gained by free-choice mineral supplementation high in calcium (Ca) and low in phosphorus (P). This study further examined the efficacy of mineral supplementation.

Two experiments were conducted in late 2008 extending through the spring of 2009. After summer fallowing of pasture ground, pastures were fertilized according to soil testing and in early September planted to winter wheat. Experiment 1 turned out a mix of 425-pound heifers and steers on pasture in mid-November for an 84-day grazing period, pulling them off again in early February. Experiment 2 followed in later February by turning out 545-pound steers on same pastures for another 84-day grazing trial, pulling them off in mid-May. The two treatment groups were offered either mineral/salt supplementation or no supplementation. The mineral offered was a free-choice mineral (*Wheat Pasture Pro; Land O'Lakes Purina Feed, LLC, St. Paul, MN*) which was fed in ground type mineral feeders (*Sioux Steel Company; Sioux City, SD*). Basic profile of mineral was 15-17% Ca, 4% P, 5.5% Mg, 18.5-22% salt, 100,000 IU VitA/pound.

In Exp 1 during fall and winter, the steer and heifer calves grazing on pasture without supplementation gained an average of 132 pounds (lbs.) in 84 days, averaging 1.14 lbs/day gain. At the same time, the mineral supplemented group gained 178 lbs in the same 84 days, averaging 1.65 lbs/day gain. Therefore, supplementation netted on average 46-lbs heavier calves in Exp 1.

In Exp 2 during the spring, steer calves grazing on pasture without supplementation gained 158 lbs in 84 days averaging, i.e. 1.89 lbs/day gain. At the same time, steers grazing on pasture with supplemented mineral gained 205 lbs in the same 84 days, averaging 2.46 lbs/day gain. Thus, supplementation netted on average 47-lbs heavier calves in Exp 2.

Obviously, no added feed expenses were incurred beyond pasture cost for the cattle grazing without supplementation in both experiments. In contrast, mineral supplementation did add expense. In this study, the mineral used cost in the range of $800 per ton. Mineral intakes during trial ran within or slightly higher than manufacturer's recommended range (Exp 1 – 2.6 oz/day, Exp 2 – 5.9 oz/day). The researchers reported, "These intake rates (of *mineral supplement*) and added ADG by the cattle resulted in ratio of mineral cost to *pound* of added ADG of $*0.12 - 0.29*." In terms of the added gain alone, economics of feeder calves sold even in a depressed market would result in mineral supplementation consistently being a wise investment, not an expense.

One additional evaluation from this study was to determine which particular mineral was of greatest value as stockers grazed wheat pastures: "Two minerals of greatest concern for cattle grazing wheat pasture are Ca and Mg. The analyzed mineral composition of wheat forage indicates that it contains sufficient P and Mg, excess K, and inadequate Ca for growing cattle. Hence, **Ca** is most likely the limiting mineral for cattle grazing wheat pasture." This statement is supported by previous studies from early 1980s to present.

Calcium Carbonate: Particle Size – Acid Solubility Influence Layer Hen Nutrition

When considering laying hen diets the need for coarse particulate particles of calcium supplementation is a given confirmed by volumes of previous research. Benefits of supplementing diets with large oyster shells have been practiced for decades to improve eggshell quality. Additional research verified parallel benefits from large particulate calcium carbonate ($CaCO_3$) but at greater economical advantage. However, allowing for feeding coarse particles alone stops short of properly meeting the hen's need for egg shell formation. Another dimension to the size of $CaCO_3$ particles fed is corresponding solubility rates as $CaCO_3$ particles dissolve in stomach acid to release Ca^{++} for absorption and utilization. Particle size *and* acid solubility of supplemental $CaCO_3$ need to be well thought out as laying hen diets are put together.

Laying hens have dietary calcium (Ca) requirements in the neighborhood of 3.75-4.0%. Most layer diet ingredients are very low in Ca. Of particular exception to this is Meat and Bone Meal. Typical corn-soy diets even including distillers dried grains with solubles (DDGS) are substantially lacking in Ca.

The laying hen's need for calcium is twofold. To begin with, the major need hens have for calcium is making eggshells. Secondly, there is need for supplemental Ca in meeting other physiological demands such as bone formation. Often overlooked, but Ca is needed for blood clotting and regulation of heartbeat, muscle contractions & nerve impulses, along with enzyme activation & hormone secretions. Calcium is needed initial bone development and replenishment of lost Ca from bones that have been mobilized to meet these other bodily demands.

Replacement of depleted Ca for bone reformation is chiefly accomplished by dietary supplementation with granular small particle – highly soluble $CaCO_3$. Small particles will not deposit in the gizzard but rather continue by ordinary rate of passage through the stomach into the intestines undergoing normal monogastric digestion. Greater surface area exposure of these smaller particles allows for rapid dissolution in stomach acid releasing ionic Ca^{++} for proper absorption in the small intestines and subsequent utilization in rebuilding bone.

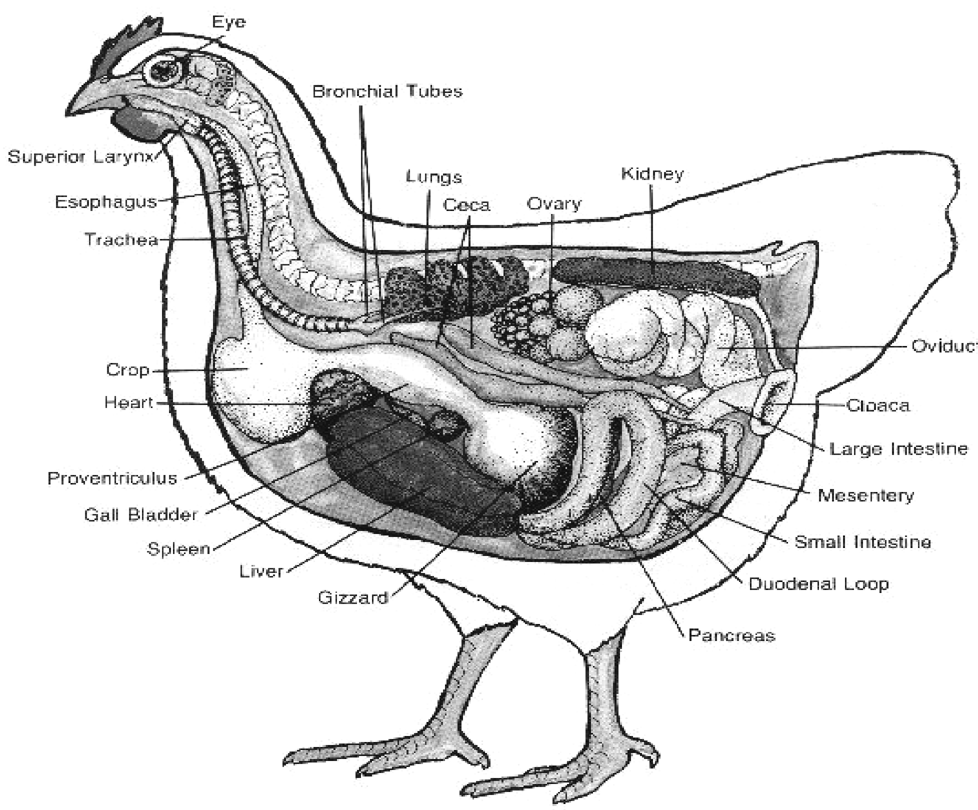
Small particle sizes from 1000 microns (μm) down to 100 μm fit a desired range for this purpose ILC Resources' FreFlo is a blend of larger to small granules averaging 600 μm, but encompassing the whole range. On the other end, Unical-S is a small granular product averaging upwards of 200 μm, covering the lower portion of this range. These two products' *in vitro* acid solubility percentages range from lower to upper fifties (53-57%, respectively). Let's pause for a moment and look at acid solubility and what *in vitro* values tell us.

What is acid solubility and how does it relate to particle size? As $CaCO_3$ is ingested by the bird, it passes into the stomach where it is exposed to and reacts with stomach acid (hydrochloric acid – symbolically HCl). That reaction releases ionized Ca^{++}. The rate of that reaction is mostly dependent on *surface area* exposure of the $CaCO_3$ particles to HCl.

$$CaCO_3 + HCl \rightarrow \mathbf{Ca^{++}} + H_2O + CO_2$$

The smaller the particle, the greater the surface area is to react. On the other hand, larger particles actually have less total area exposed and thus, are slower to react. By laboratory (*in vitro*) procedure mimicking digestion, a measured small amount of $CaCO_3$ sample is reacted in dilute HCl for a given time period (ten minutes). The amount dissolved out of total sample gives the acid solubility value. Solubility comparisons with particle size data allow for better comparisons among different products than just particle size alone.

This leads into another part of this consideration. What happens when particles of $CaCO_3$ are consumed in the live bird ? *Refer to diagram of chicken's digestive system below.* All feed ingredient particles when ingested pass into and through the crop – which is nothing more than simply a storage vat for food awaiting digestion further along proventriculus (glandular stomach) and ventriculus (gizzard) before entering the small intestine. Large feed particles will deposit in the gizzard to be *ground up* into smaller particles for further digestion. Historically, this action evolved in wild birds pecking at small stones and seeds which deposited in the gizzard to facilitate grinding of the seeds. In the case of today's laying hen, these stones are replaced with large particulate $CaCO_3$ instead. This is where coarse particulate sizes of $CaCO_3$ come into the diet. Coarse particulate $CaCO_3$ ranging from over 1000 µm to some 5000 µm will deposit in the gizzard (pouch-like organ within stomach). There, these large particles will slowly dissolve in the acid bath of the stomach's HCl. Two products are available as core products or in blends from ILC Resources that meet this size range. Shell & Bone Builder is an extra coarse particulate product that averages 3600 microns, and is 35% acid soluble. Unical-F is a medium coarse particulate product measuring some 2300 microns and is over 40% soluble in hydrochloric acid. Specific blends of these two are available to fine tune specific dietary considerations. Gilmore City's products of EggMaker and Henbits are comparable to Shell & Bone Builder and Unical-F, respectively.



Eggshell formation occurs throughout the day, of course, but disproportionately more takes place during nighttime darkness hours. How can adequate supplemental Ca be provide when the bird is not eating? Referring to above, a source of Ca^{++} is available continuously from the gizzard with coarse particle $CaCO_3$ (1000 µm to over 5000 µm) present in the gizzard being constantly bathed in stomach acid (HCl). Coarse $CaCO_3$ particles react slowly because of their small area of exposed surface. Smaller particles from most other dietary components including small particle Ca simply bypass the gizzard and are digested in the stomach and small intestines for absorption as the rate of digesta passage flows along. Slow solublizing creates a more metered release of ionized Ca^{++} to make Ca available during longer periods of the day, especially at night when the bird is not feeding and yet is actually "making eggshell."

The need for BOTH types of particles is essential for proper hen performance. Small particle $CaCO_3$ will supply Ca for some eggshell formation during the day and for replacing lost Ca from depleted bones. Coarse particulate $CaCO_3$ will provide a continuous source of Ca^{++} from the gizzard during the course of 24 hours each day to supply Ca for eggshell formation and for relieving the need for mobilizing Ca from bones to meet other needs while at the same time allow more phosphorus (P) to be retained in bones, thus reducing fecal P losses. Both types of supplemental $CaCO_3$ sources are necessary.

These dietary dynamics of coarse and small particle $CaCO_3$ sources are in a constant state of flux as one considers age of bird, her status in the laying cycle (early-lay transitioning to late-lay) and which molt the hen may be in (e.g. first or second). In very early-lay, especially considering a maturing pullet, her Ca needs suggest using more small particles of higher solubility due to smaller eggs being produced plus her greater demand for continued skeletal growth. As she transitions into greater laying rate, reaches skeletal maturity and produces a larger egg, more coarse particulate $CaCO_3$ is needed in the diet. As a general recommendation, early-lay calls for approximately 2/3 smaller granular particles with 1/3 coarse particulate $CaCO_3$ to make up her supplemental Ca. As the laying cycle transitions towards late-lay these proportions shift to 1/3 small particle to 2/3 coarse particulate $CaCO_3$. For simplification some operations follow a steady 50/50 small granular to coarse particulate pattern throughout the laying cycle. This article is designed for general dissemination of information about the laying hen's need for Ca. More in-depth evaluations are considered by nutritionists formulating diets for egg laying operations. Part of their assessment calls for proper matching of solubility data with particle size data when choosing sources of $CaCO_3$ products. Straight across particle size for particle size is not the answer alone.

One dietary ingredient merits mentioning yet in this discussion. If a laying operation is feeding *meat and bone meal* (MBM), there is substantial Ca being supplied from this source. For the most part, Ca present in MBM needs to be considered as a highly soluble source. Adjustments are required accordingly – both in terms of amounts of supplemental $CaCO_3$ needed and in terms of particle size proportions.

In conclusion, this is presented as general information regarding the dynamics involved in calcium source selection requiring equal consideration of particle size traits and corresponding acid solubility properties of $CaCO_3$ products.