Limestone quality and calcium level: impact on poultry performance

Calcium (Ca) is the most abundant inorganic component of the body and plays a major role in a wide variety of biological functions. The main role of Ca is to provide structural strength and skeletal integrity in the body. Therefore, the deficiency of Ca can lead to several skeletal deformations, development of rickets, bone fractures, neural weakness, poor feather condition, reduced body weight, increased mortality, and eggshell problems in laying hens and breeders.

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Impact on nutrient digestibility

The major source of Ca in poultry diets is limestone, followed by monocalcium phosphate (MCP) and dicalcium phosphate (DCP). However, the Ca level and availability from these sources are highly variable and sometimes may result in an oversupply or undersupply of Ca in poultry diets. Because limestone is a cheap ingredient and used as a carrier or anti-caking agent for some poultry ingredients, we usually see oversupply rather than undersupply issues of Ca.

A higher Ca level in the diet can have an adverse effect on the performance, litter quality and nutrient utilisation such as energy, nitrogen (N), Ca, and phosphorus (P).

During fat digestion free fatty acids have the potential to bind with Ca and form insoluble soaps; then both the fatty acids and the minerals will become unavailable for absorption and excreted.

In addition, high dietary Ca may increase the pH in the upper digestive tract and may reduce N digestibility and reduce the bioavailability of several biologically important minerals such as P, Zinc (Zn), and Magnesium (Mg). Lower N digestibility may have deleterious effect on gut health and microbiota, which may lead to wet litter in poultry farms.

Calcium also interacts quickly with phytate, forming a complex and reducing the ability of phytase to break down phytate.

Phytate is a well-known anti-nutrient that inhibits the digestibility of several nutrients and increases endogenous losses of amino acids.

Therefore, from a sustainability point of view adjusting the Ca level to only satisfy the animal requirement is of great importance to optimise efficiency and prevent unnecessary excretion of nutrients. This trend towards sustainability may encourage the industry to overcome the challenges of adapting the digestible Ca system in ingredients and instead use Ca in the feed formulation.

Impact on eggshell quality

Improving the persistency of laying hens, so keeping laying hens for longer production cycles without molting, is becoming the new normal.

The main reason for this shift is to support improved profitability and sustainability, as keeping laying hens, for example, 10 weeks longer with a good egg production can reduce nitrogen excretion with 1g for every dozen of eggs. However, the risk of this approach is that eggshell fragility might increase as laying hens become older.

Therefore, extra care to improve eggshell quality is needed. Understanding limestone quality, Ca release, and Ca metabolism is important to decrease the chance of eggshell issues throughout the laying period.

It is, for example, recommended to feed a fine limestone with quick Ca release, which will support calcification at the final stages of eggshell formation in the morning and help to replenish the medullary bone reserve that was depleted during the night. At the same time, coarse limestone with a slow calcium release is important for the night, when most of the eggshell calcification occurs.

Limestone evaluation

The current industry methods used are based on solubilising limestone with an acidic solution for a certain amount of time, after which the mass lost is measured and used to calculate the soluble fraction.

Limestone is composed of different minerals, which may also solubilise into this solution, and these minerals or impurities are then included in the calculation of limestone solubilisation. This could explain why the solubility method does not correlate well with bird performance.

The method that Cargill has recently developed measures the amount of Ca released in a more diluted acid solution, which was specifically chosen to mimic the in-vivo biologic conditions of calcium utilisation by the bird.

This allows us to predict the rate of calcium availability to the bird over time. Another advantage of this method is that it can be used with other types of calcium sources. Understanding calcium release on top of calcium solubility and Ca content will provide extra information on how to better apply the limestone in an optimum way.

Calcium, phytate, and phytase interaction

Several reports have shown that the degree of phytate degradation was highly dependent on the dietary Ca level. As Ca-phytate complexes were formed at pH ≥5 – similar to the conditions in the small intestine – rapid phytate degradation took place in the proximal gut where the digesta

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was more acidic (gizzard + proventriculus). Using phytase enzymes has been proposed to mitigate the negative effect of Ca on phytate degradation and increase nutrient availability for the bird. Older generation phytases have been shown to be negatively affected by high levels of dietary Ca or a high ratio of Ca to available P.

However, new generation phytases with optimum activity at low pH can hydrolyse phytate at low pH in the proximal intestinal tract and may be less prone to inhibition by higher dietary Ca levels.

Furthermore, the industry trend toward higher phytase inclusion also supports rapid phytate degradation and less effect of Ca level or speed of release from limestone on phytase efficacy on phytate degradation.

On the other hand, recent Cargill research showed that when broilers are fed diets without inorganic P sources and supplemented with phytase, a slight increase in Ca levels has a significant negative impact on broiler performance (Fig. 1).

This suggests that broiler performance is sensitive to the level of Ca in inorganic P free diets.

Cargill research also demonstrated that limestone particle size from the same source does not have a significant impact on broiler performance when phytase is added and when the diet is fed in pelleted form, which is the case in most broiler diets.

Other researchers reported an effect of limestone particle size on Ca digestibility.

The apparent discrepancy can be partly explained by the methodology, as digestibility response does not always correspond to the effect on performance.

For laying hens, we evaluated the impact of different limestone quality on eggshell percentage and observed that a quicker calcium release of the fine fraction of limestone resulted in improved eggshell quality, as measured by eggshell percentage. So, the two different limestone qualities had different impact on eggshell quality, even in the presence of phytase.

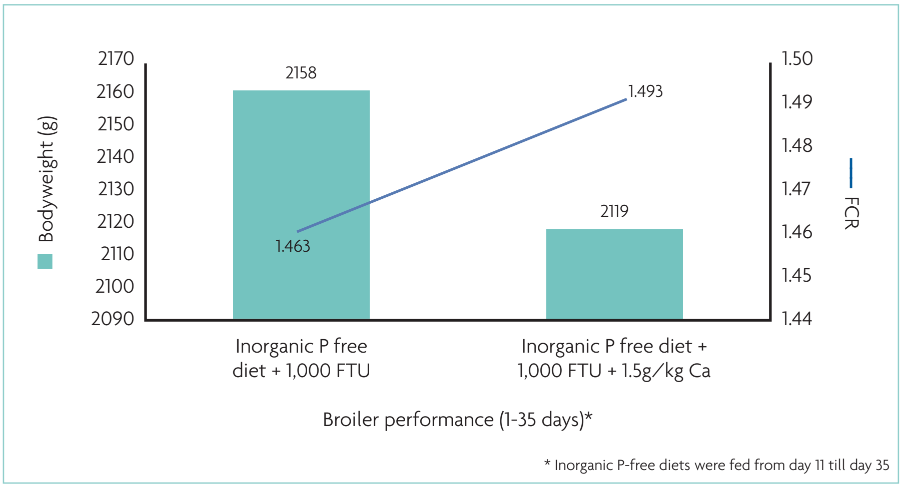

Fig. 1. Impact of higher calcium level on broiler performance when fed inorganic P free diet.

Final thoughts

Although Ca is considered a very cheap nutrient, oversupply of this nutrient could have deleterious effect on nutrient digestibility, animal performance, and litter quality. Better understanding of limestone quality – understanding the Ca release per se rather than solubility – contributes to more accurate inclusion of limestone to satisfy the Ca requirement.

For laying hens, this can result in better eggshell quality, which is becoming more important now as laying hens are kept for longer laying cycles.

The variation in the time of calcium release between the sources, even with similar particle sizes, seems to be key to better understanding limestone quality. Further research is required to investigate the impact of limestone sources and particle size on broiler performance as the impact is less clear compared to laying hens.

This may be explained in part by the lower inclusion level of limestone in broiler diets compared to laying hens and the functional role differences.

New generation phytases seem to be less influenced by Ca level, due to higher efficacy at lower pH in the proximal digestive tract and the increasing trend of higher phytase inclusion which will break down phytate to lower esters before forming phytate-Ca complex.

However, when inorganic P sources are removed from the diet, the level of Ca might have a bigger impact on broiler performance even in the presence of phytase. ■

References are available from the authors on request