Going for growth; improving healthy broiler performance from week two onwards

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In the last issue, I discussed the part that first week nutrition had to play in contributing to the 65% improvement in broiler finishing weights since the 1960s. This article looks at how producers can maximise return on their feed investment and minimise challenges from week two up until the time that it takes to reach the ideal finishing weight required to supply the most popular poultry products.

A broiler's digestive capability is generally mature by its second week at which stage the bird can no longer rely on the contribution of the yolk which provides around 30% of the nutrients required for growth and maintenance in the first few days after hatch.

The ratio of protein, lipid and carbohydrate in the diet and the digestibility of these nutrients will have a major impact on skeletal development and the body composition from this point onwards.

As the bird ages, protein content is typically reduced and the energy component increased.

These dietary changes, combined with other factors such as production stress, can also cause gut health challenges which can impact not only growth but liveability.

Skeletal development

Despite improvements in genetics and production practices, 2-6% of broilers a year are still lost due to skeletal issues. A 5,000% increase in weight from around 36-40g at hatch to over 2,000g 5-6 weeks later requires a correspondingly rapid development of the skeleton and musculature, for example a four-fold increase in tibia and femur length over six weeks.

Selection for rapid growth of breast muscle has also resulted in change of body conformation, moving the centre of body gravity forward which not only causes increases in the energy required simply to move around but also puts extra strain on the bird's immature skeletal structure.

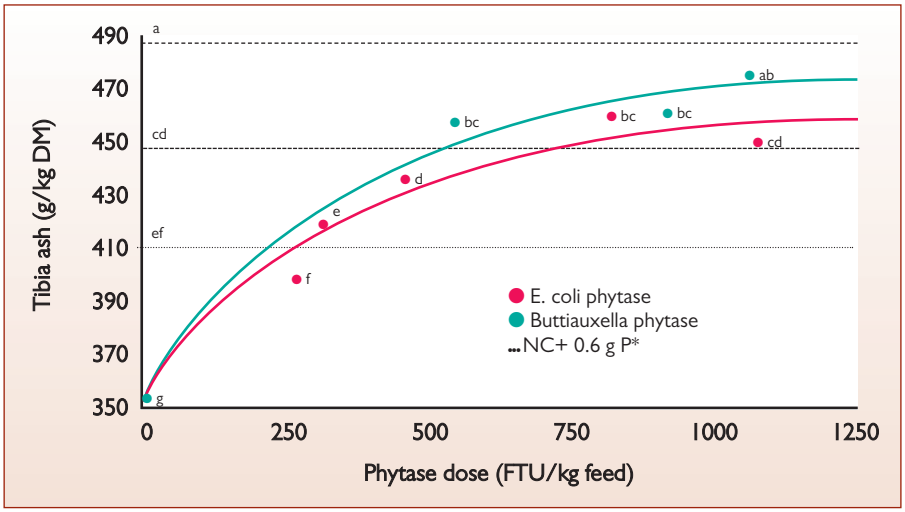

Fig. 1. Improvements in bone mineralisation delivered by higher doses of both best in class E. coli phytase and novel Buttiauxella phytase, 5-20 day trial with Ross 308 male broilers, PC reduced by 0.15% av.P (Schothorst Feed Research, 2014).

Rapid bone formation happens proportionally from days 4-18 for all poultry and likewise mineralisation, which takes from 4-11 days post-hatch.

There is also virtually no carry over effect of starter nutrition on bone composition because the fast growth of the bones means that all bones formed during the starter period have been replaced completely by the end of the finisher period.

As bone grows, there is an increased accumulation of calcium and phosphorus; therefore bone mineral ash should increase with age. However, the cortical bone of a modern broiler chick is less mineralised than 'non-selected' birds and even as an embryo, its bones are more porous. The tibia, particularly the epiphyseal end, is particularly impacted by dietary deficiencies in the growing phase.

We know that calcium and phosphorus make up more than half of a bird's mineral requirement. Research has also shown that insufficient calcium and also inadequate calcium: available phosphorus ratios are the most likely causes of bone mineralisation issues such as tibia dyschondroplasia.

This is a cartilage anomaly which is the most frequent cause of lameness in broiler chickens and accounts for 60% of the skeletal disease in chickens. 30% more birds are impacted by another disease associated with rapid growth, angular bone disorder. This can cripple young birds meaning that they can not reach feed or water and lead to increased culls.

These diseases not only cause economic losses because of flock mortality but also producer profitability is at threat from increased carcase condemnation, and downgrading at slaughter.

In addition, porosity of the bones can lead to some breakage issues when the birds are processed, resulting not only in immediate food safety hazards from fragments of bone stuck in the meat but quality issues such as black bone syndrome. This occurs when bone marrow expands after being frozen, is forced out through porous bones and stains the meat 'black' around the bone when it is cooked. While it is not in itself harmful, the impact that it has on brand reputation of broiler producers and retailers alike certainly is.

The most recent research shows that by far the biggest threat to achieving healthy broiler growth performance is a high level of phytate, the form in which phosphorus is naturally stored in feed raw materials at a range of 2.5-4.0g/kg in typical poultry rations. Phytate should, in theory, be a

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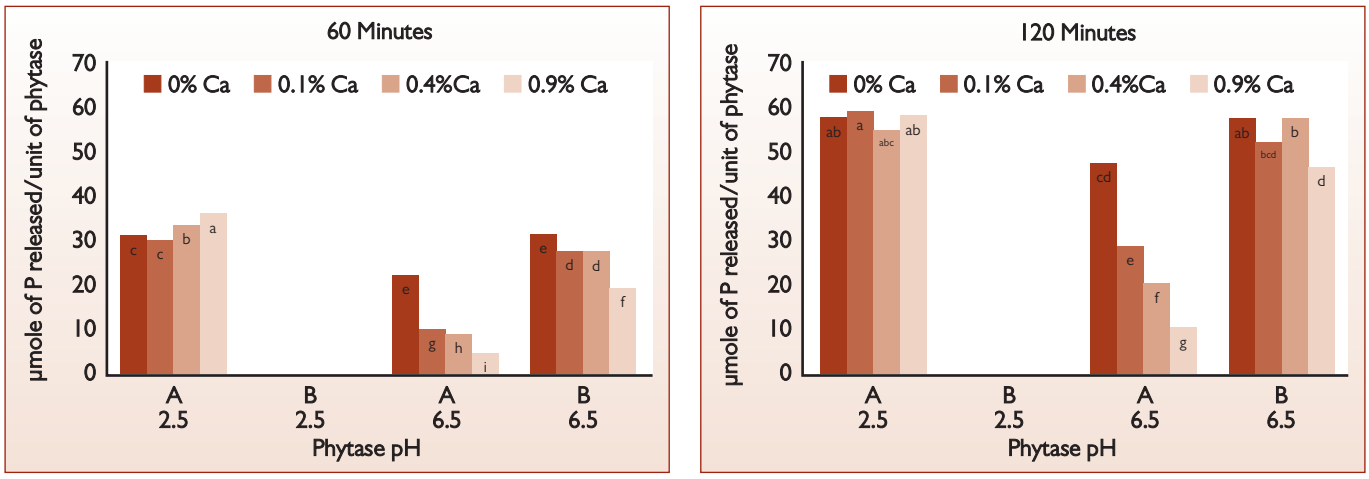

Fig. 2. In vitro trials show activity of some phytases are reduced by high calcium at pH 6.5 but not pH 2.5. Higher doses (>1000 FTU/kg feed) of all phytases have been shown to offset these effects as long as there is sufficient phytate in the diet (Tamin, Angel and Christman, 2004).

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valuable source of phosphorus, but this phosphorus 'pool' remains largely unobtainable to the bird because their own enzymes can not degrade phytate effectively. Even average levels of phytate have been shown to reduce feed intake and growth performance by impacting the availability of essential minerals and amino acids, and wasting vital energy.

The strategic use of phytase, which in simple terms has been shown to break down phytate and make more minerals and amino acids available to the bird, can have a significant, positive impact on broiler performance, as well as contributing substantially to feed costs savings.

Many different factors impact phytase efficacy not least of which is the phytase source. There are a number of phytase products on the market and they do not all have the same activity levels at the different pH levels found in a broiler's gut.

The first E. coli phytase, launched back in 2003, offered a 20% improvement in bio-efficacy and associated feed cost savings compared to traditional fungal phytases.

However, the latest Buttiauxella-based phytase is even more cost effective because it offers much higher activity earlier in the gastrointestinal tract. It has an optimal pH which better matches that in the proventriculus and gizzard of a broiler, where the pH can be as low as 2.5 and feed has a residency time of 40-60 minutes.

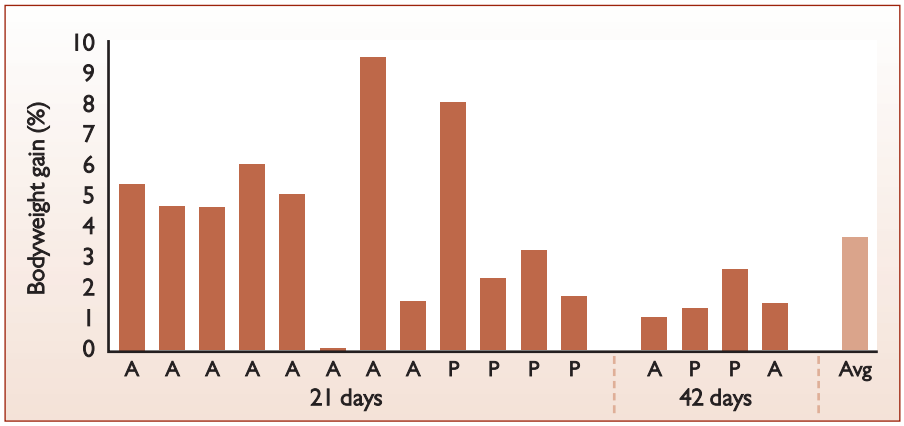
The activity of the Buttiauxella phytase at pH 4.0 is almost double the activity at pH 5.5, the level at which all commercial phytases have their activity standardised and much higher than other phytases. Research has shown that this offers a high and fast rate of phytic acid degradation compared to E. coli phytases at 500 FTU/kg feed.

The other factor that has been shown to impact phytate degradation is the dose of phytase used. This should be determined through proper application of evidence-based matrices that vary according to factors such as the age of the bird (older birds tend to utilise phytate phosphorus much more readily), levels of phytate and available nutrients in the diet, and health status.

While the level of phytate degradation is always higher with the latest advanced phytases such as Buttiauxella, trials have shown that higher doses, for example 1,000 FTU/kg will improve performance for both best-in-class E. coli and the Buttiauxella phytase, both in terms of bone mineralisation (Fig. 1) and feed conversion ratios.

There was also a much less pronounced effect from high calcium levels when a Buttiauxella phytase was used because its ability to rapidly degrade IP6 in the acid stomach results in more consistent phytate hydrolysis (Fig. 2).

Fig. 3. Improvement in bodyweight gain response (%) at 1,000 vs. 500 FTU/kg across nine broiler trials, with Buttiauxella phytase (A) and/or a best-in-class E. coli phytase with an average phytate-P level in feed (0.26%) (DuPont unpublished, 2014).



The impact of phytase

Research has shown that achieving maximum degradation of phytate is also a key factor in the release of 'extra-phosphoric' nutrients (for example amino acids and energy).

Shan & Davis (1994), Cabahug et al (1999) Sands et al (2004) and Woyengo et al (2012) have shown that high dietary phytate-phosphorus levels reduce feed intake and growth performance in broilers.

Ten broiler studies using Buttiauxella phytase clearly supported the correlation between the level of dietary phytate and amino acid digestibility response.

Plumstead et al (2013) also showed that the improvement in amino acid digestibility from the same Buttiauxella phytase was dependent both on the dose of phytase and the phytate level of the diet.

In addition, trials have shown that using both a best-in-class E. coli and bacterial phytase at doses higher than 500 FTU/kg showed improvements in diets with sufficient phytate (Fig. 3).

Very recent research has shown that losses in amino acids and energy are caused by sodium imbalance, reduced amylase activity and increases in mucin secretion.

The importance of sodium recovery, digestibility and absorption for the effective absorption and conversion of nutrients – in particular glucose – along four areas of the small intestine was established in these studies, which were conducted on broilers

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aged 7-21 days. It was concluded that adding a Buttiauxella phytase enhanced the absorption of sodium – and therefore also protein and glucose – from the gut, with positive effects on growth performance.

Reduced AGP use

As the bird grows and the gut microbiota matures and caecal flora develop, it is important to ensure that its gut microbiota is balanced to support strong growth performance.

The viscosity of the gut contents play an important role in the development of the microbial population, especially in the small intestine. Undigested nutrients flowing to the hind gut can not only impact performance but also directly contribute to good bacteria in the gut microbiota being outnumbered by bad, which in turn impacts the dynamic balance of the mucus layer, epithelial cells and immune cells.

Bacterial overgrowth – known as dysbacteriosis, which tends to impact the bird between 20 and 30 days of age – may lead to coccidiosis and necrotic enteritis (NE) which in turn result in malabsorption of feed, diarrhoea and damage to the intestine, ultimately leading to diseased birds, poor growth performance (and therefore a lack of uniformity in the flock) and increased mortality.

When you are producing millions of birds a week, it can seem very hard to ensure that non-beneficial bacteria do not get the upper hand. Clostridia can form spores and survive in litter for long periods, even in some disinfectants, to infect chickens whose immune systems are compromised by a gut imbalance at a later date.

Risk of necrotic enteritis

The risk of necrotic enteritis (NE), due to the Gram-positive bacterium Clostridium perfringens, has increased in recent years because of the voluntary or legally required withdrawal of the use of certain in-feed antibiotic growth promoters (AGPs) with anti-clostridial activity.

The microbial imbalances that have been proven to cause clostridial blooms and outbreaks of NE are also not easily detected so it pays to have an 'insurance' policy in place, especially as poor gut health through poor coccidiosis control and enteritis has been calculated to cost up to 6.8p/bird.

To understand if AGPs can be replaced in this capacity, it is important to understand their mode of action and those of the possible 'alternatives'.

Like AGPs, feed enzymes such as xylanase, amylase and protease have been shown to help prevent microbial overgrowth in the small intestine.

Unlike AGPs whose mode of action is anti-microbial, these feed enzymes support healthy bird performance by improving fibre, starch and protein digestibility which, in turn, reduces the amount of available substrate for non-beneficial bacteria. Like feed enzymes, probiotics – 'live microbial feed supplements which beneficially affect the host animal by improving its intestinal microbial balance' – support healthy performance.

Unlike enzymes, their mode of action is to establish and maintain a beneficial – as in diverse and stable – microbial population in the gut of the bird. This makes the gut environment less conducive to colonisation by micro-organisms that may have a negative impact on animal performance.

Spore forming probiotics such as Bacillus spp are particularly favoured for inclusion in animal feed because of their proven stability in feed production and through the digestive process.

They complement the mode of action of enzymes by making the gut environment less conducive to colonisation by micro-organisms that may have a negative impact on performance, for example salmonella, E. coli, campylobacter and clostridium.

Combining a three strain Bacillus spp with commonly used enzymes such as xylanase, amylase and protease was shown to deliver net benefits of 14% in relative cost per kg live weight gain in a necrotic enteritis (NE) challenge model in a series of US trials (Fig. 4). A three-to-one return on investment was also shown through significantly improved digestion and gut health support in the low challenged birds in these trials.

Another study countered the common argument that feed additives are more costly than AGPs, showing a 2.5% higher gross profit when phytase was added to the enzyme and probiotic combination.

Research has shown that individual birds within a group have different microbial communities compared to each other, indicating that animals of the same age and breed have unique microbial populations.

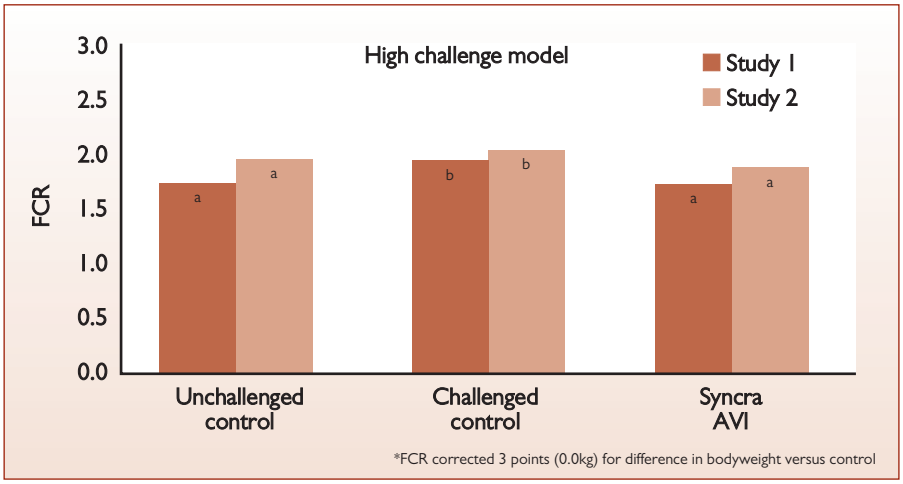

Fig. 4. Meta-analysis of two studies with NE challenge model, showing that a combination of multi-enzymes (xylanase, amylase and protease) and Bacillus spp three strain probiotic maintained feed conversion ratio similar to unchallenged control under necrotic enteritis challenge (Mathis et al., 2013).

The same study demonstrated that the diversity of the intestinal microbiota increases with age, especially within the caeca. So whether you are using probiotics on their own or with enzymes, it is important that your probiotic supplier has completed a large number of gut sample screenings in your region over a decent period of time.

They should also work with you to develop tailored gut health solutions that will help resolve complex-by-complex variability or livability challenges.

Natural betaine supplementation has also been shown to have positive effects on broiler gut structure. Its gut integrity benefits can help protect the animal against dehydrating conditions associated with situations such as coccidiosis or the proliferation of other undesirable micro-organisms in the gut, which can contribute to poor performance.

Research on coccidia-challenged broilers at the PARC Institute, USA in 2013 showed that coccidial lesion scores at 21 days were reduced when natural betaine was supplemented to diets containing varying levels of the coccidiostat salinomycin. It also helps maintain optimum villi height and crypt depth, which may support the bird's ability to absorb nutrients.

What's next?

Feed additive science will continue to offer producers new opportunities to develop larger, more healthy and uniform birds in less time and at a lower cost. It is important in such a competitive market that any solutions offered are proven to work in comparable production conditions and with birds of a similar age. ■

References are available from monica.hart@dupont.com