Getting off to the best start: the importance of first week broiler nutrition

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In the late 1950s, when the production of 'dual purpose' chickens for egg and meat production ceased and new poultry strains were produced specifically for meat production, under 50 million commercial broiler chickens were raised commercially worldwide. Today, the number of broilers produced runs into the billions and chicken is set to overtake pork by 2020 as the number one worldwide protein source.

Although broiler chick quality is determined partially by genetics, breeder age, egg storage, biosecurity and incubation conditions, early stage nutrition has a major impact on growth performance and liveability.

Whereas a century ago, birds took 112 days to reach just 1.25kg, modern broiler chickens reach their 2.2kg to 2.9kg slaughter weight in just 35-49 days.

The relative importance of the first seven days after hatch has subsequently increased, with it now accounting for up to 20% of the broiler's life. This trend can only continue with predictions that the time to market post hatch will shrink even further; Cobb recently forecast that by 2050, a 2kg broiler would be marketed at 19 days.

To ensure broiler chicks show strong, uniform growth as well as developing robust immune systems, they need to increase live weight approximately 4.25 times in the first seven days (Cobb 2013). The challenges are many, including intestinal challenges that can lead to more serious problems like necrotic enteritis, malabsorption problems and bone mineralisation issues. Highly digestible feed combined with correct brooding conditions should improve growth performance and curb mortality.

This article looks at how feed additives such as phytase, probiotics and betaine can contribute to broiler productivity and liveability at this critical early stage.

Skeletal integrity

Due to the higher growth rate and increased pectoral muscles required by the market, broiler embryos require extra energy and protein as well as trace minerals from the yolk during incubation.

Bone development begins in the embryo with the formation of a cartilage matrix, which begins to be calcified in the egg. Mineralisation of the tibia and femur bones increases rapidly from 14-21 days after which, the broiler skeleton will be a well formed miniature version of the frame that it will have as an adult.

Correct broiler breeder nutrition – with adequate calcium, phosphorus, zinc, manganese, copper and vitamin D – is important. However, there are only limited reserves of nutrients stored within eggs and at the point of hatching, the yolk phosphorus, zinc, iron and copper reserves are almost completely depleted (with phosphorus depletion being due to the impact of excess calcium in the yolk).

While the development of the digestive system is much faster post hatch than the rest of the body with the gastro-intestinal tract (GIT) becoming fully functional within a few days, the chick's capacity for nutrient retrieval is immature.

Williams et al (2004) has shown that growth-selected embryos and chicks are particularly at risk of being inadequately calcified in the pre and post-hatch period because of rapid increases in body growth. This, in turn, can lead to more porous bones and leg problems, which could result in flock losses of up to 6%.

While it is not very clear what the calcium requirements are in pre-starter diets in the first week after hatch when bone growth is most rapid (Fig. 1 and 2). It is known that post-hatch chicks are much more susceptible to phytate, the anti-nutrient that binds with phosphorus and reduces the availability of essential nutrients such as calcium, protein/amino acids, iron and zinc to the animal.

The bird's own enzymes cannot degrade phytate, which in turn increases endogenous losses of energy and amino acids, while also stimulating the gut to produce more mucin and further decreases the nutritional value of diet formulations at this vital stage of broiler growth.

Recent work using advanced Buttiauxella

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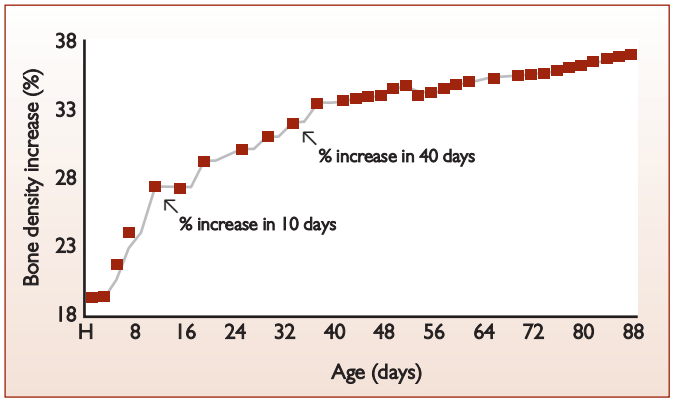
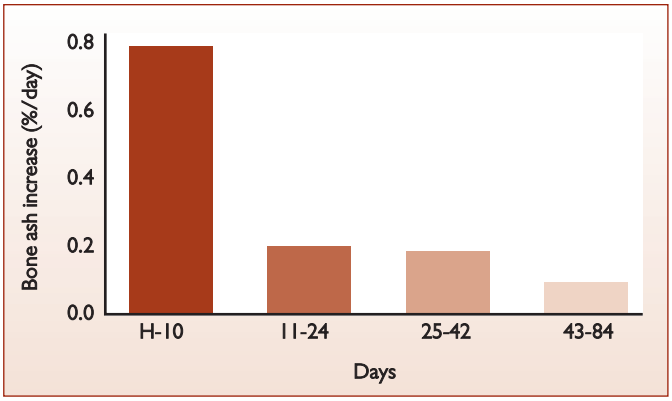
Fig. 1 and 2. Data from Angel et al suggests that the period from hatch to seven and 10 days is critical, with bone density with bone ash increasing by about 0.7% per day. Once 10 days of age is reached, this drops to 0.2%.





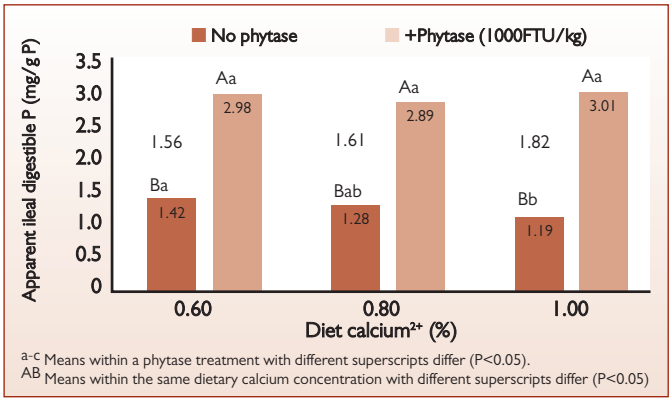


Fig. 3. Buttiauxella phytase contribution at 1000 FTU/kg was not influenced by dietary calcium level (0.42mm limestone) (Kim et al, 2013).

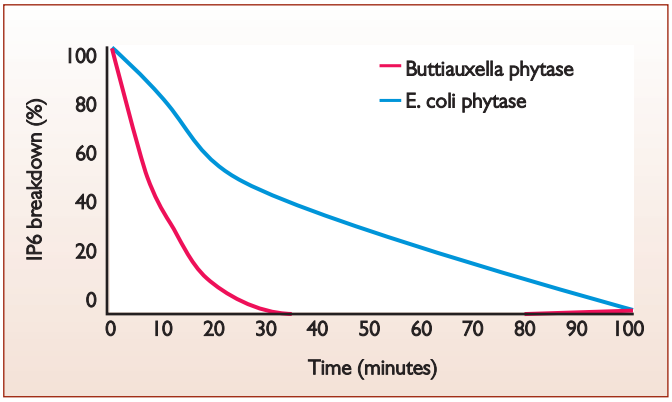


Fig. 4. Phytases that are optimised to work rapidly to degrade IP6 in the acid stomach offer more consistent phytate hydrolysis.

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phytase in diets for young birds has shown that they are relatively insensitive to calcium levels. This is a valuable attribute in the young bird, as it is important at this stage to try and maximise bone growth at the same time as reducing the negative effects of phytate by using phytase at higher doses (for example 1000 FTU/kg, Fig. 3).

This advanced phytases have an optimal pH which better matches the chicken's digestive tract, offering a high and fast rate of phytic acid degradation in the bird's upper digestive tract (Fig. 4). Its higher bio-efficacy offers additional savings of ~$1.23/tonne compared to E. coli phytases (at 500 FTU, based on current feed prices). These improved savings, achieved as a result of enhanced phosphorus, calcium, energy and amino acid release, can be also magnified at higher doses (>500 FTU/kg feed).

Many factors impact phytase efficacy, not least the level of phytate in the diet, which varies significantly across raw materials. Establishing this is fundamental to optimising phytase dose rates and to quantifying the release of 'extra-phosphoric' nutrients as a result of phytate degradation for example amino acids and energy. Simply put, if there is no phytate, even advanced, highly bio-efficacious phytases will have little effect.

It is also very important to ensure that your phytase supplier does not extrapolate data between pigs and poultry given the difference in their digestive physiology, especially at the crucial early stage in production.

Achieving gut balance

The acquisition of a healthy microbiota in the first few days after hatching also has a profound effect on the overall health and performance of a broiler chick, and to the profitability of the whole flock.

Immediately after hatch the chick gastrointestinal tract is populated by bacteria from the surrounding environment (for example from feed and litter). The level of bacterial colonisation over these first couple of days quickly escalates. Intensive rearing conditions do not usually allow for the natural microbial succession required for the establishment of a positive microbiota and the sufficient development of a mucosal immune system.

We have already discussed the fact that young chicks have immature digestive systems. Undigested nutrients flowing to the hind gut have been shown not only to impact performance growth but to also directly contribute to undesirable shifts in the gut microbiota. This, in turn, impacts the dynamic balance of the mucus layer, epithelial cells and intestinal immune cells and negatively affects Feed Conversion Ratio (FCR) and chick health.

Undigested protein, for example, has been suggested as a factor linked to the overgrowth of Clostridium perfringens, coccidiosis, and associated necrotic enteritis episodes in broiler chickens.

Antibiotic intervention on its own will not correct an unfavourable microbial ecology caused by diet related factors, particularly in the young bird. Combinations of feed enzymes such as xylanase, amylase and protease enzymes have, however, been proven to reduce the amount of undigested nutrients or 'substrates' in the duodenum, jejunum and ileum increasing the digestibility of even so called 'simple' diets and improving broiler performance. As well as the indirect effect that protease has on reducing undigested protein, it has been suggested that it is also associated with improving immune responses of broiler chickens to coccidial challenges.

Certain strains of Bacillus spp – a probiotic whose mode of action has been widely researched in the quest for alternatives to antibiotic growth promoter use in poultry diets – have been observed to change the gastro-intestinal microbial profile and

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Fig. 5. Improvements in broiler FCRc after multi-strain Bacillus addition to the diet (Danisco trials, 2010). ab shows significance at P<0.05 in the individual trials. FCRc: corrected 3 points per 100g of live-weight difference.

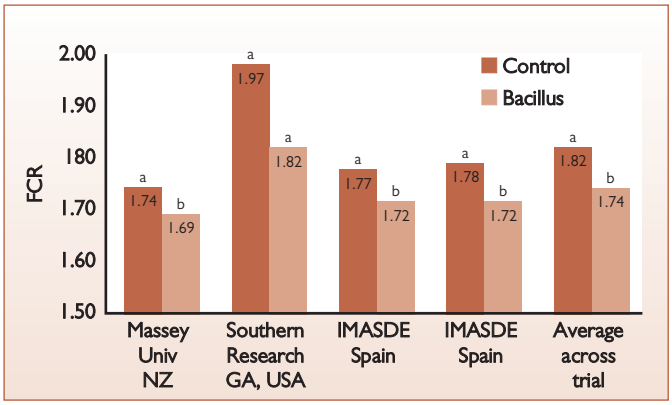
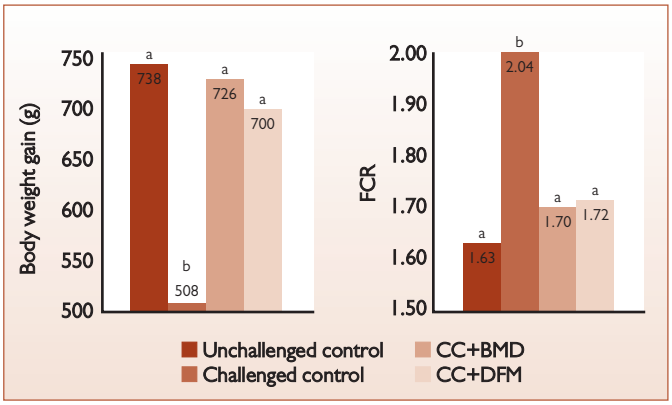


Fig. 6. Application of three strain Bacillus produces body weight gain improvements in the face of necrotic enteritis (NE) challenge (0-28 days, unpublished data).



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contribute to the reduction of non beneficial bacteria that results from substrate overgrowth and other chick challenges.

Santoso et al (1999) reported increased nutrient digestion and utilisation in broiler chicks due to supplementation with a Bacillus, possibly due to secretion of protease, amylase and lipase by the probiotic. Hooge et al (2004) reported increased body weight and reduced feed conversion ratio for chicks fed Bacillus in a series of experiments.

Trials from Danisco Animal Nutrition (Fig. 5) show the positive impact of a three strain Bacillus on broiler feed conversion ratios (FCR) in the first few weeks post hatch.

Bacillus spp have also been shown to lower the gut pH through acid fermentation, creating a positive environment for beneficial bacteria such as Lactobacilli which have been shown to reduce amounts of pathogenic bacteria such as salmonella, E. coli, campylobacter and clostridium.

Fig. 6. shows that application of the Bacillus produces body weight gain improvements in the face of necrotic enteritis (NE) challenge from hatch to 28 days.

Given the different, but potentially complementary modes-of-action of exogenous feed enzymes and probiotics, it seems logical that the two products could deliver additive benefits in broiler production when used in combination.

Two experiments (Southern Poultry Research, Georgia, USA, 2013) involving the combination of a three strain Bacillus probiotic and xylanase, amylase and protease enzymes gave net benefits of 14% in relative cost per kg live weight gain with an NE challenge model, illustrating the strong economic value of this concept.

Broiler chick gut health and subsequent performance can also be impacted by production stress. Supplementation with natural betaine – which is known to increase lean meat yield and reduce the need for expensive choline chloride and methionine in the diet – has been shown to have positive effects on birds suffering heat stress.

Significant benefits

Trials at Massey University (2013) showed a significant improvement in carcase breast meat yield, bodyweight gain and feed conversion ratio with natural betaine supplementation compared with the heat stress control group. Natural betaine has also been shown to strengthen both the gut structure and the animal's immune system.

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.

Recent trials have also shown that natural betaine can help improve broiler production profitability by improving hatchability, another early stage metric in the breeder-hatchery-broiler production chain.

Trials with Ross broiler breeders at 32 weeks of age (Turi Foods Bannockburn Breeder Farm study, Australia, 2014) showed natural betaine significantly improved hatch rate from 84.75% to 86.89% (P=0.004). Given that a 2.5% improvement in hatch rate is worth approximately 1.5 Australian cents per egg, savings offered by betaine to the Australian broiler industry alone could be as much as a net $8.3 million.

It is clear that supporting the building blocks for optimum future growth in the pre-starter period is key to healthy growth performance and that nutrition has a vital role to play. We have seen that applying high quality feed additives that impact skeletal and intestinal health, as well as immune development, will ensure that the chick survives and prospers.

In the next issue of International Poultry Production, we will look at the developing dynamics of the young broiler and how healthy nutrition can boost growth performance and liveability in the few weeks through to maturity. ■

References are available from monica.hart@dupont.com

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