Effective application of poultry specific probiotics to day-old chicks

Under natural conditions, the commensal microbiota is horizontally transferred from the mother hen to her chicks. However, in modern poultry systems, beneficial bacteria seldom colonise the gut as early as hatching, because biosecurity requirements ensure a pristine environment in the hatching chamber. Colonisation of the intestine is therefore dependent on environmental sources once the chicks leave the hatching chambers.

by Luis Valenzuela, Product Manager, Biomin. www.biomin.net

The gut of the day-old chick represents an empty space with ideal conditions for pathogens to multiply without restriction, at this point, the chick's immune system is unable to respond to the threat, and death of the young bird is imminent.

Therefore, without a balanced gut microbiota, gut surface tissue does not develop properly, and this affects activation and maturation of the whole immune system.

Early microbiome development

Newly hatched chicks are colonised during a critical period for immune and gastrointestinal development, and the first 21 days of the chick's life are crucial for development and maturation of the bird's microbiota.

The gut microbiota develops in various stages during this period, with colonisation beginning immediately after hatching.

During the first 7-14 days, there is a rapid turnover of microbes due to changes in the intestinal wall, which provides attachment sites for the bacteria. This rapid exchange of microbes during the first week is essential for the gut to mature correctly.

Researchers at Wageningen University have demonstrated that the guts of chicks that have never been treated with antibiotics (non-disturbed chickens) have reached the first milestone at day 14, having developed gut tissues, immune responses and a dense network of blood vessels, all linked to ideal gut health.

Conversely, disturbed chicks (this includes two separated treatments 1. given low-dose antibiotics as growth promoters and 2. treated with antibiotics at a higher dose) exhibited down-regulation of the genes involved in immune-related and metabolic processes, suggesting a delay in the development of cell-mediated immunity.

As processes crucial to maturation occur in the first week of life, researchers concluded that maturation is directly linked to the microbiota-driven programming of the immune system.

During days 14-21, particular bacterial populations are established in the upper gastrointestinal tract and enrichment and stabilisation of driver bacterial populations in the caecum occurs after 30 days.

Importance of the first bacteria in the chicken gut

Several studies have indicated the importance of certain bacterial genera in the chicken gut.

The intestinal microbiota has effects on gut morphology, effective nutrient absorption, and immune response. It is also involved in controlling intestinal diseases by promoting colonisation resistance to pathogens (competitive exclusion).

Lactobacillus, Enterococcus and Pediococcus spp. are some of the bacteria that are essential for gut development, and Bifidobacterium spp. are among the most important in activating and imprinting the immune system.

Research in both poultry and humans has revealed that Lactobacillus spp. are some of the main drivers of intestinal health.

In poultry, Lactobacillus reuteri has been reported to increase protection in the upper gastro-intestinal tract by neutralising environmental pathogens entering in the feed.

Some Enterococcus spp., such as Enterococcus faecium, are often referred to as the warriors of the gut, as they are some of the most resilient strains, protecting the small intestine from pathogenic intrusion by secreting certain metabolites, which allow other beneficial bacteria to thrive, promoting an eubiotic or balanced state in the gut microbiota. Therefore, pathogens such as Clostridium perfringens and avian pathogenic E. coli are neutralised, and production of endogenous butyric acid promotes local regeneration of enterocytes, improving nutrient absorption, and cell regeneration in the case of coccidia cell-damage.

Other Lactobacillus and Pediococcus spp. can establish colonies in the caecum, where there is constant competition for space because it is an optimal environment for opportunistic and potentially pathogenic bacterial species to inhabit.

Beneficial bacteria in the caecum can outcompete pathogens, such as Campylobacter spp. and Salmonella spp., as they produce lactic acid and other short-chain fatty acids, such as propionic, butyric and formic acid.

Therefore, establishing specific beneficial strains in the gut as early as hatching will positively affect the structure and barrier function of the gut, benefits that can last the bird's lifetime.

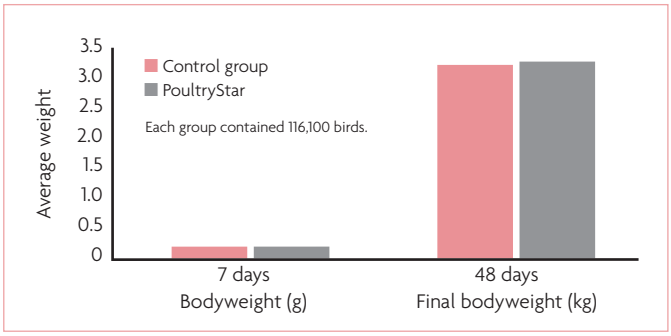
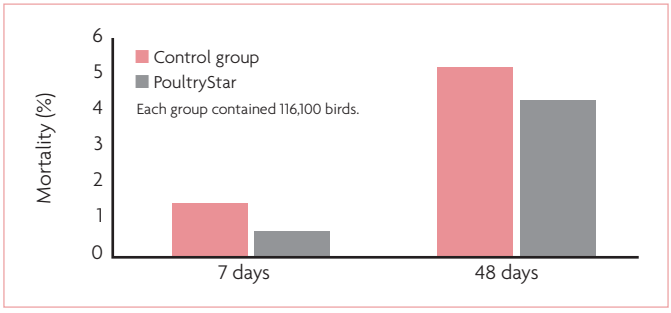


Fig. 2. Application of PoultryStar in the hatchery, plus a follow up in the feed during the pre-starter phase (1-9 days).

Fig. 1. Application of PoultryStar in the hatchery, plus a follow up in the feed during the pre-starter phase (1-9 days).



Early bacteria and immune system activation

Activation of the immune system in day-old chicks is a race against the clock. Activation, development and maturation of the bird's immune system depends largely on establishing and diversifying the commensal microbiota, and one of the bacterial genera that is essential for imprinting and the fast reaction of the immune system is Bifido-

Continued on page 27

Continued from page 25
bacterium. Bifidobacterium are among the first microbes to colonise the gut, but members of this group are very susceptible to antibiotics and challenging environmental conditions. Their successful proliferation depends on their synergism with beneficial bacteria nearby.

Studies have indicated that frequent use of antibiotics or growth promoters inhibits proliferation of this genus. Bifidobacterium animalis has been well documented for its close relationship with the Peyer's patches.

Some strains have found a niche in the ileum, where interaction with M-cells helps to activate, and then boost, the bird's immune system, stimulating secretion of specific IgA, and enhancing vaccine response, enabling the bird to cope naturally with pathogenic and environmental challenges.

These bacteria also promote a homeostatic state by releasing anti-inflammatory cytokines, such as IL-10 and other anti-inflammatory molecules.

Advantages of gel droplets

Vaccines, probiotics and other liquid additives have traditionally been administered in hatcheries by water spray systems or pumps.

With increasing restrictions on antibiotic use in poultry production systems, these common application methods have enabled hatchery managers to deliver vaccines immediately after hatching, which is essential to protect and stimulate the bird's immune system.

However, the downside of this method of application is that the water soaks the young bird's feathers, causing stress.

It has been proven that spraying birds with water reduces the bird's temperature by up to 4°C, and it is thought that about half of the probiotic or vaccine applied is dispersed into the air and does not even reach the chick. With the invention of the gel droplet applicator, probiotic wastage is reduced and the droplets ensure delivery of a more consistent dose, making this a more effective application method.

The droplets stick to the feathers, triggering a preening reflex in the chick. This is a natural instinct, minimising stress post-vaccination and stimulating early feeding behaviour, while seeding the gut with specific beneficial bacteria for a strong start in life.

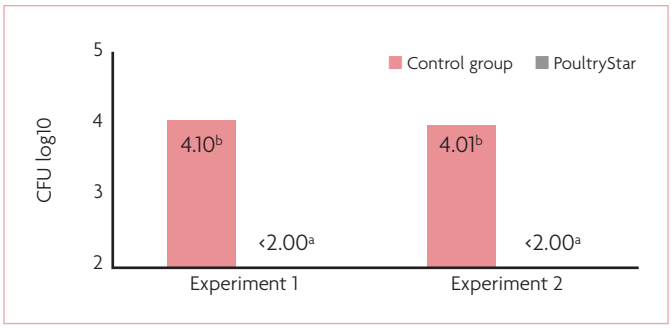


Fig. 3. Application of PoultryStar Sol days 1, 2 and 3. Average Number (CFU Log10) of Salmonella enteritidis (SE Nal/spec) in the caecal content. Salmonella contamination measured on day 5, 7 and 10.

Hatchery application

Biomin has recently developed PoultryStar Hatchery, a water-soluble additive that forms gel droplets when applied to day-old chicks.

The additive combines the synergistic action of carefully selected probiotic strains (multi-genus probiotics) with the prebiotic inulin (fructooligosaccharide derivate), which selectively stimulates beneficial bacteria by the 'Bifidogenic effect'.

Using the complete PoultryStar program (hatchery application plus a follow-up with the drinking water or feed application in barns) in commercial operations has maximised flock performance, resulting in higher weights, lower mortality, more uniform flock weight and better feed conversion ratio than control diets.

Applying PoultryStar at the hatchery, followed up with feed application during the production stage, has increased viability and body weight in the first week and at 48 days (Fig. 1).

Mortality at day seven was greatly reduced (by 51%), and overall mortality at day 48 reduced by 17% compared to the control group.

In the same trial, average weight in the PoultryStar group was 11g heavier at seven days, and 40g heavier at slaughter (Fig. 2).

Feed conversion ratio (FCR) was also three points better over the 48-days production cycle.

In two experiments with a Salmonella enterica serovar enteritidis (SE) challenge, early application of PoultryStar in the water on days 1, 2 and 3 protected the birds from colonisation by the SE (Fig. 3).

The results demonstrate that effective early colonisation of the gut by beneficial bacteria stimulates development and maturation of the bird's immune system, improving the viability and overall quality of day-old chicks.

As demonstrated many times previously, the quality of the day-old chick contributes significantly to the success of a poultry operation. Therefore, it is essential to give birds the best start as soon as possible after hatching. ■

References are available from the author on request

Fig. 4. Supplemented microbiota development in chickens by day 21. The development of a beneficial and balanced microbiota promotes structural changes in gut morphology, including widening of villus, architecture of crypt depth, delayed apoptosis of enterocytes, stem cell proliferation, increased blood vessel density, thickening of inner mucus layer and maturation of mucosa-associated lymphoid tissues.

A) Initial microbiota in day-old chicks, the villi in the upper gastric tract are short and thinner and immune activity is very slow as the lymphoid tissue is immature. The crypts are less deep and contain fewer proliferating stem cells. Furthermore, the mucus thickness in both layers is thin and immune activity is nearly inexistent. **B)** With the supplementation of essential probiotics, Peyer's patches along other lymphoid tissue become active and mature, overall architecture of the villi is enhanced for a better nutrient absorption, tight junctions are strengthened for a selective permeability and levels of both specific immunoglobulin A (IgA) and antimicrobial peptides (AMPs) are higher than in conventionally raised animals. **C)** In a well-developed microbiota, Lactobacillus spp. are known to ameliorate intestinal inflammation by generation of functional regulatory T (TReg) cells, which modulate the immune system, maintain tolerance to self-antigens, and prevent autoimmune disease. In addition, development of Bifidobacterium spp. along other beneficial bacterial communities, allow the gut to damper immune responses by production of anti-inflammatory cytokine, among them interleukin-10. This interleukin exhibits a suppressive action against immune-cells within the lamina propria and upon the epithelial layer, promoting a homeostatic state.