Maintaining gut health for efficient poultry production

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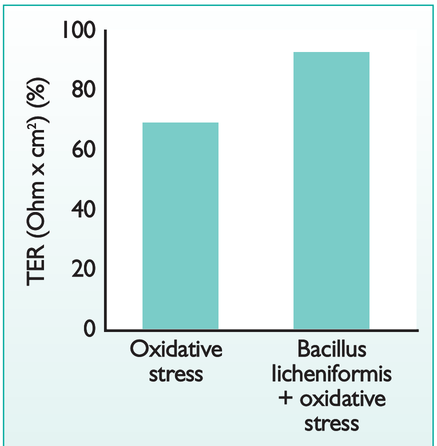
The intestinal innate immune system is essential in maintaining gut health. The intestine is described as a complex and dynamic ecosystem. The gut, apart from absorbing nutrients, is the barrier against non-desirable compounds and germs (the immune system in the intestines plays an important role in this). As the gut is constantly exposed to foreign substances such as feed, it is not surprising that the body has developed a system to control inflammation and immunity in the lower part of the gastrointestinal tract.

Anti-inflammatory components were normally added to the feed in the past, the most prevalent of those being the antibiotic growth promoters (AGPs). Some AGPs work by inhibiting the intestinal inflammatory response by direct inhibition of inflammatory cells, and indeed it has been proved to be a correlation between the use of AGPs and a direct anti-inflammatory effect (cyclines (oxytetracycline), macrolides or peptides (Zn-Bacitracin)).

However, there is increasing scientific evidence that implicates negative consequences of dietary antibiotics on gut microflora, local innate immunity and disease resistance.

Fig. 1. Bacillus licheniformis increased Transepithelial Electrical Resistance compared to control.



	No. of living cells (%)	
	NRU	TBDE
Oxidative stress	58.37	55.48
Sodium butyrate + oxidative stress	68.71	82.20
Bacillus licheniformis + oxidative stress	79.60	-
		P< 0.05

Table 1. Incubation of cells with sodium butyrate or Bacillus licheniformis conferred cytoprotection against oxidative stress (2013 ADSA-ASAS Joint Annual Meeting).

With the increasing pressures to restrict the use of antibiotics either as AGPs or as therapeutics, there is a great need for effective alternatives. These alternative additives could be selected on the basis of known anti-inflammatory activity.

Gut health

● Immune system

During recent decades it has become clear that over nutrition has an impact on the immune system. Chronic over nutrition can be involved in the development of low grade inflammation associated with an increased risk of several immune related pathologies. For this reason, it is relevant to investigate strategies to suppress low grade inflammation as a preventive measure for these chronic diseases.

β-galactooligosaccharides and fructo-oligosaccharides had demonstrated immunomodulatory effects. Short chain fatty acids (SCFAs), especially butyrate, seem to exert broad anti-inflammatory effects.

Bailón et al. 2010, hypothesised that the anti-inflammatory activity of butyrate in different cell types might also depend on the state of the particular immune cell.

They considered that butyrate could be a new potential therapy for several chronic processes, such as inflammatory bowel disease.

● Intestinal defence barrier

Intestinal epithelial permeability is an important parameter of the intestinal defence barrier. Under normal conditions, the epithelium provides a highly selective barrier that prevents the passage of toxic and proinflammatory molecules into the systemic circulation. Macromolecules pass the epithelial barrier mainly via the paracellular route for which tight junctions are the rate-limiting structures. Increased permeability indicating impaired epithelial barrier function, is thought to be involved in the pathophysiology of several gastro-intestinal inflammatory diseases, but can either be a cause or a consequence of inflammation.

Host defence peptides (HDPs) are natural broad spectrum antimicrobials and an important first line of defence in almost all forms of life.

Sunkara et al. (2011) evaluated in a study if sodium butyrate was capable of inducing HDPs and enhancing disease resistance in chickens. The authors concluded that dietary supplementation of butyrate had potential for further development as a convenient antibiotic-alternative strategy to enhance host innate immunity and disease resistance.

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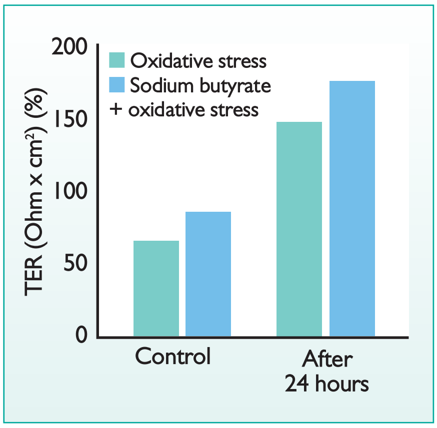
Fig. 2. Sodium butyrate increased Transepithelial Electrical Resistance compared to control and compared to oxidative stress cells.



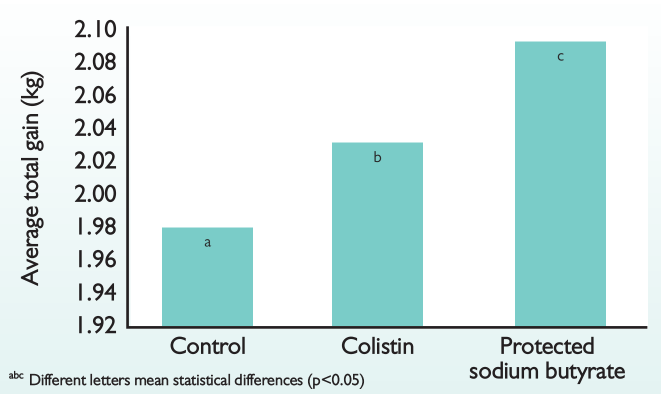


Fig. 3. Effect of dietary protected sodium butyrate and colistin on average total gain of broilers.

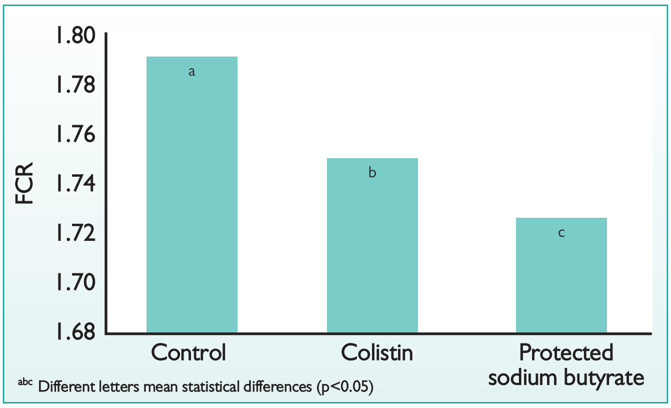


Fig. 4. Effect of dietary protected sodium butyrate and colistin on feed conversion ratio of broilers.

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Trials

Ortiz (2013) presented a study that evaluated the protective effect of Bacillus licheniformis and sodium butyrate (SB) on oxidative stress-induced inflammation in intestinal epithelial cells by measuring Transepithelial Electrical Resistance (TER) in IPEC-J2.

TER is a widely accepted experimental technique that determines the tightness of epithelial and endothelial cell layer in vitro. TER was measured in IPEC-J2 cells to elucidate the effect of the additives on cell barrier function in normal conditions and under oxidative stress.

In addition, Neutral Red Uptake (NRU) and Trypan Blue Dye Exclusion (TBDE) methods were used to determine if additives conferred cytoprotection against oxidative stress (positive control); NRU assay can be used to test for cytotoxic effects of chemical substances and environmental samples on cell membranes, TBDE test is a method to asses cell viability in response to environmental aggressions.

Bacillus licheniformis significantly ($p<0.05$) elevated TER values compared to control (90.10% vs 69.32%) (Fig. 1) and SB increased TER values compared to positive controls (84.09% vs. 67.55%); this barrier strengthening property remained after a 24 hour recovery period (174.41% vs. 143.16%) (Fig. 2). SB significantly elevated ($p<0.05$) the number of viable cells (measured with NRU staining methodology) compared to oxidative stressed cells (H_2O_2 treated samples) (68.71% vs. 58.37%) and increased ($p<0.05$) the number of viable cells compared to H_2O_2 treated samples (cells with oxidative stress) (82.2% vs. 55.48%) in the TBDE assay.

Bacillus licheniformis also increased cell viability significantly (79.6% vs 58.37%; $p<0.05$) as a reduction in dead cells was found (Table 1). It is concluded that Bacillus licheniformis and sodium butyrate have a protective effect on intestinal epithelial cells and improve barrier function.

Chamba et al. (2014) presented a study performed with the objective of determining the effect of AGP (colistin) and sodium butyrate in intestinal physiology.

Some 924 one-day-old mixed Cobb chicks were divided in three treatments with seven replicates each in a randomised block design.

Treatment one (T1) was a control diet without any growth promoter, treatment two (T2) was the control diet plus colistin at 100,000 IU/kg BW and treatment three (T3) was the control diet with partially protected sodium butyrate at 700ppm.

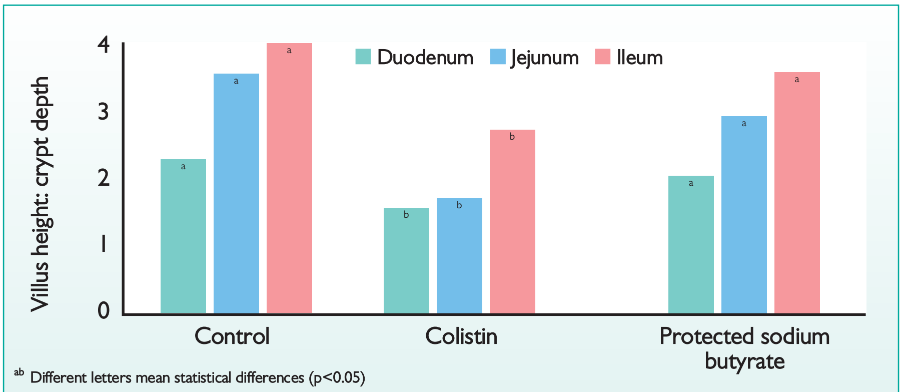
Chicks were fed in mash form for three phases: starter (1-14 days), grower (15-28 days) and finisher (29-42 days). Diets were mainly based on corn, soybean meal and animal protein sources. Chicks did not receive any additional antibiotics during their rearing period. There were no significant differences on performance among all treatments in starter phase (1-14 days).

Chicks fed partially protected sodium butyrate in the grower and finisher phases had the highest weight gain (Fig. 3) and the better feed conversion ratio (Fig. 4).

Colistin performance was similar to sodium butyrate in the finisher phase. Relative digestive organ weights were not affected by treatment in any phase. Jejunum and small intestine relative lengths of birds fed sodium butyrate and colistin at 14 days were longer than those of birds fed the control diet. Jejunal villi of birds fed sodium butyrate and colistin at 42 days were higher than those in birds fed the control diet. Colistin produced the deepest crypts and the lowest villi height/crypt depth ratios in all intestinal segments at 14 days (Fig. 5).

Intestinal E. coli growth was not affected by any treatment. These data indicate that partially protected sodium butyrate and colistin improves performance, colistin as an antibiotic growth promoter and partially protected sodium butyrate by improving intestinal villi development in broiler chickens.

Fig. 5. Villi height: crypt depth ratio in broiler chickens fed either colistin or protected sodium butyrate.



Conclusions

Consumer concerns about the use of AGPs have increased and it is necessary to find effective alternatives among non-antibiotic compounds. One focus in this search can be the improvement of intestinal metabolism, that will lead to a healthy and efficient animal production. Gut health is a very important determinant for health and performance in production animals. Inflammation and permeability are inversely related to growth and barrier function respectively. The alternative additives could be selected on the basis of known improved performance of the gastrointestinal system through their effect on immunity, anti-inflammatory effect and intestinal physiology. ■

References are available from the author on request