An integrated approach to understanding gut function and gut health of chickens

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The gastrointestinal tract performs a selective barrier function between the tissue of the host animal and its lumenal environment. On the one hand, the mucosa must allow efficient transport of water and nutrients, but on the other, it must resist the passage of potentially harmful microorganisms, and toxins produced either by gut microorganisms or ingested in the feed. The integrity of the barrier can be disrupted when pathogenic microorganisms and toxins damage cells lining the lumen, or alter tight junction integrity. The barrier comprises physical, chemical, immunological, and microbiological components. Mucus coating the villi, tight junctions between enterocytes on the villi and commensal bacteria attached to the mucosa block the approach and entry of potentially harmful agents such as pathogenic bacteria, viruses, fungi, parasites, toxins, undigested feed and antigens in feed, and, of course, digestive enzymes. Mucins secreted by goblet cells in the intestinal villi also provide a chemical defence by binding to bacteria. The intestine is also an immunologic organ of considerable significance; capable of mounting innate and specific challenges to antigens associated with microorganisms and ingested feed. Development of the commensal microflora in the chicken gut plays an important role in intestinal maturation, physiology and immunology. Commensal bacteria, such as members of the Lactobacillus genus, which are naturally present in the chicken gut at high numbers throughout the production period, are likely to play an important role in gut health.

Metabolic stresses associated with diet, environment and management can negatively affect the delicate balance among the physical, chemical, immunological, and microbiological components of the chicken gut and severely impair efficient growth and feed conversion. To maintain productivity, vaccination and in-feed antibiotic growth promoters have been the mainstays of industry to control a range of economically important diseases. Currently, there is keen interest in developing improved nutrient formulations to increase protein accretion and hence enhance growth rates. Little attention has been given to the use of nutraceuticals such as ω3 PUFA as dietary supplements to reduce stress, and indigestible carbohydrates to favourably modify the gut microflora, and improve intestinal health and immune responsiveness.

In a recent comprehensive review of dietary regulation of intestinal gene expression, Sanderson and Naik concluded, “Understanding how nutrition can alter intestinal gene expression is an early step in the realization of its therapeutic implications for the future”. They pointed out that the diet is a potent mechanism for altering the environment of enterocytes and described how various nutritional factors such as complex carbohydrates and metabolic products of gut microflora can influence gene expression. More recently, Sibjen et al. described changes in cytokine gene expression in chickens after challenge with S. typhimurium lipopolysaccharide and modulation by dietary omega-3 polyunsaturated fatty acids. Kelly and King concluded “Unravelling the cellular and molecular basis of bacterial colonization, host recognition and the modulatory effects of bacteria in intestinal cell signalling and gene expression will provide the platform for the development of safer therapeutics to prevent disease and promote intestinal health”. The Australian Poultry CRC seeks to establish the respective roles of these dietary supplements in sustainable poultry production without reliance on antibiotics. We hypothesise that impairment of intestinal barrier integrity and stress-induced inflammatory responses in intensively housed birds will be attenuated by ω3 PUFA modulating cell membrane structure/function and inflammatory mechanisms, and by indigestible carbohydrates favouring the development of a healthy gut microflora in general and lactobacilli in particular.

References