

Probiotics, Immunity, and Gut Health - How Does the Microbiome Influence Health and What Can We Do to Support It?

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As practical diets and husbandry practices shift towards the majority of poultry being raised using ‘no antibiotics ever’ approaches, or other limited antibiotic use situations, probiotics are increasingly popular in poultry diets. Probiotics, by definition, are living microorganisms that confer health benefits when administered to the host in adequate amounts. Dead bacteria and their components, certain fibers, and other microorganisms such as yeast can also confer health benefits. Prebiotics, on the other hand, are a group of nutrients that can be degraded by gut microbiota into short chain fatty acids, which interact with the local gastrointestinal tract and can also be used systemically. Fructooligosaccharides and galactooligosaccharides are the two important groups of prebiotics with beneficial health effects that are often used in combination with probiotics in diets. Probiotics will be the main focus of this talk.

Probiotics have been successfully used to prevent or ameliorate digestive and metabolic disorders, but the mechanism of action of probiotics are diverse, heterogenous, and strain-specific. Mechanisms of action include normalization of perturbed microbial communities, competitive exclusion of pathogens, modulation of biliary salt, short chain fatty acid production, and enzymatic activities, intestinal physiological changes, and immunoregulation. The poultry gastrointestinal tract is colonized after hatch with eggshell and environmental bacteria. The microbiome becomes stable, yet dynamic. Compared to other livestock, poultry have a faster digesta transit time and shorter overall tract, with the large intestine representing less than 1% of the total tract, and paired ceca providing a stable home for most of the microbial diversity.

Using 16S sequencing, 13 phyla of bacteria exist in chickens and turkeys, with *Firmicutes*, *Bacteroidetes*, and *Proteobacteria* accounting for >90% of the intestinal bacteria. The most predominant microbial genera in the chicken and turkey gastrointestinal tract are *Clostridium*, *Ruminococcus*, *Lactobacillus*, and *Bacteroides*, but with different distribution between the two species. Because of complex interplay within host species, strain, feed, manure ecology, age, and other production and management factors, individual bird microbiomes may tend resemble each other within a particular building but will be diverse across production sites. Chickens and turkeys have distinct intestinal microbiomes, sharing only 16% similarity at species-equivalent level. It is therefore not a surprise that many probiotics contain *Lactobacillus* strains. Other popular probiotic microorganism genera include *Bifidobacterium*, *Enterococcus*, *Streptococcus*, *Lactococcus*, and *Bacillus*.

Extensive interactions occur between the poultry host and the gut microbiome, including nutrient exchange and modulation of host gut morphology, physiology, and immunity. The gut microbiome has evolved to be symbiotic in most cases, but in competition with host resources in others. As expected, the early post-hatch period is critical for poultry growth and health as the host switches from the yolk to carbohydrate and protein-based metabolism using the developing gastrointestinal tract. The gut microbiome in turn plays roles in development of host intestinal morphology and immune function, importantly for both innate and adaptive immune features. Because of the diversity in probiotic type, dose, mode of action, and complexity, combined with

poultry strain and management conditions, commercial settings may not all respond similarly to dietary or water-based probiotic inclusions. Importantly, because most probiotics do not colonize the host, it is important to use them in a continuous and long-term fashion to see the most benefit.