# An Introduction to Probiotics

Probiotics were initially defined in 1989 as a "live microbial feed supplement which beneficially affects the host animal by improving the intestinal microbial balance[1,3,4,7]." A greater understanding of probiotics has led to a more in-depth definition proposal by Schrenzenmeir and De Vrese in 2001[8], "A preparation or a product containing viable, defined micro-organisms in sufficient numbers which alters the microflora in a compartment of the host and by that exerts beneficial health effects in this host." The goal of a probiotic is to fill the ecological niche within the gut which prevents colonization by pathogens or displaces an established pathogenic bacteria population. In order to accomplish this an ideal probiotic will possess the following characteristics[3,7]:

- Be of host origin
- Non-pathogenic
- Withstand processing and storage
- Resist gastric acid and bile
- Adhere to epithelium or mucus
- Persist in the intestinal tract
- Produce inhibitory compounds
- Modulate immune response
- Alter microbial activities

A chickens gastrointestinal tract is sterile at hatch making it highly susceptible to pathogenic infestation. It takes nearly three weeks to develop a completely mature immune system and around two weeks for the microflora within the small intestine to develop. Over 640 species of bacteria have been identified in the intestinal tract of poultry and of these only 10% were previously known[2]. Due to the extremely high numbers of intestinal bacteria that live in the gastrointestinal tract (GIT) of chickens the competition for nutrients and environmental niches is highly intense. Generally probiotics can be classified into one of two categories: a) bacteria that are naturally found in the GIT of poultry i.e lactic acid bacteria, or b) allochthonous flora which simply means microorganism not normally found in the GIT i.e. yeast and spore-forming bacteria [9]. A few known species used ideally for poultry include:

- Lactobacillus spp
- Bifidobacterium spp
- Enterococcus spp
- Saccharomyces spp
- Bacillus spp
- Aspergillus spp

A live fungal (i.e. yeast) or bacteria used as a probiotic is often referred to as a direct fed microbial (DFM). A direct fed microbial must be stable during processing and storage, host specific, alter microbial activity, be non-pathogenic, adhere to mucus or epithelium, resist bile and gastric acid secretions, and increase immune system responses. The main mode of action for DFM's is competitive exclusion. Competitive exclusion was first described in 1973 by Nurmi

and Rantala, who stated that early administration of "good" bacteria would prevent infestation by pathogenic bacteria such as Salmonella [1,9]. When a stable microbial or mixture of specific microbials are administered into the undeveloped gastrointestinal tract of chickens an early establishment of normal microbes can populate; consequently, leaving no space for pathogenic bacteria to colonize. In a noncommercial poultry situation chicks would peck at the hens fecal droppings immediately after hatch dosing them with developed intestinal microflora, without this initial bacterial dosage newly hatched chicks must rely on bacteria in the environment to help colonize the sterile GIT. A poultry specific competitive exclusion product will instantly provide a chick with the fully developed GIT microflora of an adult chicken. Competitive exclusion can be very successful in young neonates but when used in older animals' issues can arise. Older animals often already have an established microflora population that the probiotic must come to equilibrium with or in many cases an established pathogen load that has to be displaced. Choosing a product that is specific to poultry, production stage, and also the given scenario is critical to achieve results in older animals[4]. Most competitive exclusion research has focused on poultry due to the focus on Salmonella and other production diseases. A competitive exclusion product prepared from adult birds of the same species will alleviate any variation regardless of breed, strain, or sex[1,7]. The primary difference between competitively exclusive probiotics and direct fed microbial probiotics is that one or more specific bacteria strains is selected to colonize the GIT when using DFM's.

The gastrointestinal tract is the largest immune organ in the body and is negatively affected by stress. Commercial poultry production will ultimately always have multiple stressors such as dietary changes, catching, transport, feed withdrawl, and molting. Stress will effectively and rapidly alter the intestinal population allowing for opportunistic pathogens to adhere to the gastrointestinal tract. Lactobacilli and Bifidobacterial species are examples of beneficial bacteria that populate the GIT and whose populations decrease when birds become stressed [6]. A probiotic will work to repair or repopulate deficiencies within the intestinal microbiota inturn stimulating the immune system against pathogenic infestation. To accomplish this probiotics work by indirectly and directly competing for nutrients and attachment sites, enhancing the immune system, and producing antimicrobial compounds such as volatile fatty acids[1,4,7] . The use of antibiotics greatly alters microbial populations as both beneficial and pathogenic bacteria become decimated. The constant use of sub-therapeutic antibiotics for disease prevention and growth improvement can lead to bacterial resistances and useful microflora becoming permanently damaged. The use of a direct fed microbial during antibiotic treatment can have significant results as beneficial bacterial strains are initiated back into the GIT while simultaneously stimulating the immune system.

The largest disadvantage to using direct fed microbials is that in order to be effective viable bacteria must be present. The production process and storage of the product is essential to keeping live microbes viable. Many DFM products on the market are packaged by making the microbes inactive until oxygen or water is present; coincidently, the moment the microbes become viable their life span starts to decrease quickly. Making sure the live organism is still live after processing and storage is one of the top concerns for a producer who wants to maximize the benefits of a DFM probiotic into their flock. Lactobacilli and Bifidobacteria are very popular bacterial DFM's that are found naturally in the gastrointestinal tract of poultry. Unfortunately, they have very poor stability and do not survive in viable quantities once they

have been through processing or storage . Since most poultry diets are pelleted the most stable DFM is the fungal spore Bacillus spp. which is heat resistant and stays significantly viable during storage due to its spore forming nature[5,6,9]. Vegetative cells are bacteria that are asexually reproducing due to a fulfilled nutrient environment. When the Bacillus bacterium detects unfavorable environmental conditions it forms an endospore that consists of several protective layers surrounding the nucleoid of the spore core resulting in it becoming metabolically dormant [6]. Unlike the vegetative form, the spore form can withstand extreme temperature changes and gastric conditions such as bile salts and pH changes. Cartman et al.,2008[5] was able to prove that Bacillus subtilis spores will germinates once in the gastrointestinal tract of a chicken. The available nutrients in the GIT cause the dormant spores to become metabolically active and thus germinate. It is important to note that not all Bacillus species are safe for probiotic usage as some produce toxic compounds and exploit the gut much like a pathogen; always be conscious of strain or variety.

The key to a functional probiotic is that it reaches the chickens' intestinal tract in sufficient numbers and in viable form. If a DFM survives processing and storage then its next big hurdle will be to survive the crop, proventriculus, and gizzard on the way to the intestinal tract. The crop will hold the direct fed microbial for approximately 50 min in a 5.5 pH environment before it moves to the proventriculus and gizzard where it stays for approximately 90 min in a 2.5-3.5 pH environment[3]. When it comes to picking a competitive enhancement technique keep in mind that the main functions of the gastrointestinal tract are digestion, absorption, and propulsion[1]. To review, a probiotic is the addition of a direct fed microbial or competitive exclusion product that improves the gastrointestinal tracts health and diversity of the intestinal microbial ecology. Probiotics are easy to apply, natural, and can be used at very low economic costs. Regardless of which probiotic treatment is being used it should always be efficient, always be practical, and always be safe.

**Supplier links for this article:**

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