An Introduction to Prebiotics:

Prebiotics are a “non-digestible food ingredient that affects the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon”[1,2,5,7]. A prebiotic essentially improves a chicken’s gastrointestinal health by providing a nutrient source for one or more beneficial bacteria currently residing within the animal. These bacteria populate the gut filling any niches were pathogenic bacteria may attempt to take hold. This concept is better known as competitive exclusion. Prebiotics function by lowering the gut pH through lactic acid production, inhibiting/preventing colonization of pathogens, modifying metabolic activity of normal intestinal flora, and stimulation of the immune system [4]. *Bifidobacteria*, *Lactobacillus*, *Ruminococcus, and Streptococcus* are examples of beneficial bacteria found in poultry that utilize the nutrients prebiotics provide. By “feeding” these beneficial bacteria they indirectly produce metabolites that have been shown to enhance B vitamin production and increase mineral bioavailability[5,7]. The following characteristics should be considered when selecting a prebiotic[1,7]:

- Be neither hydrolyzed or absorbed by the tissues or enzymes of the host
- Selectively enrich for one or a limited number of beneficial bacteria
- Beneficially alter the intestinal microbiota and their activities
- Beneficially alter luminal or systemic aspects of the host defense system

Prebiotic additives to poultry feed, water, or both have proven to be most effective during times of stress and immune system development. High stress incidences in poultry include: temperature extremes, transport, molting, vaccinations, subclinical diseases, poor management, dietary changes, and overcrowding. The microflora of the gastrointestinal tract (GIT) are highly susceptible to stress. The intestinal epithelium along with the immune system become compromised when the animal becomes stressed resulting in an intestinal environment primed for pathogenic invasion.

Pathogenic bacteria such as *Salmonella* and *Campylobacter* can be transmitted easily to birds from a number of different sources. Water is a very important pathogen transporter particularly for *Campylobacter*. Water lines that do not get sufficiently cleaned produce biofilms which provide a nutrient substrate for bacteria. It is of great importance to properly maintain the water lines within your barn. Any leaking drinkers or standing water will greatly increase the presence of harmful bacteria in the environment. The gastrointestinal tract of a newly hatched chick is sterile taking around 3 weeks to fully develop. During this time period the environment is influential in determining the type of bacteria that will colonize the GIT. Flies, rodents, wild birds, and beetles are all potential pathogenic transporters. *Doyle and Erickson, 2006* [3] reported that 90% of chickens that consumed a *Campylobacter* infected darkling beetle or larvae became infected with *Campylobacter*, whereas 100% of birds that consumed 10 infected beetles or larvae tested positive for *Campylobacter*. *Salmonella* has been confirmed to survive for long periods of time in feed with very low moisture and in environments where the relative humidity is 51% or greater. Feed ingredients and dust within feed mills can also be sources for Salmonella contamination. The following proper sanitation practices can help prevent pathogen contamination:

- Always clean houses and equipment between flocks including water supply systems
- Remove all manure between flocks
- Restrict and minimize traffic onto the farm, between flocks, and in houses
- Clean and disinfect transport crates, vehicles, and equipment after every use
- Use proper sanitation equipment (bio-security suits, footwear, gloves)

Many of the non-digestible sources that are used for prebiotics are derived from plants. The most common are carbohydrate sources that cannot be broken down by the chicken but can be utilized by the beneficial microflora of the intestinal tract. Oligosaccharides, polysaccharides, and lactose are non-digestible carbohydrate sources typically used in poultry as the foundation for prebiotics[1,5]; however, dietary fibers and certain fungi can also be used. Lactic acid based prebiotics are very popular due in part to the fact that birds are unable to enzymatically digest lactose. Many native species of microflora in the gastrointestinal tract utilize the lactose as a nutrient source. Fructo-oligosaccharides (FOS) and mannan-oligosaccharides (MOS) are the two most common prebiotics available for use in poultry.

Fructo-oligosaccharides are found naturally in plants sources such as onions, Jerusalem artichokes, chicory, and bananas. Commercially they are made by the hydrolysis of inulin (a class of plant fiber) or by enzymatic synthesis from sucrose and lactose. FOS is a type of fiber that is indigestible by poultry but fermentable by the microflora of the gastrointestinal tract. The bacteria in the intestinal tract ferment the fiber and turn it into short chain fatty acids. These short chain fatty acids acidify in the large intestine allowing for beneficial bacteria like *Bifidobacteria* and *Lactobacillus* to grow[5]. The epithelial cells which line the mucosa of the intestine can utilize the short chain fatty acids for energy. This helps to preserve intestinal health and also contributes to enhanced nutrient absorption which can decrease feed conversion. FOS is fermentable by most strains of helpful bacteria such as *Bifidobacteria*. *Bifidobacteria* are gram-positive, anaerobic (not requiring oxygen) bacteria naturally found in the gastrointestinal tract of humans and many warm-blooded animals[2]. These bacteria suppress the growth of pathogens such as *E.coli* by producing natural antimicrobial compounds by lowering the gut pH through volatile fatty acid production.

Mannan-oligosaccharides are derived from yeast cell wall and work slightly differently than fructo-oligosaccharides. The major difference between fructo-oligosaccharides and mannan-oligosaccharides is that MOS products do not selectively enrich for beneficial bacteria. The binding and removing of pathogens while stimulating the immune system are the primary modes of action for MOS products [7]. The most common strain of yeast used on the market is *Saccharomyces cervisiae* which is obtained from fruits and grains. The yeast cell wall gets broken down into mannan, glucan, and protein[5]. While the composition remains consistent between yeast strains the interaction among the components has a tendency to vary. MOS is theorized to work against type 1 gram-negative pathogenic bacteria by binding their fimbriae. Fimbriae are used by bacteria to attach to their host; type 1 gram-negative bacteria use fimbriae to bind to mannose receptor sites found in the mucosal lining of the gastrointestinal tract. *E.coli* and *Salmonella* are examples of type 1 gram-negative bacteria. MOS essentially works by attaching to the fimbriae of the bacteria preventing them from binding to the epithelial lining so they pass through the host. The major difference between fructo-oligosaccharides and mannan-oligosaccharides is that MOS products do not selectively enrich for beneficial bacteria. Research has shown that mannan-oligosaccharide based products made from *Saccharomyces cerevisial* or *Saccharomyces boulardi* have decreased the colonization of *Salmonella* and *Campylobacter* [6] . Prebiotics have also been shown to decrease incidences of necrotic enteritis. Necrotic enteritis is due to pathogenic *Clostridium perfringens*. In many European countries, after the banning of sub-therapeutic antibiotics in 2006, subclinical necrotic enteritis has been reported at percentages as high as 40% and costing as much as $.05 per bird. *Hofacre et al, 2003 [6]* conducted a study comparing non-antibiotic feed additives(prebiotics, probiotics, herbal supplements, organic acids, and competitive exclusion products) and their affects on birds challenged with necrotic enteritis. The results indicated that the use of competitive exclusion products alone or in combination with MOS products can effectively reduce mortality and feed efficiency in birds suffering from subclinical necrotic enteritis.

If a pathogen cannot bind to a receptor site nor grow as fast as the environmental passage rate, then the constant flow of digesta will essentially wash the pathogen out of the animal. Decreased feed conversion and increased weight gain have both been scientifically proven results from the usage of either FOS or MOS; unfortunately these results are highly inconsistent. As with any feed additive prebiotics offer both advantages and disadvantages to the producer. As previously mentioned prebiotics provide competition against pathogens, improve gut health, decrease production costs, reduce ammonia emissions, enhance nutrient utilization, and are effective at low inclusion rates[1,2,5,7]. The lack of consistent research results is the largest hurdle prebiotics face in the poultry industry. While most prebiotic research has focused on humans, the major factors for variation in commercial poultry production are theorized to be differences between strains, sex, age, diet composition, diet inclusion levels, and a very limited understanding of the immune system and gastrointestinal tract of poultry. The exact modes of action prebiotics have on bacteria are not exactly known in depth presently.

Supplier links for this article:

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