UNDERSTANDING GUT HEALTH ENHANCEMENT PRODUCTS

INTRODUCTION

Gut health and function are critical for the growth, health, and welfare of all livestock. Optimizing gut health and function is a key focus in global poultry production. Gut health support can come in many forms, and the support required by the bird depends upon the age, life stage, and challenge. Support in the gut can include aiding digestion, supporting the development of the gut tissues and immune system, and assisting the development and maintenance of a balanced gut microbiota. The gut microbiota is a community of microorganisms residing in the intestinal tract. This community helps to promote gut function, gut development, the gut immune system, and inhibit pathogens. Failure of this community to develop correctly can be detrimental to gut health throughout the life of the bird. Many gut enhancement products target the microbiota to ensure it develops correctly and help to keep it balanced.

Another aspect of enhancing gut health and function is the inhibition of important pathogens, such as *Clostridium perfringens*; this is becoming more of a focus as the industry is actively reducing antimicrobial use. Many products are available to support the development and maintenance of the intestinal tract. The range of products available can be daunting when choosing the right product to enhance the gut health of birds in a flock. Therefore, understanding how a product works and improves gut health is critical to help with decision-making. This article aims to outline the key gut health enhancement products and give insight into when and how to use them to support the intestinal tract of broilers and breeders. Finding a complete strategy can take some time to assess, as efficacy can take a number of flocks to become established in the both the bird and environment.

PROBIOTICS

Probiotics are one of the most common gut health enhancers. Yet, they can be a great source of confusion due to the large variety of products available. Probiotics are live microorganisms (typically bacteria or yeast species) that benefit the host animal when consumed; they can be administered in feed or water. Common bacterial species used in poultry probiotics are *Bacillus*, *Bifidobacterium*, *Enterococcus*, *Lactobacillus*, and *Pediococcus*. Yeast-based probiotics use species of *Saccharomyces*, such as *S. cerevisiae* or *S. boulardii*, although some other types of yeast are used, such as *Pichia* and *Candida*. A critical point to remember is that there is a large diversity of bacterial species, which means different strains of the same species can have separate modes of action. For example, two different strains of *Lactobacillus johnsonii* can have abilities to stimulate gut tissue development or kill pathogens differently. Therefore, it is always advantageous to determine the mode of action and activity of probiotic products before use.

A question that often arises is, "Which probiotic is best?" There is no simple answer to this question, as it depends on why the product is being used and how the probiotic is intended to be delivered.

THE PURPOSE OF GIVING PROBIOTICS:

- **Stimulate early gut development and microbiota development:** Bacteria such as *Bifidobacterium spp.*, *Enterococcus spp.*, and *Lactobacillus spp.* are good choices, as they are known to stimulate the development of the gut tissues and gut immune system. *Enterococcus* and *Lactobacillus* colonize the gut very quickly and are, therefore, very useful as early colonizers of the chick gut. Some bacterial species are known as "microbiota

modulators," where they can help direct the resident microbiota's activity to promote a healthy community in the gut. Some species of *Bacillus* and *Pediococcus* have been shown to stimulate the activity of beneficial bacteria in the gut; therefore, they are good candidates for chick probiotics.

- **Inhibit pathogens:** If there is a problem with a specific pathogen in a flock or on a farm, such as *E. coli*, *Clostridium perfringens*, or *Salmonella spp.*, a probiotic can be used as part of a control strategy. Published data shows the ability of probiotic bacteria to inhibit the growth of pathogens, which can be a good alternative to using antimicrobials. There is a range of modes of action for pathogen inhibition:

  i. **Competitive exclusion:** The probiotic species block pathogens' attachment to the intestinal tract's surface.

  ii. **Nutrient competition:** The probiotic species compete against pathogens for nutrients, thus starving the pathogen.

  iii. **Production of inhibitor compounds:** Some probiotic species secrete substances into the gut which inhibit or kill pathogens.

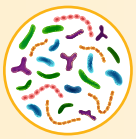
- **Reduce gut inflammation or bacterial disruption:** Inflammation and bacterial disruption in the gut can result from infection by pathogens or environmental stressors such as heat. When the gut is inflamed, its efficiency and function can be impaired. Some probiotic bacteria and yeasts can reduce inflammation in the gut and help modulate the immune system to ensure optimal gut health.

COMPARE FEED AND WATER APPLICATION:

- **Water application** is usually more flexible as the probiotic product can be easily added into the water lines with a dosing system. As the probiotic is mixed daily and administered, there is scope to increase the dose if a gut health issue is suspected. However, this approach can be challenging with young chicks as their water intake is low; thus, the flow rate may not be high enough to draw enough probiotic through the water lines.

  When administering a product in the water lines, it is essential to check for compatibility with water sanitation programs. For example, chlorine kills pathogens in the water, which can also kill probiotic species. Therefore, check with the probiotic supplier for the probiotic species' tolerance levels to sanitizers.

- **Feed application** is usually the most straightforward method of probiotic delivery as it can be added at the feed mill and, therefore, requires no mixing on the farm. However, as the dose rate is fixed, any short-term dose increases may require top dressing of the feed or administration of extra product via the water lines. The major drawback of feed application is the heat treatment of the feed, as this can kill many probiotic species. *Lactobacilli*, *enterococci*, *bifidobacteria*, and *pediococci* are intolerant to heat; therefore, when used in feed, the product manufacturer must protect the bacteria. On the other hand, bacillus-based probiotics are well-suited for feed treatment as they are delivered in the form of spores that tolerate extreme temperatures very well.



WHAT DO I CHOOSE – SINGLE OR MULTI-STRAIN PROBIOTICS?

Some probiotics contain one species of bacteria, some contain multiple species of bacteria, and some contain multiple strains of the same species. The choice of product depends on what the goal is for using the probiotic and what the probiotic strain can do.

1. If the aim is to target a specific pathogen, then a single-strain probiotic is suitable if it has activity against that pathogen.
2. If the aim is to provide bacteria to seed the chick gut, then a multi-strain probiotic may be more appropriate to promote bacterial diversity.
3. If the aim is to fulfill multiple actions, then a multi-strain product may be more appropriate (unless all the desired actions are fulfilled by one species).
4. Ultimately, ask the probiotic manufacturer to provide what their product can do and check that it will fulfill the requirements on farm.

COMPETITIVE EXCLUSION PRODUCTS

Competitive exclusion products are direct-fed microbials with an undefined mix of bacteria isolated from healthy adult chickens. These products were first used in the poultry industry to inhibit bacteria like *E. coli* and *Salmonella spp.* through the process of competitive exclusion. Competitive exclusion is the process by which beneficial bacteria compete with pathogens for attachment sites and nutrients in the gut and, thus, exclude the pathogen. Over time, these products also provide young chicks with a beneficial microbiota after hatching and help restore gut balance.

ACIDS

Acids are common products used in the livestock industry to inhibit pathogens, sanitize water, and improve gut health. Acids are often classified into organic and inorganic acids, referring to their chemical structure. Organic acids are organic compounds (i.e., they contain carbon) that are weakly acidic; acetic acid, lactic acid, propionic acid, and butyric acid are examples of organic acids. Inorganic acids (sometimes called mineral acids) do not contain carbon and have a much higher acidity than organic acids; examples include sulphuric acid, phosphoric acid, and hydrochloric acid. Most acids used for gut health enhancement are organic acids. These acids can be given in water or feed depending on the product type, so check with the manufacturer for guidance.

- **Free organic acids:** These acids are the simplest form of organic acid and are very effective at inhibiting pathogens. The method by which the acid inhibits a pathogen depends upon the specific acid and the point at which it releases its hydrogen ion to exert its acidity; this is known as dissociation (**Figure 1**). In the gut, some organic acids will release their hydrogen ion quickly, reducing the pH of the gut and providing an inhospitable environment for many pathogens. Other organic acids pass into the bacterial cell, and at this point, the acid will exert its acidity and lower the bacteria's pH. This will either kill the bacterial cell or the bacteria will use energy to remove the excess hydrogen ions and, in doing so, have less energy to cause infection. Organic acids can be given as a single acid or a blend of several acids. The main advantage of a blended acid is that some of the acids will lower the gut pH, and other acids will lower the pH in bacterial cells; therefore, there is a combination of activities, and thus, they potentiate each other.

  Organic acids come in a buffered or unbuffered form; buffering influences the point at which the organic acid dissociates to release its hydrogen ion to exert its acidity. Unbuffered acids will dissociate in the drinking water and readily reduce the pH (i.e., they are perfect for sanitizing water), but the impact on the gut environment is limited. Buffered organic acids do not dissociate as readily in drinking water; therefore, they are much better at reducing the pH of the gut environment. It is worth bearing in mind that free acids exert most of their effect from the crop to the beginning of the small intestine. However, as gut pathogens enter via the beak into the crop, these acids are beneficial at killing pathogens.

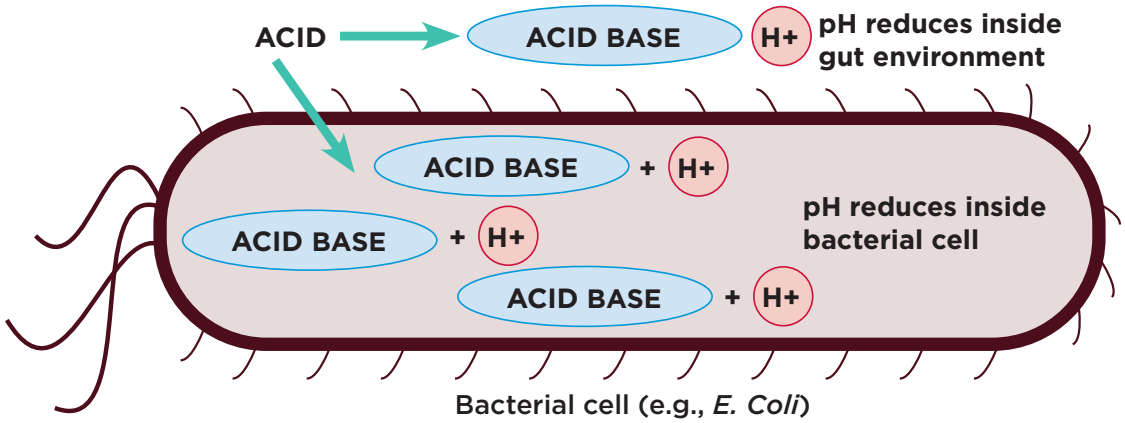
  Even though most of the activity of free organic acids is in the beginning of the gut, they help slightly reduce the pH of the small intestine, promoting the activity of bacteria like *lactobacillus*, which prefer an acidic environment. Additionally, the organic acid salts produced by dissociating the organic acids (e.g., lactate, acetate, and propionate) are used by other beneficial bacteria to produce beneficial acids, such as butyric acid.

- **Protected organic acids:** As mentioned in the previous section, free organic acids are mainly active in the early part of the gut. Protected organic acids use a fat or carbohydrate matrix to encapsulate the acid, which prevents the acid from dissociating. As the protected acid passes through the gut, the matrix is digested and, thus, the acid is released along the whole intestinal tract. This can help acidify the entire gut and prevent the overgrowth of opportunistic pathogens in the gut microbiota, as seen in conditions like dysbacteriosis. Additionally, organic acids can benefit the gut tissues; therefore, releasing the acid along the whole intestinal tract helps the entire gut. For example, lactic acid can stimulate villi development, which improves nutrient absorption. Butyric acid helps stimulate the development of tight junctions, which are the structures that hold the cells that form the gut barrier together to prevent bacterial invasion of the gut tissues.

- **Fatty acid products:** These are a subgroup of organic acids that have a chain of hydrocarbons attached; these are classified as short-chain fatty acids (SCFA), medium-chain fatty acids (MCFA), and long-chain fatty acids (LCFA). The SCFA includes acids like acetic acid and butyric acid, where the mode of action on bacteria is usually pH-related. The LCFA group consists of compounds such as linoleic acid and eicosapentaenoic acid, which are beneficial antioxidants. For gut enhancement, MCFA, such as lauric acid and capric acid, offer an additional mode of action for bacterial inhibition. They can easily be incorporated into the bacterial cell membrane, forming pores. These pores can cause lysis and death of the bacteria, or they can potentiate the activity of other organic acids to reduce the pH inside the bacterial cell. MCFA usually come in one of two forms: a free fatty acid or a fatty acid tri-glyceride with three acid molecules bound to a glycerol backbone. In the triglyceride form, the acids are inactive until the enzymes remove the glycerol backbone in the bird's gut; this means the product is protected until it is in the gut environment.

FIGURE 1. Dissociation of acids.

During dissociation, the hydrogen ion is released by the acid. During this process the pH will fall, resulting a more acidic environment. Different acids dissociate under different conditions, which is why acid blends can be more effective. Some acids will dissociate in the gut lumen, reducing the pH in the gut environment. Other acids will do this in the bacterial cells and inhibit growth.



PHYTOGENIC PRODUCTS

This group of gut enhancement products has various activities, including antimicrobial and antiparasitic effects, stimulating immunity, reducing inflammation, stimulating gut tissue development, and influencing feed intake. Depending on the product, they can be given in feed or the water lines. Common products in this group contain oils and extracts from plants like oregano, thyme, rosemary, cinnamon, capsicum, and clove. The choice depends upon the requirements of the birds on the farm. There are three main presentations for phytogenic products:

- **Dried plant material:** This is the cheapest version of phytogenic products, but the concentration of the active compounds can vary from batch to batch.
- **Extracted natural oils and compounds:** The harvested plant material is processed to extract the oils and beneficial compounds. This method ensures much better product consistency and accurate dosing than using the dried plant material.

- **Nature identical compounds:** These products use chemically synthesized versions of the key active compounds in the natural extracts.

As with many of the product types mentioned above, phytogenic products can be individual compounds or blends of many compounds; some are blended with organic acids. Depending on the product, they can be administered in feed and water. In some cases, the active ingredients are encapsulated to allow for slow release along the whole intestinal tract (similar to the protected organic acids mentioned previously).

PREBIOTICS

Prebiotics are ingredients that, when ingested, lead to the modulation of gut microbiota activity, which is beneficial to the host animal. These ingredients are not digested or absorbed by the host animal and are utilized only by the resident microbiota or exert an action against members of the resident microbiota. Common prebiotics that promote a beneficial microbiota are fructooligosaccharides (FOS), galactooligosaccharides (GOS), and pectin. Another prebiotic is mannan-oligosaccharides (MOS), which modulates microbiota composition by inhibiting the attachment of bacteria such as *E. coli* and *Salmonella spp.* to the intestinal surface. Therefore, these products are typically heat stable and can easily be included in the feed. Many probiotic products include a prebiotic to help the growth of the bacteria in the product—this combination is sometimes referred to as a "*synbiotic*."

POSTBIOTICS

Postbiotics in the poultry industry are typically products made by growing bacteria or yeasts in a specific growth medium, where they ferment ingredients to produce metabolites and compounds that benefit the host. The resultant broth is then heat-treated to form a product containing the dead bacterial/yeast cells and all the beneficial compounds produced through fermentation. These products have been shown to inhibit pathogens, stimulate gut development, stimulate and modulate the immune response, and improve gut function. These products can be added to feed or administered in the water lines.

TOXIN BINDERS

As the name suggests, these products bind toxins to prevent them from impacting the intestinal tract. Products are available for various toxins, and these should be considered if the flock is at risk from toxins, such as mycotoxins.

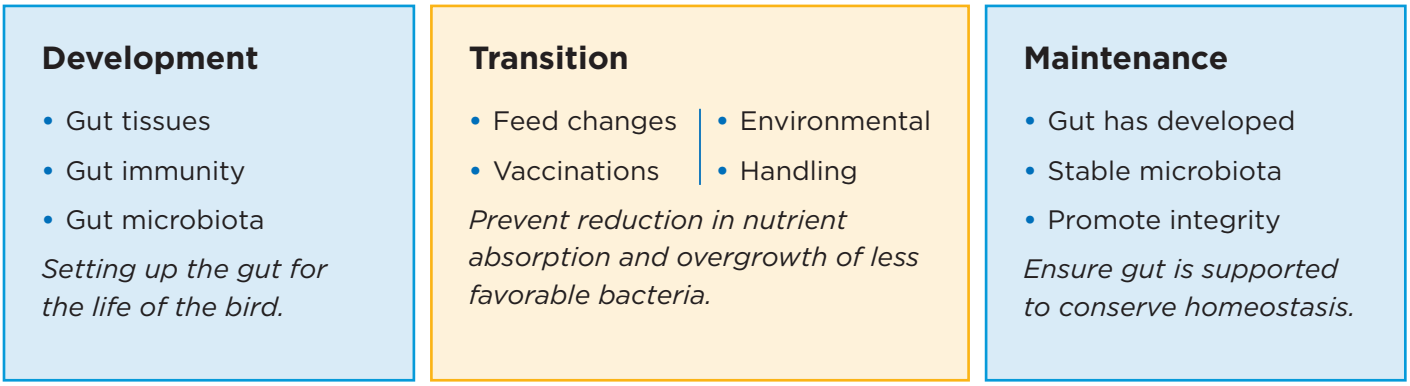
FEED ENZYMES

Feed enzymes are not a usual consideration as a gut enhancement product, but including these enzymes can improve the bird's gut function and nutrient absorption. Within the diet, various anti-nutritional factors such as phytate, arabinoxylans, and beta-glucans can impact nutrient availability and viscosity in the gut. Feed enzymes can help break these compounds down and reduce their negative impact on gut health.

CONCLUSIONS

Not all gut health enhancement products have the same mode of action, nor do they have the same impact on the bird or their microbiota. No "one solution" fits all when it comes to using gut enhancement products, as each farm and flock is unique. As such, it is important to the product manufacturer how their product works and how that mode of action will benefit your broiler or breeder flock. The gut has different requirements throughout the bird's life, as shown in **Figure 2**.

FIGURE 2. Progression of gut requirements throughout a bird's life.



Appreciating what the gut needs at any time in the bird's life is the key to choosing the right product. Very often, a strategy is required to help support the birds throughout their lives; that is, what a chick needs in support differs from that of a 25-day-old bird. Whether it is a probiotic, organic acid, or essential oil product, as long as its action fulfills the bird's needs, it is the right product.

However, it is essential to note that good bird management, litter quality, feed quality, biosecurity, and water quality are the best tools for ensuring optimal gut health and expression of full genetic potential. It can take a number of flocks for the full efficacy to be realized.