Nutrition Affects Microbiology of the Gut and Enteric Disease

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The gastrointestinal tract serves as a direct path from which pathogens can gain entry into the pig and cause disease. In order to combat potential pathogens, the intestine has a number of mechanisms that provide protection, including secretion of antibodies, maintenance of a healthy natural microflora, production of a mucin barrier, peristalsis or movement of digesta through the system, and inhibition through physiological environment. Nutrition can greatly affect all of these mechanisms, and understanding how diet interacts and affects a healthy gut can be very helpful in developing nutritional strategies to maintain or improve pig health, and thereby performance.

Gastric and Intestinal pH

Gastric and intestinal pH affects the activity of digestive enzymes and digestive rates, thereby influencing the amount of nutrients available for absorption. It also is a primary environmental factor influencing ability of pathogenic organisms to colonize in the gut. The low pH of the stomach initially provides a barrier against pathogens. Growth of opportunistic organisms, such as *E. coli* and salmonella, is known to be favored by near neutral pH conditions. Lowering pH in the gut tends to favor growth of resident bacteria, including lactobacilli, and therefore contributes towards a healthy microflora. Research indicates that immediately after weaning, pH in the gut increases, resulting in an increase in the proportion of pathogenic bacteria.

Volatile Fatty Acids

A considerable amount of fermentation of feed nutrients occurs in the intestine, and this activity produces fermentation acids, including volatile fatty acids (VFAs). VFAs appear to play several important roles in resisting pathogens. Studies indicate that increased VFA levels in the intestine increases resistance to opportunistic organisms, including pathogenic *E. coli*. Part of the positive effect of VFAs may be due to their ability to contribute towards reduced pH in the gut, but VFAs also contribute to the health of the intestinal tract by providing a ready source of energy to the gut tissues. VFAs provide a large proportion of the energy needs for these tissues. Increased VFA concentrations may also increase gastric emptying and ileal contractions in the pig. Decreased movement of food material in gut contributes to increased colonization of pathogens.

Intestinal Mucins

Mucins are proteins produced by epithelial cells of the intestine. These compounds protect the gut from abrasive action of feedstuffs and from bacterial colonization. Gut mucins may also specifically bind pathogen adhesins, thus reducing the risk of attachment by pathogens to similar receptors on host cells. Mucins have been reported to be the major inhibitory component against certain types of adhesive *E. coli*. Binding of pathogen adhesins to mucins decreases exposure of the adhesins to gut tissues, and may thereby prevent or reduce immune response and infection. Mucins are also fermentable

by microflora, and some enteric bacteria may select specific carbohydrate components of the mucins for use as nutrient substrates.

Microflora

Considerable evidence indicates a direct effect of microflora on pathogen colonization. A stable resident microflora provides resistance against enteric pathogens through a number of mechanisms. Healthy microflora compete with pathogenic organisms for nutrients, and byproducts produced by these microflora have been shown to prevent colonization of intestinal tissues by pathogens. Resident microflora may also stimulate production of immune factors, such as immunoglobulins and inflammatory response effectors, providing further protection.

Nutritional Influences

Difficulty exists in attempting to alter gut microflora considerably, since most diets incorporate large amounts of cereal grains for energy-dense diets, and economics dictate that these types of diets continue to be fed. However, diet can greatly affect VFA concentrations. Most effective in promoting increases of these fermentation byproducts is to provide fiber in the diet. However, one needs to weigh responses against negative effects of high fiber inclusion on growth and feed conversion

A variety of direct fed microbial (DFM) products exist that can be included in the diet or water supply to supplement and/or aid in establishing a health gut microflora. These products have been shown to be beneficial for animal health and performance, especially immediately post-weaning and in situations where conditions are conducive for pathogenic infections.

Supplementing early nursery diets with specific carbohydrates, such as galactose, may help maintain carbohydrate balance and thus decrease degradation and fermentation by enteric bacteria. This may not be a significant issue in older growing pigs, but may be quite important for the newly-weaned pig in enhancing their protective microflora and/or mucin.

Promoting increased, or at least maintenance of feed intake postweaning, continues to be key in lowering the risk of health problems and improving performance. Abrupt changes in diet intake and composition greatly affect microbial populations, and thereby ensuring adequate intake decreases potential for opportunistic pathogenic bacteria and improves nutrients available for growth as well as immune function. Ensuring adequate feeder space, proper adjustment of feeders, removal of stale or spoiled feed, and proper maintenance and adjustment of waterers are important to optimize intake.

As knowledge of the interaction of gut microflora, diet components, and pathogenic agents increases, we will ultimately be better able to characterize enteric disruptions and provide more effective prevention and control strategies. Diet formulation is becoming an increasingly recognized tool for gut maintenance and enteric disease prevention, especially as increasing public pressure is applied to reduce usage and/or dependence on antibiotics for animal health.