Maintaining and Optimizing Gastrointestinal Health

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To comprehend the microbial world co-existing within the human and animal host is a daunting task. In humans, for example, the micro-organisms inhabiting the gastrointestinal tract, both permanent and transient, exponentially outnumber the number of cells comprising the host by as much as 10 to 1.[1] It is now clearly recognized that a delicate balance and symbiotic relationship exist among these microbes and their host. Alterations that favor one microbial strain or species over another could result in disease and even death, or the change could lead to improved disease resistance, optimized growth parameters, and optimal nutrient digestibility. There are many conditions in horses that disrupt the delicate microbial balance within the gastrointestinal tract, with most resulting in serious diseases. Examples of these conditions include high grain feeds, antibiotic treatments, stress from traveling or hard training and competition, and changes in feed type and volume.[2-5]

Probiotics and Prebiotics

Products promoting digestive health generally contain live micro-organisms and/or inert compounds, with the aim being to encourage growth and activity of the "good" microflora in an animal's digestive tract, ideally at the expense of "bad" or pathogenic micro-organisms. Probiotics, by definition, are viable, live micro-organisms that provide a health benefit to the host beyond their nutritive value. In contrast, prebiotics are inert, non-live, normally non-digestible compounds that selectively aid in the growth, survival, and function of the desirable microflora, most often by acting as a direct dietary source for these microbes. However, this is not their sole mode of action. Health benefits conferred by probiotics and prebiotics are well-documented both directly within the intestinal tract and in the host.[6,7] For example, certain bacteria control the growth and colonization of pathogenic microbes by competing for nutrients and intestinal binding sites and by releasing bacteriocidal products that kill many pathogens. Certain bacteria can strengthen the immune system both systemically and at the level of the intestinal cell. Improvements in nutrient digestibility and utilization, plus the provision of key micronutrients such as certain vitamins and volatile fatty acids, are well-documented benefits of these bacteria. A variety of other systemic effects of these microbes have recently been identified, including improved function of the liver and kidneys, anti-cancer effects and cognitive alterations.

Probiotics are often gram-positive, lactic acid-producing bacteria of the *Lactobacillus* and *Bifidobacterium* genera,[7] in part because they have consistently been identified as natural residents of the intestinal tract in both animals and humans. Utilization of these microbes as probiotic agents in animals that rely predominantly on microbial fermentation is of questionable value, simply due to the lack of published studies documenting their efficacy. In direct contrast, there are many documented beneficial effects of live yeast products and fungi, making them viable probiotic options.

Saccharomyces cerevisiae

Saccharomyces cerevisiae is a natural and traditional yeast species that has repeatedly been shown to help optimize starch and fiber utilization in ruminants by increasing lactic acid-utilizing bacteria, reducing lactic acid and maintaining intestinal pH, and by increasing cecal cellulolytic bacteria that are primary fiber fermenters.[8,9] Horses are similarly reliant on microbial-based fermentation of structural carbohydrates to improve digestibility of their forage-based diet. The documented benefits of *Saccharomyces cerevisiae* supplementation in horses include improved microbial activity, nutrient digestibility, and feed efficiency.[10-12] The protective benefit of *S. cerevisiae* for horses fed a high-starch diet, a common feeding practice today, has important implications due to the occurrence of "carbohydrate overload," which puts horses at risk for disorders such as laminitis and colic.[3,13] *S. cerevisiae* supplementation limits the detrimental effects of decreased cecal and colonic pH and the increased concentration of lactic acid that is associated with such feeding practices.[10,11,14]

Saccharomyces boulardii

While the primary benefits attributed to *S. cerevisiae* supplementation relate to improvements in nutrient utilization and feed efficiency, a different *Saccharomyces* species, *Saccharomyces boulardii*, has additional immune and anti-pathogenic advantages. In fact, *S. boulardii* has long been recognized for its protective role against gastrointestinal disorders in humans. For example, *S. boulardii* strains have a protective role in the management of antibiotic-associated diarrhea, an acute, intestinal inflammatory condition often associated with overgrowth of *Clostridium difficile*, *Clostridium perfringens* and other pathogenic bacteria.[15,16] Further, research indicates that *S. boulardii* is effective for other types of diarrhea, as well.[17] In fact, *S. boulardii* purportedly has diverse therapeutic benefits in light of its multiple *in vitro* and *in vivo* effects. *Saccharomyces boulardii* strains stimulate both adaptive and innate host immune defenses,[18] prevent adherence of pathogens to intestinal cell walls,[19] neutralize toxins, including those from *C. difficile*[20] and *E. coli*,[21] and maintain intestinal membrane integrity.[22,23] In 2005 a study published in the Journal of American Veterinary Medical Association supported the use of *S. boulardii* in horses with acute enterocolitis. The authors of that study documented a reduction in both the severity of disease and the duration of hospitalization among horses receiving the supplement when compared to non-supplemented counterparts.[24] *S. boulardii* has also been suggested as a possible therapy for diarrhea in foals.[25]

Putting it into Practice: Note to Practitioners

There are a few reports in the literature of systemic yeast infections associated with different Saccharomyces species in severely immune compromised human patients, with contamination of central venous catheters by probiotic powder being the likely source of the yeast. Although this type of an infection is highly unlikely to occur in a horse, anyone administering a dietary supplement that contains yeast should use caution when mixing and feeding the product to prevent contact with any intravenous catheter sites. Good hand hygiene and appropriate catheter management will help to reduce any possibility of infection. In an immune compromised neonatal foal, practitioners should weigh the benefit of using a probiotic product that contains yeast against any potential risk of systemic infection before the product is used.

Aspergillus oryzae Fermentation Products

Aspergillus oryzae is a fungus commonly used as a probiotic agent to promote gut health due to its ability to initiate and enhance fiber breakdown, and thereby increase the bioavailability of fiber for fiber-digesting microbes in the gut. In addition to directly supplementing the diet with live *A. oryzae* organisms, fermentation products of *A. oryzae* have also been used. Since fungi have a major role in digesting fiber themselves as well as making it more available to other microbes, these fungi can have significant impacts on nutrient digestibility and the health of the intestinal microflora. The results of several studies indicate the *A. oryzae* fermentation products enhance fungal activity, including increased fungal mass and cellulose-degrading enzymatic levels.[26,27] Other *in vitro* studies have reported increases in lactate utilization by certain bacteria after culture with *A. oryzae* fermentation products.[28,29] An *in vitro* trial utilizing equine cecal fluid reported increased production of volatile fatty acids

after incubation with this fermentation product,[30] indicating a more efficient utilization of structural carbohydrates and an augmented energy source for the horse. *A. oryzae* fermentation products are not live micro-organisms, but they do selectively enhance the activity of the desirable bacteria in the gut; for this reason, they are defined as a prebiotic.

Oligosaccharides

Oligosaccharides derived from yeast cell walls are commonly used as prebiotics, primarily as energy sources for the "good" bacteria in the gut. The unique structure of one of these compounds, mannan oligosaccharides (MOS), confers additional effects that may be of benefit to the host. These MOS contain binding sites similar to those present on intestinal cell walls, to which several pathogens bind and colonize.[31] Consequently, attachment of pathogens to MOS prevents bacterial colonization of the intestinal mucosa and aids in the direct removal of these microbes from the intestinal lumen. In doing so, MOS confers protection against enteric bacterial infection in both rat and chicken models of enterocolitis,[32-34] and a similar effect is expected to occur in horses.

Beta-glucans

Beta-glucans are another yeast cell wall component that confer immune protection in animals. Although these glucose polymers cannot be digested by animals and humans, they are readily fermented by intestinal microbes.[35] Therefore, the immune benefits associated with these compounds are, in part, attributed to alterations in microbial activity. In addition, beta-glucans have distinct binding properties that allow them to attach to and activate immune cells.[36,37] Cellular immune responses attributed to beta-glucans include proliferation of peripheral mononuclear cells, maturation of dendritic cells, and increased secretion of interferon-gamma and IL-10.[38,39] The results of studies using *in vivo* models indicate that beta-glucans enhance survival against pathogenic infections[40,41] and reduce trauma-related complications.[42]

Glutamine

Glutamine is a conditionally essential amino acid becoming an important component of the diet during times involving intestinal illness. Glutamine plays a critical role in maintaining healthy intestinal cells, preventing villous cell atrophy, reducing the permeability of the gastrointestinal tract to pathogens, and improving the immune response at the level of the intestinal cells. Glutamine protects intestinal cells against apoptosis, or programmed cell death,[43] provides defense against oxidative stress,[43] and stimulates intestinal cell growth.[43] In addition, glutamine prevents translocation of pathogenic bacteria from the intestinal lumen into the circulation,[44,45] thereby reducing potential hazards of pathogens within the intestinal tract. For these reasons, glutamine is important in any effort to optimize gut health.

Conclusion

Appreciation of the microbial world and the potential impact on health and disease of its host has fostered the identification of many products with the potential to help maintain and optimize this microscopic environment. Not only can supplementation with live micro-organisms help enhance the viability and activity of resident, healthy enteric bacteria, but some of these micro-organisms have benefits that can directly and positively impact the host. Additionally, prebiotics can provide further support to the resident microflora by supplying nutrition, activity-enhancing compounds, and by acting as a direct defense against pathogens. Because gut integrity can be affected in many different ways and with many different manifestations, no single compound should be relied upon to optimize intestinal health. Utilization of a combination of the aforementioned products,* a synbiotic-type product, can provide the safest route to best protect and enhance intestinal health of the horse.

*Platinum Balance®

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