Food For Thought: Digestive Health For Horses

by: Nancy S. Loving, DVM

A favorite pastime of humans and horses alike is to eat. Our world view of eating revolves around fundamental expectations of the types of food we eat, how these foods make us feel, and how different foods are processed through our bodies. Unlike our human intestinal constitution, the horse has a unique intestinal structure and function for processing feed. Comparing equine digestive function with human or small animal function leads to misconceptions, and, hence, mismanagement.

To understand how to best accommodate equine digestive health, it helps to briefly examine the structural function of a horse's bowel. As strict herbivores, horses have evolved a complex intestinal arrangement that focuses most of digestion in the enormous hindgut. It is there, in the large intestine, that the bulk of nutrients and fluids are absorbed. Because horses thrive on eating plant fiber materials, the entire intestinal tract has developed mechanisms to process cellulose: Huge and numerous grinding teeth crush plant fibers, which undergo limited digestion in the small intestine and pass to the large intestine, where resident bacteria (microflora) digest fiber (cellulose) to release nutrients.
It is said that to keep a horse healthy, one must direct attention to keeping hindgut bacterial microflora healthy. So, how is this done?

Fiber, Fiber, And More Fiber

The mainstay of any equine diet should be fiber--you should focus on presenting the intestinal tract with ample fiber to help the system do its work. The act of eating and the intake of forage are major stimuli for active gastrointestinal (GI) motility. In contrast, fasting leads to reduced bowel motility. Fasting occurs when a horse is fed large amounts only twice a day rather than having access to small amounts to nibble throughout the day. Periods of fasting are sometimes unavoidable, but optimal digestive health depends on continuous eating patterns that best mimic a horse's natural nibbling conditions. Fiber keeps gut motility active, and it is important in providing specific nutrients as well as serving as a reservoir for energy and electrolytes to be called on in time of need, especially during protracted exercise.

Joe Pagan, PhD, president and founder of Kentucky Equine Research (KER), promotes the use of fiber as the most fundamental of equine nutritional needs. He comments, "The single most important recommendation in feeding horses is that forage should be the foundation of every feeding program. The quality of fiber fed is critical, since this is the main food source for the good microbes in the hindgut (which includes the large intestine and rectum). Select the best forage type and amount for a particular situation, using a concentrate or supplement only as necessary to fill any remaining nutritional gaps. Unfortunately, most owners do just the opposite; they pick their concentrate first, then think about forage later."

Pagan also feels that providing microflora in the hindgut with a good environment is critical for gut health. He stresses that the role of the "good" microbes in the hindgut is to ferment fiber, using primarily cellulose and hemicellulose (both part of the fiber's cell wall matrix) as substrates for a fairly slow, but steady rate of fermentation.

Sarah Ralston, VMD, PhD, Dipl. ACVN, an associate professor at Rutgers University's Animal Science Department, weighs in on the rationale for the importance of feeding forage: "Small amounts fed frequently are key. Think about how a horse grazes. A horse's digestive system is designed to quickly extract what soluble nutrients (starch, sugars, proteins, fats) are normally present in forages by enzymatic digestion in the small intestine. Then, anything that escapes small intestinal digestion is fermented in the complex ecosystem of the hindgut, producing volatile fatty acids that can be absorbed and used as energy sources. The ecosystem of the hindgut is very responsive to what it receives as substrates."

In essence, this is the source of many digestive problems in horses--too much fermentable material passes in relatively undigested form from the small intestines, and then it overloads the hindgut with starch and soluble carbohydrates.

Ralston cautions, "If large amounts of grain are fed, more than 0.4% body weight per meal, then a lot of starch will escape enzymatic digestion, thus reducing the overall caloric value of the whole ration and influencing fermentation."

Pagan points out that in a healthy, normal hindgut, the fiber-fermenting microbes are the dominant species, but they do not work well in an acidic environment. He notes, "There are other species of bacteria inhabiting the hindgut whose preferential substrates are rapidly fermentable carbohydrates such as starch, sugar, and fructans. If these rapidly fermentable substrates enter the hindgut, then these bugs become very active and quickly multiply. Lactic acid is their primary fermentative end product, which lowers the pH of the hindgut, and this inhibits or even kills the fiber-fermenting species."

The primary objective of digestive health is to provide feeding strategies that optimize the evolutionary function of horse intestines. Pagan stresses this sentiment, "An ideal feeding protocol mimics how horses eat in Nature--that is a continual intake of small amounts of forage. This type of feeding stimulates saliva production, which promotes gastric health. Free choice access to hay is ideal."

Recommendations from the National Research Council (NRC) are to offer a horse at least one pound of roughage for every 100 pounds of body weight. However most nutritionists suggest doubling that amount of forage and minimizing grain supplements, or feeding none at all. Ralston concurs that a basic feeding strategy should be to offer free-choice forage; if forage must be restricted, then it should be divided into four equal feedings.

Water

Water is critical to maintain digestive health and to facilitate processing of large amounts of fiber consumed daily. For every pound of feed ingested, a horse needs two to four pints of water for digestion. This means that a 1,000-pound horse consuming 20 pounds of food each day needs a minimum of 7.5 gallons (30 liters) of water to process the feed material. This is the amount necessary solely for intestinal function; additional water is necessary for other bodily maintenance functions. Regular or intense exercise further increases water demands, and summer climates amplify these needs as well.

Dental Care

Because fiber digestion begins in the mouth where the material is crushed and ground by the molars, much has been made of the importance of routine dental maintenance. A study by Ralston indicated that fiber digestion is not entirely dependent on exact apposition of the grinding cheek teeth.

She comments, "In our study, the horses examined had normal, floatable mouths with (tooth) points less than 7 mm and no wave mouth (a wavelike or stairstep configuration of the premolars and molars, from front to back). We found no difference in fiber digestibility even after a 'performance' float," or one that corrects the grinding surfaces for ideal digestion and performance. That said, however, "I still recommend regular dental care to prevent the development of severe abnormalities," she continues.

Routine dental procedures serve a preventive and protective function--to keep a horse's teeth in as good a shape as possible to enable effective and pain-free chewing and grinding into a horse's latter years. Knocking off sharp points improves grinding efficiency and deters development of a wave mouth or of gum erosions that impact chewing comfort.

Effect Of Concentrates

Horses' intestinal tracts evolved to digest high-fiber forage sources, which are typically low in sugars. Once fiber reaches the hindgut, intestinal microbes break down plant cellulose to produce energy-rich volatile fatty acids, which generate circulating blood glucose at steady, even levels.

Concentrate feeds, especially carbohydrate-rich grains, cause large surges in blood glucose, then insulin hormone levels peak in response to stored glucose (glycogen) in the muscles and liver. The level of circulating glucose and responsive insulin hormone following a meal is referred to as the glycemic response.

Although grains tend to have the highest glycemic index, Ralston notes, "Grain-based concentrates in any form do have their place for hard-working horses and hard keepers that need more calories than straight forage can provide.

Grain concentrates should be no more than 0.4% body weight per feeding, i.e., no more than four pounds grain per 1,000-pound horse. Ideally, this should be fed at even lesser amounts, and only in amounts necessary to maintain body condition. Feeding relatively small grain meals frequently (three to four times a day) enhances efficiency and hopefully will not adversely impact insulin sensitivity."

Pagan echoes this sentiment, "It is important to keep the size of a concentrate meal under four to five pounds to reduce the risk of grain entering the hindgut."

Frank Andrews, DVM, MS, Dipl. ACVIM, a professor and section chief in the Department of Large Animal Clinical Sciences at the University of Tennessee's veterinary school, has made great inroads into understanding the effects of grain feeding on gastric health and ulcers. He explains that volatile fatty acids (VFAs) and fermentation products of soluble carbohydrates in grain contribute to damage of the gastric mucosa (lining). At a low pH (less than 4.0), these are fat-soluble, so they are able to permeate the nonglandular squamous epithelium lining of the stomach. Volatile fatty acids inhibit sodium transport functions of the gastric mucosa. Then, as sodium accumulates within the cells of the stomach lining, water is osmotically pulled into the cells to create edema and mucosal damage, with resulting sloughing and ulcers.

Andrews suggests that injury to the stomach lining is dependent on the "dose" of grain (fermentable carbohydrates) ingested. For a horse that has grain included as part of his diet, current recommendations for a protective strategy restrict grain to less than one pound of feed per 220 pounds body weight. Andrews stresses that if an owner feels it necessary for caloric reasons to feed more grain than this recommendation, then it is prudent to limit the dose by offering small amounts no more often than every five hours. Andrews explains that this keeps a horse's intestinal exposure beneath a "threshold level" of VFAs. He encourages owners to weigh the grain rather than feeding by volume, so you know exactly how much your horse is receiving.

Scientists also believe that legume forage, such as alfalfa hay with its high calcium and protein content, is able to buffer stomach contents for about five hours following its intake. Saliva production that results from chewing also serves to buffer stomach acid and stomach contents for horses that have free choice access to forage throughout the day.

Looking at overall digestive health, research (by Clarke and Argenzio) established that horses fed a large grain meal twice a day experienced a 15% reduction in plasma volume (body fluid) within 30 minutes of each meal. In contrast, there is no change in plasma volume in horses that are fed smaller amounts every few hours. Feeding a large grain meal activates a complex hormonal feedback loop involving aldosterone (a steroid hormone that controls salt and water balance in the kidneys), and it elicits a transient reduction in plasma volume by activating that lasts several hours. Such hormonal signals program the body to shift fluid out of the intestines into the circulation and other body compartments. This is done in two ways: First, by increasing fluid absorption while, second, decreasing secretion of intestinal fluids into the bowel.

Furthermore, grain intake supplies intestinal fill and calories that then cause a horse to slow his fiber intake. Less fiber in the bowel decreases water content of the colon, and more soluble carbohydrates increase fermentation to produce more gas and acidify the hindgut.
In summary, feeding grain twice daily elicits extremes in fluid exchange in the colon, with the potential for dehydration of ingested feed, increased fermentation, and associated colic.

Just as the amount of grain fed has significance to digestive health, so does timing of feeding. Pagan's research on timing of forage feeding relative to grain feeding revealed an unexpected result. He explains, "If a (five-pound) meal of hay is fed a couple of hours before or with a grain meal, the glycemic response to grain is greatly reduced. At first glance you could argue that this is a good thing, but in reality what happens is that saliva production and digestive juices and extra water intake (that) accompany hay consumption result in an influx of fluid into the gut. This hastens grain passage to 'wash' it through the small intestine in a relatively undigested form."

Then the hindgut is presented with an excess of fermentable carbohydrates that is not good for digestive health. He continues, "This 'wash-through' does not occur if the horse has been nibbling small amounts of hay continually before being offered a grain meal, since steady presentation of fiber to the bowel allows time for equilibration of fluids between the gut, the tissues, and the bloodstream."

Pasture Implications

Pasture is an important form of forage, fondly referred to as "Dr. Green." But as good a source of fiber as it offers, there are recent concerns about fructan (sugar) content, particularly in rapidly growing or lush fields. The small intestine is unable to digest these sugars due to lack of necessary enzymes; once passed to the large intestine, fructan is fermented to lactic acid much like starch and grain that escape digestion would be.

However, Ralston notes, "In general, grazing horses do not ingest large 'slugs' of starch, even if the grasses contain over 20% nonstructural carbohydrates (NSC, such as sugars, starch, and fructan) because each mouthful has a mixture of fiber and low fat in addition to some carbohydrates."

During spring or during rapid pasture growth, it is smart to limit intake to just a few hours at intervals, and/or to use a grazing muzzle to slow a horse's ingestion of grasses with high sugar content.

Pagan suggests that buffering the equine hindgut would be beneficial to counteract rapidly fermentable pasture fructans and/or grain. Historically, it has been difficult to deliver buffer materials that could survive passage through the stomach and small intestine on the way to the hindgut. His research team has formulated a time-released buffer product (EquiShure) to attenuate the decline in fecal pH and reduction in fecal lactate in the hindgut.

Pagan offers cautionary advice, "Feeding a buffering agent is certainly no substitute for managing a horse's feeding program to minimize hindgut acidosis. Nothing that I know of can prevent the devastating consequences of a massive overload of the hindgut with rapidly fermentable carbohydrate, such as grain or fructans."

In addition, Pagan comments, "If high fructan content is suspected, introduce a horse slowly to the pasture, feed supplemental hay, and consider supplementing with a hindgut buffer. Unfortunately, some horses and ponies simply can't tolerate pasture at all."

Probiotics

Horse owners are intent on keeping their horses' gut flora happy, and one strategy that has received much acclaim is feeding probiotic supplements. Probiotics are live organisms intended to promote the viability and health of the intestinal microflora to improve digestive efficiency.

Scott Weese, DVM, DVSc, Dipl. ACVIM, an associate professor at the University of Guelph's Ontario Veterinary College in Canada, has devoted considerable effort to researching probiotic use in horses. His findings are noteworthy when one evaluates the cost-benefit of feeding these as dietary supplements. Weese suggests, "Probiotic therapy makes the most sense to use in horses with diarrhea and perhaps those undergoing antimicrobial therapy, but there is no objective evidence yet that supports results."

In addition, he summarizes, "There are currently no studies indicating a positive effect of probiotics in any situation in horses."

Many of you are might be rearing back in disbelief, but let's look at some of the pertinent reasons why Weese has cause for concern.

He explains that because probiotics are considered food supplements and not drugs, there is no regulatory control over their manufacturing, quality, efficacy, or label claims. Basically, anyone can produce a product and market it with all manners of claims that it will cure all ills.

Yet, without product regulation, there is no guarantee that any of these claims are true. Weese elaborates, "Commercial probiotics are concerning because there is no requirement to perform proper *in vitro* or *in vivo* (on equine tissue samples in a laboratory or in the live horse) testing. A large number of probiotics are available commercially, and have been for years, yet none of them have demonstrated a positive effect through a proper trial.

Marketing of these products is riddled with numerous unsubstantiated anecdotes, or Internet publications of fictitious 'research,' along with illegal label claims. As nutritional supplements, probiotic labels cannot make a claim of health benefits, yet this is often the case on product labels or in ads. It is also surprising how often labeling is incorrect, including misspelling of names of organisms."

One point of interest about probiotics is whether they are even able to bypass digestive juices in the stomach and small intestine and make it to the large intestine in a usable form. And, once there, they must be able to colonize the bowel lining to exert favorable effects on the native gut flora. Weese notes that proper selection of live culture strains given at appropriate doses might overcome this concern.

One problem, however, is that very little is known about the numbers of organisms necessary to inoculate the large intestine of the horse to achieve the desired end. Doses suggested are simply based on conjecture, with no substantiation from clinical trials. Each probiotic organism must be tested to determine its dose and efficacy.

Weese explains, "Probiotic strains need to be tolerant to acid and bile, and these properties are quite variable. One *Lactobacillus acidophilus* might be very tolerant, while another poorly so. (*Lactobacillus* bacteria are literally "milk bacteria" and are normally found in the digestive tract.) This is why specific testing of the specific probiotic strain in the target animal species is required, although this is rarely performed.

We evaluated this with *L. rhamnosus GG*. Survival of passage through the gastrointestinal tract was moderate; with large enough doses, we could recover the organism from feces. We also showed that an equine origin *L. pentosus* had good survival properties, however this organism caused diarrhea in a randomized, placebo-controlled, blinded clinical trial. This indicated that specific safety and efficacy testing is required--a procedure that is not done for commercial probiotics."

In his research, Weese also discovered that there was little to no compliance with standard industry requirements for labeling claims. A label should accurately identify the contents in the packaging, specifically how many and what strains of organisms are present, with a guarantee that each product will provide this concentration of active organisms up until the expiration date. He found no probiotic product that provided all this information.

Pagan recognizes the same problems defined by Weese. He comments, "A probiotic should be comprised of species that normally inhabit the gut, and I'm not sure that any commercial probiotics do. **Although yeasts are not strictly considered 'probiotics,' we have done research that shows improvements in fiber digestion when we add live yeast. There is another class of substances called 'prebiotics,' which probably have greater potential to affect gut health. Prebiotics are foods for the bacteria that already inhabit the gut. We have recently developed a fermentable fiber substitute that contains these types of substances, which we believe will be useful for horses with compromised digestive function."**

So, in summary, although probiotics sound good in theory, there is still a long way to go to establish quality control and assurance of efficacy for any of these commercial products. In addition, research is still ongoing as to how these might work to the benefit of a horse's digestive health.

Parasite Control

In addition to active populations of microflora in the intestines, there are other living organisms within the intestines that can create havoc--endoparasites or worms. Intestinal worm infestation can directly impact digestive efficiency and intestinal health by interfering with blood circulation and nutrient absorption, and/or creating inflammation or intestinal blockage. At least twice weekly cleanup of manure is effective in limiting ingestion of infective larvae that are in the feces. Coupling this with a regular de-worming schedule and periodic evaluation of fecal egg counts minimizes the adverse effects of parasites on intestinal health.

Lifestyle Effects

Numerous studies have implicated colic, especially impaction colic, on recent management changes within the two weeks preceding clinical signs of gastrointestinal distress. One common management change is that of restricted exercise and/or stall confinement, particularly because of a musculoskeletal injury.

One study reports that recent stall confinement is associated with nearly 54% of impaction colic cases, while another reports 62% of the colic cases it considered were related to stall confinement or transport. It is common for stall-confined horses to experience inconsistencies in feeding intervals and amounts relative to their previous management habits, especially horses that are used to regular exercise or turnout.

There is evidence that even light physical activity such as walking has the potential to stimulate GI motility. Exercised horses have a 20% increase in fiber digestibility, and this promotes greater retention of the fluid part of the diet and shortened retention of the more formed particulate part of the feed. Progressive movement of particulate materials through the GI tract promotes efficient digestion, while not allowing digesta to linger and dehydrate or overly ferment. A horse whose activity is suddenly limited should be monitored closely for digestive problems and colic. It is best to avoid stall confinement for long periods whenever possible.

Pagan recommends, "I would try to encourage continual forage consumption in a stall-confined horse by offering free-choice hay. Even with free access to hay, however, a horse won't continually 'graze' like it will on pasture."

Bored horses or those with limited fiber to chew often ingest sand and dirt. These materials can interfere with intestinal health and absorption of nutrients, as well as create conditions for colic or an impaction. One of the best means of moving sand through the bowel is by promoting active intestinal motility.

Feeding a fiber-based diet keeps the digesta moving well and encourages passage of small amounts of sand before it accumulates and settles out in the bowel. Besides setting up feeding stations in areas free of sand and dirt, feeding psyllium is a great adjunct in some geographic areas to manage sand ingestion.

Any change in diet can be a challenge to some horses' digestion and can increase the likelihood of intestinal upset. Studies have demonstrated a twofold increase in colic following a change in hay, and roughly a four- to six-time greater risk of colic with grain feeding--the higher risk related to feeding more than five pounds of grain.

The best advice relies on slow introduction of any feed modifications, gradually increasing new foodstuffs over a two- to three-week period to allow for microbial adjustment. Once again, the goal is to keep those microbes happy! In addition, keep in mind a general and important nutritional rule to promote digestive health: Ideally, 75-80% of a horse's diet should consist of fiber-rich forages and 20-25% (by weight) concentrates.

Feeding in the period surrounding exercise might interfere with digestive efficiency. Rigorous exercise just prior to feeding might decrease feed digestibility while blood remains shunted to working muscles, away from the intestinal tract. Because strenuous exercise slows intestinal motility, a horse is better served if he has a relatively empty stomach or small intestine during exercise.

But, for most recreational equine pursuits of light or moderate exercise, there is no reason to restrict forage, and it can safely be fed at intervals surrounding exercise.
Pagan comments, "In general, most pleasure and performance horses should receive about 1.5% of their body weight per day as forage, i.e., hay or pasture equivalent. I would not worry about restricting forage at any time in any performance horse except a racehorse. It is best not to feed grain within five hours of competition due to alterations in availability of glucose for energy, not necessarily related to gut health."

Ralston elaborates on this thought: "If you want a hot horse for a sprint activity like barrel racing, feed some sweet feed (one to two pounds) about an hour before riding. If you prefer calm and steady for hours, then offer no grain for two to three hours prior to riding, or if you do give grain, then mix it with beet pulp or use a high-fiber formula. High fat is not necessary in this case."

No matter the athletic activity, proper measures should be taken to adequately cool out a hot horse before feeding large meals, particularly grain.

Take-Home Message

Pagan summarizes that the single most important consideration for proper feeding of any horse is ensuring that the microflora in the hindgut are healthy and happy. He stresses, "This is achieved with a two-step strategy: Provide the good bugs with food in the form of fermentable fiber while minimizing the supply of rapidly fermentable carbohydrates that allow bad bugs to quickly overwhelm the hindgut ecosystem and cause digestive and metabolic problems for the horse.

Supplying lots of high-quality forage while being careful about the type and amount of concentrate is the best way to accomplish these goals."

Andrews aptly sums up the basics of promoting digestive health in horses: "Provide high-quality forage and pasture grazing, and limit grain feeding. High-quality fiber stimulates chewing, and chewing stimulates saliva, which is high in bicarbonate, and bicarbonate neutralizes stomach acid." He urges an effective strategy to follow, "Keep your horse chewing!"