High-Fiber Low-Starch Diets: The New Nutritional Wisdom

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Just about everybody has heard the hype about "low-starch" or "high-fiber" diets for horses, but what is the rationale behind how horses benefit from these diets? Hard working horses have been fed high-starch diets for centuries, so why are we now coming to the conclusion that they may not be such a good thing after-all? The horse's basic diet of forage is already high in fiber, so are high-fiber diets really something new? Horses need energy in the form of calories to be able to do the things we ask of them. They get their calories from fiber, starches, sugars, and fats; it is a combination of these energy sources that can be manipulated to produce energy in the best manner possible for the health and performance of the horse. This article answers some of the challenging questions facing horse owners as the industry shifts away from traditional energy sources.

Evolution of the high-fiber/low-starch diet

Working horses have been fed the same way for centuries—forage plus grain. Forage took care of the energy requirement when the horse was at rest, but once the horse was in work, the diet included some type of grain. Grain was added because by itself the forage could not supply adequate energy (calories). The type of grain differed depending on the availability in the area. Even now, when most of the horses are not used for work, the tradition of feeding grain remains, and there are many horsemen who think that horses need it. Changing the way modern horsemen think a horse needs to be fed can be traced to one individual.

In the early 1990s, a forward-thinking researcher observed the fluctuations in weight gain of Thoroughbred yearlings as pasture grasses segued from winter to spring. He speculated that the dips in weight just as grass was getting green and lush were due to the high sugar content of the grass. The yearlings were also being fed a high-starch feed, and he felt that all the starch from the grain and sugar from the grass were affecting the microbial population in the hindgut, which in turn disrupted energy production and thus their ability to grow. He postulated that if the yearlings were fed a diet high in fiber instead of starch, it would moderate the sugars in the grass and allow the horses to maintain steady growth.

Further, he believed that the high-fiber product should contain several types of fibers that varied in their rate of fermentability; some would ferment slow, others fast. The experimental diet consisted of fibers like oat straw, soyhulls, and beet pulp. In order to get the same amount of calories in the high-fiber feed as in the high-starch/high-sugar feed, he added corn oil. In several years of testing the feed, he found that the high-fiber feed indeed had the desired effect. He then tested the feed on of all the horses on the research farm. The high-fiber/high-fat feed was tried on broodmares to see what effect it had on fertility, milk production, and composition. The feed was also tested in endurance horses, which are now known to benefit from high-fiber/high-fat diets.

A glitch with the experimental feed was soon discovered: it was difficult and expensive to manufacture, so the exact feed never made it to the market in the United States. However, using

the same principles and similar ingredients, feed manufacturers now produce a large variety of high-fiber/high-fat feeds, better known as “low-starch” feeds.

What is fiber?

Fiber is a nutritional term that gets thrown around a lot when speaking about feeding horses, but exactly what is fiber? Are all types of fiber equally utilizable by the horse? Fiber is a term that loosely describes structural carbohydrates. A plant is made up of cells, and each cell has a cell wall made primarily of structural carbohydrates. The contents of the cell held in by the cell wall are mostly nonstructural carbohydrates. The cell walls are called structural because they give the cell shape and strength, which keep the cells from looking like gelatin.

Of the structural carbohydrates, there are certain ones that can be broken down by the microbes living in harmony in the digestive tract of the horse, mostly in the cecum and colon. These are “digestible” fibers such as cellulose and hemicellulose.

There are also “indigestible” fibers found in the cell walls like lignocellulose, which are not broken down by the microbial population and have no nutritional value except to work like a laxative and help the progression of the digested material through the tract. In general, the stiffer or harder the plant component, the more indigestible fiber present. For example, the rigid stems of alfalfa plants are high in indigestible fiber, while the soft, pliable leaves are rich in digestible fiber.

The amount of digestible fiber found in fresh forage and hay is generally between 30 and 50%. If food is 100% digestible fiber, it causes stagnation problems in the tract and can lead to serious gastrointestinal disorders like enteritis or colic. The general term “fiber” includes both digestible and indigestible fibers and does not distinguish between how much energy a horse can get from it.

Commercial horse feeds commonly contain ingredients other than hay that are known to be high in fiber. Some are excellent sources of digestible fiber and others are not. Beet pulp and soyhulls have become staples in commercial horse feeds or as standalones in horse diets because they are high in digestible fiber –between 75 and 80%. Uncommon fiber products that are reasonably high in digestible fiber are sunflower hulls, almond hulls, and citrus pulp, but palatability issues keep their use limited. Other feed ingredients that are high in fiber but low in digestible fiber are cottonseed hulls, peanut hulls, oat hulls, and rice hulls. These have very little nutritional value.

Why would high fiber be good?

Horses are grassland– grazing–animals. In order to be able to survive on grass, they have an interesting symbiotic relationship with microbes in their gastrointestinal tract that digest plant material for the horse. Without the millions of bacteria, protozoa, and yeasts to break down cellulose molecules, horses would not derive any benefit from eating fiber. The key to maintaining an efficient microbial population is a steady supply of fermentable products. The horse’s digestive tract is designed to handle lots of fiber and thrives best if it has a variety of fiber types to feed the different microbes in the gut.

When feed is digested by microbes it is called fermentation, and the result of this process is volatile fatty acids or VFAs. These short-chain fatty acids are easily absorbed into the bloodstream and are used as readily available energy to fuel various body processes. The VFAs produced are primarily acetate, propionate, and butyrate. VFAs are handled like other fats in the body. Fortunately, propionate can be converted to glucose in the liver to be used as an energy source for the brain, which can only use glucose. Since this process is not rapid, it does not result in large enough surges in blood glucose to stimulate significant pancreatic release of insulin. As with any energy source in the body, if there is excess it can be stored away in fat cells (adipose tissue) for use when the energy supply does not meet demand. This is why a horse can maintain optimal body condition or get obese on just forage.

Because the digestive tract was beautifully designed to handle fiber, perhaps fiber could be thought of as an ideal way to fuel horses. Feeding forage is considered a safe way to supply energy (calories) to the horse because it is a slow process and does not cause rapid changes in blood glucose or insulin.

Forage is an obvious source of fiber, but things like beet pulp and soyhulls may not be as apparent. These are called "super fibers" because they contain even more fermentable material per gram than hays and therefore are excellent energy sources. High-fiber commercial products use super fibers because they pack more calories and are manageable in the feed-making process.

Unfortunately, fiber sources are not as calorie-dense as starch, which is why starches were fed in the first place. Fat is the other energy source that usually goes hand in hand with high-fiber feeds, because it can increase the energy density without adding to the bulk. Like fiber, fat does not have an effect on blood glucose and insulin release.

How high is high-fiber?

Forage is naturally high in fiber, but how do you know if a commercial feed is truly a high-fiber feed? The only nutrient specification on the feed bag or tag that begins to give a hint is "crude fiber" or "fiber." These ingredients are usually indicative of a high-fiber feed: beet pulp, soyhulls, alfalfa, almond hulls, and citrus pulp. Ingredients like oat hulls or rice hulls will also increase the fiber value but are high in indigestible fiber and are not a good source of fiber or energy.

So how high is high? Most high-fiber feeds have a crude fiber value of 12 to 25% on the guaranteed analysis. Many of these feeds will have added fat to help bring the energy up in line with that of a high-starch feed. Usually in the form of oil, the fat found in most high-fiber feeds ranges between 6 and 12%.

What is starch?

What is it about starch that has caused it to get such a bad reputation? Starch is a long, complex chain of sugar molecules that is the energy store for the plant, found in particularly high content

in seeds (grains). The opposite of fiber (structural carbohydrates), starches are considered "nonstructural carbohydrates" because they are found inside the cell wall structure.

When starch is eaten by a horse, it gets broken down into small sugar molecules in the small intestine by enzymes so that it can be readily absorbed. At this point, starch and sugar in the diet are handled basically the same. Sugar in the diet can come from the cell contents in grass, molasses from feeds, and treats (apples, carrots, sugar cubes, peppermints, etc). The small sugar molecules cross into the bloodstream and end up as glucose, which gets distributed to cells for use as energy throughout the body. The hormone that helps get glucose out of the blood and into the cells is insulin. This distribution system of getting glucose to the cells for energy, glycogen-building, or adipose (fat) storage is part of the energy-generation system for the working horse. The harder the horse is working, the more important the system is.

Why would low starch be good?

Avoiding high amounts of starch may be beneficial in some horses for a couple of reasons. After digestion of a starch meal, large amounts of glucose hit the bloodstream and trigger the release of insulin, which starts clearing the glucose out of the blood and ferrying it into cells. If a horse's blood profile is looked at for several hours following the ingestion of a starch meal, a rise in glucose is seen for the first two hours and then glucose gradually drops over the next four hours. Looking at the profile of insulin after ingestion of starch, it parallels that of glucose with a similar pattern of rising and falling. If there is a potential problem with the way an individual handles starch, it can possibly be because of the glucose and insulin fluctuations in the bloodstream.

Rising glucose levels can have an effect on the brain of some horses and make them more excitable. Because glucose is the only fuel that passes the blood-brain barrier, something that can deposit a lot of glucose into the bloodstream at one time can have the potential to send significant amounts to the brain. High levels of glucose in the brain are associated with increased dopamine production and can cause heightened awareness or excitability. Certain sports depend on the heightened awareness and energy, like horse racing, but are not necessary for the pleasure horse.

The other part of the glucose and insulin cycle that can go awry in some horses is the ability of insulin to do its job and get glucose delivered into the cell. Insulin resistance occurs when insulin loses its effectiveness and the levels of glucose and insulin remain higher in the bloodstream for longer than normal. The high insulin levels can cause a host of problems, the worst of which is making a horse more susceptible to laminitis. Insulin resistance is often associated with obesity, and losing weight is one of the strategies for improving insulin sensitivity, as well as decreasing starch and sugar in the diet.

Other individuals that have difficulties with handling starch in the diet are horses with genetic muscle disorders like polysaccharide storage myopathy (PSSM) or recurrent exertional rhabdomyolysis (RER). PSSM horses are quite efficient at tucking away blood glucose into the muscle cell and end up with abnormally high amounts of glycogen, which, oddly enough, cannot be easily broken down and used for energy. Keeping foods that cause increases in blood glucose

out of the diet is the recommended strategy for horses diagnosed with PSSM. RER also responds to a decrease in the amount of starch and sugar in the diet but for different reasons, and they are more tolerant to limited amounts.

Another instance in which high starch can pose a problem for a horse is when there is a shift in how the starch is digested. There appears to be a limited amount of the enzyme that digests starch in the small intestine (amylase), and the amount varies among individuals. By itself, that does not pose a problem for starch digestion because if there is any starch left in the digesta when entering the cecum there are microbes that will ferment it.

The problem lies in that the end product of fermentation of starch and sugar is lactate, which can have a significant effect on the pH of the cecum. If high levels of starch are fed, the subsequent drop in pH in the cecum may affect the balance of the fiber-digesting microbial population, thus upsetting the ability of the horse to get calories from the fiber. This is referred to as "hindgut acidosis." It is this effect of large grain meals on hindgut pH that is the basis for the recommendation of never feeding more than five pounds of grain per feeding. However, it appears that the amount of starch that escapes digestion in the small intestine can be variable enough to make certain individuals much more susceptible to hindgut acidosis. Signs of hindgut acidosis are subtle but can be a cause for poor performance, sour attitude, or intermittent mild colic.

Tolerance to high amounts of starch can be quite variable from one individual to the next because of how well their body digests the starch and how it handles the cycles of glucose and insulin once the starch is digested. Finding the level of starch and sugar that an individual can handle may require considerable trial and error. Switching to a low-starch feed has made a difference in the attitude and performance of many horses. Trying to avoid starch completely may not be appropriate for every horse, and high-level performance horses cannot get enough calories out of a fiber-only diet to be able to maintain their weight or have sufficient energy for athletic endeavors.

How low is low-starch?

At this time, feed manufacturers can put "low-starch" on a bag without having to correlate it to a number or define exactly what they mean. Because of liberal use of the terminology, legislation may be forthcoming that may assign actual numbers in order for a horse feed to be classified as low starch.

A low-starch feed does not contain a high concentration of cereal grain. But if there is little grain in the feed, then something else must be used to provide the calories. This is where fiber and fat come in. This relationship can be useful when trying to decipher a feed tag: the lower the starch, the higher the fiber and fat. Another number that is often mentioned as an indicator of starch and sugar is nonstructural carbohydrates (NSC). Finding the NSC value of the feed may require a call to the feed manufacturer. Approximate indicators of starch levels may be as follows: high, NSC >35%; relatively low, NSC =35-20%; and low, NSC <20%. When looking at the ingredients, a low-starch feed will have little to no grains like corn, oats, or barley, and when present may be near the end of the ingredient list. Fiber ingredients that may be at the top of the

list could be soyhulls, beet pulp, and alfalfa meal. Rice bran is a high-fat/high-fiber ingredient found in many low-starch feeds.

What horses benefit from high-fiber/low-starch diets?

Horses involved in various disciplines and of any breed may benefit from a low-starch diet, depending on the individual. Horses that are easily excitable, fractious to handle, obese, insulin resistant, or diagnosed with muscle disorders or hindgut acidosis are all obvious candidates. Trying to get the horse back to a physiologically rationale diet is also reason enough to switch. Not only will the horse benefit but also the rider and handler because many times a noticeable difference will be noted in performance and/or demeanor.

Low-starch feeds may not be the right fit for all horses. The caveat with high-fiber/low-starch feeds is that there are some horses that cannot hold their weight well and need the extra punch from starches. Other horses might hold their weight fine but lack any energy when asked to perform. Further, the raw materials used in making commercial high-fiber/high-fat feeds are more expensive than common grains, so switching a horse to a high-fiber/high-fat feed may be more costly.

If low-starch, high- fiber/high-fat feeds are the right solution for the horse, then the benefits on the health and well-being of the animal outweigh any of the cost issues. These types of feeds are steadily taking a larger percentage of the horse feed market and are surely here to stay as a viable option for feeding horses.