



Confusion About Carbs

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Tips for feeding Starch Safely:

- 1) *Slowly increase the amount of grain you offer (allow 3 days of adjustment for every 1 pound you add).*
- 2) *Feed no more than 5 pounds of grain (for a 1000-lb horse) at a single feeding. Smaller, more frequent meals are always best.*
- 3) *Select products that have a higher level of oats than corn or products that include processed grains, like cracked corn, steam flaked corn or rolled barley.*
- 4) *Give your horse 2 weeks to adjust to a new brand of feed (gradually blend the new feed in with the old feed).*
- 5) *Cut back on the grain if your horse's level of activity changes, either due to a lay-up or a reduction in training.*

Whether it's our diet, or that of our horses, we seem to be obsessed with carbohydrates lately. Low carb feeds, reduced starch feeds, and "controlled energy" products have flooded feed stores, making the choice of what to feed your horse more complicated than ever. Are carbohydrates really that bad? It depends on which carbohydrate you're talking about. It also depends on how much is fed and to what type of horse.

Some carbohydrates have been linked with digestive disturbances leading to colic and laminitis. Certain carbohydrates can also exacerbate diseases, such as insulin resistance, Cushing's disease, and polysaccharide storage myopathy (PSSM). Most horses, however, do not experience problems with reasonable levels of starch and sugar in their ration (see Tips at left). And some horses, particularly those that compete in high intensity activities, need starch in their diet to perform well.

To help you better understand the role of carbohydrates in the equine diet, this article will describe the different types of carbohydrates in feeds and how they are processed in the horse's digestive system. In addition, key carbohydrates that can impact horses with digestive or metabolic conditions will be discussed.

Sources of Carbs

As an herbivore, the horse is built to process high fiber roughages. Although **fiber** is often discounted as "fill," it is an important carbohydrate. Forages, including pasture and hay, provide fiber that serves as a key source of energy for the horse. Fiber is also needed to maintain gut health and motility. Therefore, fiber is one carbohydrate no horse can do without.

Another major class of carbohydrates is **sugar**. The term "sugar" usually refers to monosaccharides, such as glucose, as well as disaccharides, such as sucrose (a glucose unit hooked to a fructose, best known to us as table sugar). Sources of sugar in the horse's diet include molasses and cereal grains, such as oats and corn; but they can also be present in forages, particularly in lush spring and early summer pasture.

Starches are also carbohydrates. Starches are made up of very long chains of individual glucose units. Cereal grains are the richest source of starch in the horse's diet. Legumes such as alfalfa and perennial peanut, as well as warm season grasses, such as bahia and Coastal or Tifton-85 bermudagrass also contain some starch.

How the Horse Processes Carbs

Sugars and starches are digested by enzymes in the horse's small intestine (see Figure 1). Because they are small, sugars are rapidly digested and absorbed in the small intestine. By comparison, digestion of starches is not quite as simple. The starch contained in oats, for example, is more available for enzymatic digestion in the small intestine than the starch found in corn and barley. Some of the starch in corn and barley may escape digestion in the small intestine and be transported to the large intestine.

When starch enters the large intestine—regardless if it originates from hay, oats or corn—it is rapidly fermented by microorganisms to lactic acid (Figure 1). If significant quantities of starch are fermented in the hindgut, the lactic acid can wreak havoc, resulting in colic and laminitis.

The amount of starch bypassing the small intestine and reaching the hindgut can also be affected by meal size. Grain meals larger than 0.5% of the horse's body weight (e.g., 5 pounds for a 1000-pound horse) can exceed the small intestine's ability to process the starch contained in the grains. Such large meals result in more starch flowing back into the large intestine where it can be rapidly fermented to lactic acid.

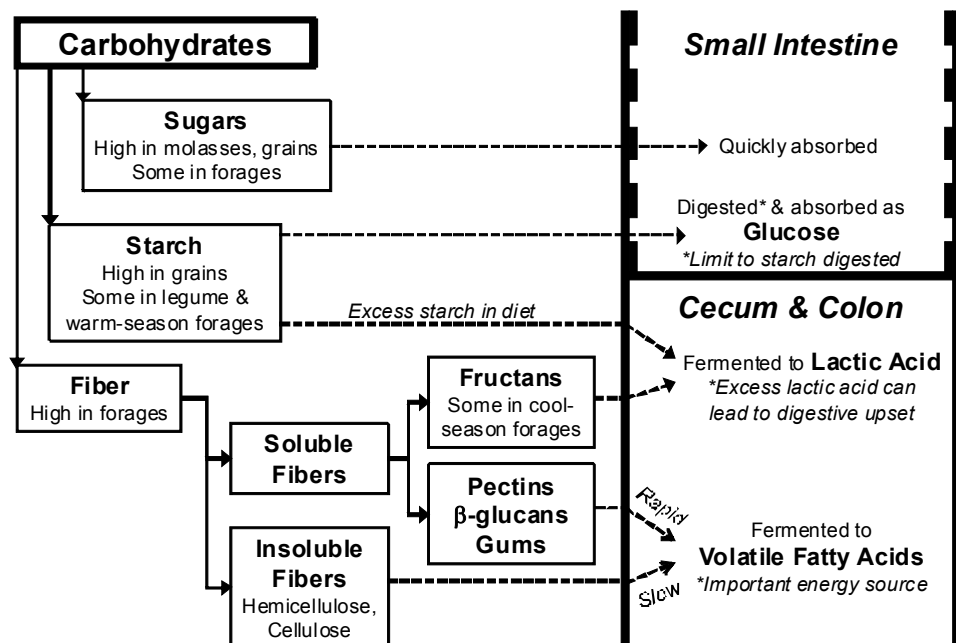
Processing of cereal grains can also influence starch digestion. Cracking, flaking or rolling oats,

corn and barley disrupts the tougher outer shell of the grain, exposing more of the starch to enzymes in the small intestine. In addition, the heat generated during the pelleting and extruding of some feeds will gelatinize the starch, making it easier for the horse to digest in the small intestine and allowing less to escape into the hindgut.

When sugars and starches are digested in the small intestine, the resulting glucose and fructose are absorbed into the bloodstream. These sugars can be used as an immediate energy source, or repackaged and stored as muscle and liver glycogen or fat for use at a later time. The hormone insulin, which is produced by the pancreas in response to elevated blood glucose, drives this process.

The cycle of increased blood glucose, followed by an increase in insulin production is referred to as the glycemic response. Feeds that are more rapidly digested and absorbed as glucose produce a greater glycemic response. Insulin is not produced in response to the absorption of volatile fatty acids from fiber digestion. Therefore, feeds that contain a higher level of sugar and starch yield a higher glycemic response than those that contain larger quantities of fiber. Large fluctuations in the glycemic response should be avoided in horses with carbohydrate-sensitive metabolic conditions, such as insulin resistance, Cushing's disease and PSSM.

Figure 1: Types of carbohydrates and their digestion and absorption in the horse.



In contrast to sugars and starches, fiber cannot be digested directly by the horse. Instead, billions of bacteria and fungi that reside in the horse's large intestine digest the fiber for the horse (Figure 1). In return, the microbes produce volatile fatty acids that can be absorbed by the horse and used as a source of energy.

However, just like starches, not all fiber is the same. Some fibers, including hemicellulose and cellulose, are insoluble and more slowly fermented. Other fibers are soluble and are more rapidly broken down by microbes (Figure 1).

Of the fibers that are more rapidly broken down, some are good while others put the horse at risk for digestive disturbances. More specifically, pectins contained in beet pulp, soy hulls and alfalfa are good fibers that are converted by microbes into volatile fatty acids (similarly to slowly fermented fibers, just at a more rapid pace) (Figure 1).

In contrast, fructans present in cool season grasses, such as timothy, orchardgrass and fescue, are fibers that are rapidly fermented to lactic acid by microbes in the large intestine (Figure 1). The amount of lactic acid produced is proportional to the fructan content. In most cases, fructan levels are not significant enough to cause problems in healthy horses. However, when these grasses are rapidly growing or stressed by drought or frost, fructan levels can accumulate and may cause laminitis in susceptible horses. It is worth noting that warm-season grasses, including bahia and Coastal and Tifton-85 bermudagrasses, store carbohydrates as starch, not fructans.

Measuring Carbohydrates in Feeds

Carbohydrates are a very complex class of chemicals, making it difficult to separate and measure each specific carbohydrate fraction in the laboratory. Instead, we have to rely on values found by subtracting one measurable fraction of carbohydrate from another, as well as our knowledge of feeds and the digestive process.

Historically, the term “non-structural carbohydrates” (or **NSC**) has been used to describe the starch and sugar content of feeds. Although it varies by laboratory, NSC is determined by measuring the starch in a feed and adding this value to the water soluble carbohydrate content of the feed. Water soluble carbohydrates (**WSC**) are determined by soaking the feed and measuring the carbohydrates that become suspended in water. Water soluble carbohydrates include sugars, but they also include fructans. These carbohydrates are digested in different parts of the digestive tract (sugars in the small intestine, fructans in the cecum and colon); therefore, they can affect a horse's blood sugar and gastrointestinal health differently.

For example, say you are comparing two different hays. One has 10% sugar/starch and 5% fructan. The other has 5% sugar/starch and 10% fructan. Although they both have the same NSC (15%), they are not the same hay. The hay with 10% fructan could be more of a problem with a laminitic horse. In contrast, the hay with 10% sugar/starch would be more of a concern for an insulin-resistant horse, because sugar and starch cause a greater glycemic response than fibers like fructan.

Table 1: Carbohydrate Fractions in Common Feeds Fed to Horses

Feed	% WSC	% ESC	% Starch	% NSC
Molasses	53	52	1.0	60
Oats	3	3	44	49
Corn, steam flaked	2	2.5	73	75
Wheat midds	8	6	26	33
Legume hay	9	7	2	11
Timothy, orchard hays	11	8	2.5	13
Bermudagrass hay	7.5	8	6	13
Pasture – bahiagrass	5	5	1	6
Beet pulp (molassed)	10	11	1.5	12
Soybean hulls	4	1.5	2	6

Because of the limitations of NSC, most nutritionists are moving away from this value and are instead evaluating feeds based on the starch, WSC and ethanol soluble carbohydrate contents. Ethanol soluble carbohydrates (**ESC**) are a subset of WSC that do not include fructans. Fructan content can be estimated by subtracting ESC from WSC. Ultimately, these three fractions can be used to compare feeds for horses with different carbohydrate-related needs (Table 1).

- ★ For horses with **insulin resistance, Cushing's disease, or PSSM**—all of which can't tolerate large swings in blood sugar—you should select feeds that are low in starch and ESC. This implies there will be less carbohydrate digested and absorbed from the small intestine, which produces a lower glycemic response.
- ★ For horses with a **history of diet-related laminitis**, you should select feeds that are low in starch and WSC. The less starch and fructans (a component of WSC) reaching the hindgut should mean less opportunity for excessive fermentation and large intestinal disturbances that could trigger laminitis.

Conclusions about Carbohydrates

An understanding of the different types of carbohydrates and where they are digested along the digestive tract can be extremely useful for making decisions on what feeds to select for a particular horse. This information is even more essential when managing a horse with laminitis, insulin resistance, PSSM, or Cushing's disease.

Unfortunately, at the present time there is no satisfactory, commercially available analytical method to segment carbohydrates into categories that are physiologically meaningful to the horse. Furthermore, although we know some horses are more sensitive to some carbohydrates, defining what is meant by a "low" level of starch or "low" level of water or ethanol soluble carbohydrate is difficult. This is because the amount of starch, sugar and fructans required (or tolerated) by horses with carbohydrate-related digestive and metabolic problems has not been researched. Also, it is likely that sensitivity to different carbohydrates varies with the individual horse.

Some Horses Need Starch



Starch should be limited in the diet of horses with a history of laminitis or those diagnosed with insulin resistance, Cushing's disease and PSSM. But for the vast majority of the horse population, starch is not an enemy. In fact, some horses will truly benefit from having starch in their diet.

Glycogen stored in the liver and muscle is an important source of energy for muscles during exercise. Research has shown that horses that begin a bout of exercise with low to moderate levels of glycogen will fatigue easier than those who start with a full measure of glycogen. A horse that tires more quickly can lose a race, nick a rail going over a jump, or take a misstep and strain a tendon.

Glycogen itself is a carbohydrate and can only be made from carbohydrates provided in the diet. The best source of dietary carbohydrate to make glycogen comes from the starch in grains like oats, corn and barley.

Because glycogen is an important energy reserve, horses that compete in activities that rely heavily on glycogen need starch to replenish their glycogen stores after exercise. Such horses include racehorses, horses used for timed events like barrel racing and roping, three-day event horses and other sports where bursts of high speed or power are required. In addition, horses that are ridden fairly heavily and frequently, such as a heavily campaigned jumper or a reliable lesson horse may also benefit from being fed a traditional grain mix higher in starch.

If you have a performance horse or just simply prefer to feed a traditional grain mix or sweet feed, the safety of feeding the relatively high level of starch in these products can be improved in several ways. Refer to the "Tips for Feeding Starch Safely" at the beginning of this article.