

Sugar Content in Feed and Forage Affects Horses Health

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Quick Facts...

- Carbohydrates/sugars play an important role in equine health.
- Sugar and starch are absorbed in the upper intestine - fructan has to be fermented in the lower digestive tract (hindgut).
- Feed can be tested for sugar levels. Consult a veterinarian or nutritional consultant to determine the right sugar levels for your horse.
- Feed testing facilities can provide instructions on proper sampling and recommended procedures to send samples to the lab.
- Different environmental conditions raise the level of fructan in pasture grass

Main Article

There has been much written about sugar levels in feeds and forages because they play an important role in equine health. Some would describe low sugar feeds as “low-carbohydrate” feeds. Actually, there is no horse feed that is low in “carbs” because the fiber in forage/hay is carbohydrate in nature. Fiber is made up of complex carbohydrates and the horse’s digestive system needs it to function properly. Feeds vary in sugar and starch content - the “high sugar feeds” can be detrimental to horses because they:

- disrupt normal digestion,
- exacerbate certain medical conditions, and
- lead to serious complications like colic and laminitis – two serious conditions that can strike any horse.

Carbohydrates can be classified into three categories: simple sugars, starches, and complex carbohydrates.

1. Simple sugars are a one-sugar unit that is readily and rapidly digested in the upper intestine.
2. Starches are a small group of sugar units connected together that quickly digest and absorb in the upper intestine.
3. Complex carbohydrates are made up of sugar units connected together that cannot be digested and absorbed from the upper intestinal tract. They must be fermented by bacteria and protozoa in the lower digestive tract or “hindgut.” (cecum, dorsal colon, and ventral colon).

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One important complex carbohydrate in equine feeds is fructan. It is a non-structural carbohydrate (NSC), like simple sugars and starches, but is different than sugar and starch because it must be fermented in the hindgut like other “fiber-type” complex carbohydrates. Fermentation of fructan, other complex carbohydrates, and fiber involves a longer process than sugar and starch. It also requires a delicate balance of the proper population of microorganisms in the hindgut.

Feeds will vary greatly in their sugar, starch, and fructan levels. To view multi-year averages of different carbohydrate levels in different feeds go to www.dairyone.com/Forage/FeedComp/MainLibrary.asp. Click the “OK” to the Summary Statement and then click on “Main Library.”

Fructan is commonly found in certain types of grasses and hays, and the content varies immensely. Fructan is a type of carbohydrate that plants accumulate and store for energy. It can be found in high levels in cool-season grasses and hay made from these grasses. Cool-season grasses like timothy, orchard grass, brome, and ryegrass predominate in horse pastures and hay fields.

Normal Digestive Physiology – It Takes “Guts” and the Right Kind of “Carbs”

Horses’ digestive physiology works best when the horse eats frequently and mostly on forage or hay. For most horses, little or no grain/concentrate is needed if they are on a good quality forage/hay. Yet because of the physical demands humans have placed on performance horses – grains and concentrates are fed to horses. If you talk to the horsemen of years gone by – they will tell you that when their horses were working on the farm, they fed them grain through-out the day, not just in the morning and night. When the horsemen worked in the fields with horses and took a break, the horses took a break and this meant another feeding of grain.

Here are some of the important physiological processes of the equine “gut.” As forage/hay is eaten, the feed is chewed and a profuse amount of saliva is produced by the salivary glands. When there is less chewing, less saliva is produced, and less saliva means less buffering of the acids in the stomach. This results in increased bacterial growth in the stomach, increased acid and the possibility of gastric ulcers. On a roughage type of diet, the horse normally produces up to 10 gallons of saliva a day, which has a tremendous capacity to buffer stomach acids. If the stomach becomes more acidic than it should be (it happens on a high grain diet or with infrequent feeding) – gas is produced by bacterial fermentation. The horse is incapable of belching, so the result can be pain, colic, or in severe situations – stomach wall rupture.

Normally, the ingested feed doesn’t stay very long in the stomach – it starts emptying food 15 minutes after a meal. Once it reaches the small intestine, the transit time is slightly longer – it takes a ½ hour to 1 ½ hours to make it to the cecum, which is the start of the “hindgut.” To travel through the “hindgut” feed can take up to three days. It is important for ingested feed to spend the majority of the time in the hindgut. If ingesta moves through faster than normal, proper digestion and fermentation does not happen and there are serious consequences – the most serious being laminitis and colic.

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Differences between Digestion and Fermentation

There are huge differences in function between the small intestine and the hindgut. The majority of the digestion and absorption of sugar, starch, protein, and fats takes place in the small intestine. In the small intestine, absorption of sugars occurs through enzymatic action. In the hindgut, fermentation brings about breakdown of the fiber into digestive derivatives called volatile fatty acids that the body can use for metabolism. This process within the hindgut gives the horse the capability to digest the complex carbohydrates and fiber found in grass and hay. But the microflora in the hindgut responsible for fermentation are sensitive to changes in diet. An overload of high-sugar type feeds or high levels of fructan can upset the normal population of bacteria and protozoa - changing the environment within the hindgut that causes a cascade of problems.

Detrimental Effects of Feeding High Sugar / High Starch Feeds

Typically, grain and concentrate type of rations are higher in sugar and starch than forages. When horses are on a ration or diet that has a high sugar and starch content, it can have dramatic effects on the digestive physiology such as:

- There is less chewing, less saliva produced, more acidic contents in the stomach – possibly more gas or development of gastric ulcers.
- The ingested feed moves faster through the small intestine - more sugar/starch substrate enters the hindgut upon which abnormal bacteria feed and proliferate.
- The bacteria that feed on sugar and starch grow rapidly causing normal gut bacteria to die, bringing about inflammatory changes in the gut, and the dying bacteria give off endotoxins that are absorbed into the bloodstream. This can potentially lead to laminitis. These changes can result in abdominal pain, inflammatory disease, and digestive upset. Thus colic is another possible consequence.
- The sugar and starch is absorbed rapidly from the small intestine, resulting in an elevated blood glucose level and a subsequent increase in insulin in the blood.

Therefore, three serious problems that occur from ingestion of high-sugar/high starch feeds are: laminitis, colic and insulin resistance.

The body normally produces insulin from the pancreas and it is secreted in response to high blood sugar (which occurs after eating and absorbing sugar and starch). Insulin is used to help the cells use the sugar that is circulating in the blood – it helps transport sugar from the blood into the cells where it is used. In a condition called insulin resistance, the affected horse has a high blood sugar level from sugar and starch digestion. A resulting high insulin level occurs and persists because the body's cells are not responding to the insulin. Therefore, the cells are not able to transport the sugar from the blood into the cells – it could be likened in some respects to Type II diabetes in humans. The insulin is there but there is an abnormal lack of response to it.

The body's resistance to insulin can also be involved in laminitis in that the resultant high levels of insulin may cause a decreased blood flow to the hoof and/or the high insulin may affect the uptake of blood

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sugar into the laminae of the foot. The resulting effect of either is a cascading set of events that result in laminitis or a painful breakdown in the bond between the hoof and the underlying bone.

Other medical conditions that are very sensitive to sugar and starch levels in the feed are:

- Gastric Ulcers
- Cushings Disease
- Equine Metabolic Syndrome
- Osteochondritis dissecans (OCD)
- “Tying-up” syndromes like Polysaccharide Storage Myopathy and Exertional Rhabdomyolysis

Detrimental Effects of Feeding High Fructan Forage or Hay

As mentioned above, fructan is a complex carbohydrate and is not like simple sugars or starch. Typically forages or hay are higher in fructan than a grain-based feed. A feed can be low in sugar and/or starch but if it has a large amount of fructan, problems occur in the hindgut. Remember that most of the fructan is fermented in the hindgut.

- When excessive fructan arrives at the cecum and large colon (hindgut), the bacterial flora is overwhelmed, the normal gut bacteria can die, increased levels of the digestive derivatives from fructan called volatile fatty acids are formed and this can cause digestive upset and colic.
- When abrupt changes like this occur in the bacterial flora, the results can be local inflammation in the hindgut, endotoxins from the dying bacteria in the gut are released, and laminitis can be one of the outcomes.

Best Horse Feeding Practices

It is best to feed horses only small amounts of high sugar/starch feeds (grains and concentrates) in frequent feedings – this will provide for optimal equine digestion and fewer medical problems. This may run counter to the schedules of many current horse owners. It may be hard to divide grain feedings into three to four feedings per day but this is what is best for the horse’s digestive system.

Insulin resistance is treated and prevented mainly by nutritional changes and exercise. The insulin resistant horse should not be on any grain or high concentrate feed and they may need to be taken off pasture grass completely and only fed hay that is low in sugars and starch. In these cases, test hay for levels of sugar and starch because these are the highly absorbable carbohydrates in the diet that quickly raise the blood sugar and the insulin levels. A proper hay would be a prairie hay or a second or third cutting of alfalfa hay processed after the bloom stage. But you cannot tell the sugar content by type of hay or a particular cutting of hay. It should be tested. Even the new Nutritional Requirements of Horses published by the National Research Council (NRC) does not give us a definitive value. Current thought is that a safe sugar content for sensitive horses is 10 percent or less. (Genrick et al.)

Feeds can be classified according to their “glycemic index”, which is an indicator of how a particular feed will elevate the blood sugar level and the subsequent blood insulin level after consuming it. The elevated blood sugar and resulting insulin is called the glycemic response. Horses with insulin resistance should

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be on a low, glycaemic index feed because they have an abnormal glycaemic response after eating feeds that are high in sugar and/or starch.

In a recent study (Rodiek and Stull 2007), glycaemic index values were determined for 10 feeds. A high index value predicts a high blood sugar response to this feed. They are listed from highest to lower:

- Sweet feed
- Corn
- Jockey oats
- Oats
- Barley

In contrast, the following were shown to have lower glycaemic index values (A low index value predicts a low blood sugar response to this feed). They are ranked from mid-range to lowest:

- Wheat bran
- Beet pulp
- Alfalfa
- Rice bran
- Soybean hulls

Fructan will be at a higher level in the plant at different times of the season and at different times of the day. It will be higher in plants in these situations:

- after a very sunny day – photosynthesis produces a greater quantity
- after a period of stress whether it is nutritional or from drought
- after cool evening temperatures – below 40 degrees Fahrenheit
- after quick and rapid drying of cut grass and hay

Good Grazing Management

Good grazing management will lower the consumption of fructan and reduce the incidence of colic and laminitis. Good practices should include:

- Limit grazing on high fructan grasses – less than one hour a day for susceptible horses.
- Use grazing muzzles when necessary.
- Don't overgraze pastures – fructan is higher in the lower few inches of the plant (Watts and Chatterton 2004).
- Fructan is lower on fertilized fields - the plant is less stressed, less fructan.
- Graze early morning – fructan is higher in afternoon/evening after a sunny day
- After a sunny day and a cool night, limit grazing in the morning – the plant has not used up its energy store of fructan during the night

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Resources

- Cuddeford, D, (2002). Sugar is bad for my horse, isn't it? *Journal of Equine Veterinary Science* 22, p. 89.
- Downing, T., Gamroth, M., (2007). Nonstructural Carbohydrates in Cool-season Grasses. Oregon State University Extension Service, Special Report 1079-E, November 2007.
- Frank, Nicholas (2006). Insulin Resistance in Horses. *AAEP Proceedings*. 52, 51-54.
- Frape, David, (1998) *Equine Nutrition and Feeding* (3rd ed.). Ames, Iowa: Blackwell Publishing Professional.
- Genrick, R., Duncanson, A., Assurance Feeds, Valberg, S. Low Sugar Hay and Pasture. University of Minnesota Extension. www.extension.umn.edu/forages/pdfs/Low_sugar_hay_and_pastures.pdf
- Kronfeld, D. (2005). Glycemic index, insulin signaling, exercise, and EGAD. *Journal of Equine Veterinary Science*. 25, 484-487.
- Lawrence, Larry; Valberg, Stephanie (2007) Spring Pasture, Fructans, and Founder. *University of Minnesota Horse Newsletter*, Volume 3, Issue 4, April 2007.
- Longland, A.C., Byrd, B.M. (2006). Pasture Nonstructural Carbohydrates and Equine Laminitis. *American Society for Nutrition, The WALTHAM International Nutritional Symposia* 2099S-2101S.
- Longland, A.C., Cairns, A.J. (2000). Laminitis – Fructans and Their Implications in the Aetiology of Laminitis. Institute of Grassland and Environmental Research, Plas Gogerddan, Aberystwyth Sy23 3EB Retrieved April 23, 2007. members.aol.com/wdds1/horsetalk/dh-sci1lam.htm
- Merritt, A.M. (2003). The Equine Stomach: A Personal Perspective (1963-2003). *AAEP Proceedings* 49, 75-101.
- McClure, Scott R., Murray, Michael J., Carithers, Douglas, Gross, Sheila J., Holste, John E. (2005). Gastric Ulceration in Horses Exposed to Training and Activities Typical for Recreational Showing. *AAEP Proceedings* 51, 55-57).
- Powell, Debra M. (n.d.). The Equine Low Carb Craze. The Ohio State University Agricultural Technical Institute. Retrieved April 23, 2007 from www.ati.osu.edu/equine_center_news.html
- Rodiek, Anne V., Stall, Carolyn L. (2007). Glycemic Index of Ten Common Horse Feeds. *Journal of Equine Veterinary Science* 27, 205-211
- Watts, Kathryn A., Chatterton, N. Jerry (2004). A Review of Factors Affecting Carbohydrate Levels in Forage. *Journal of Equine Veterinary Science* 24, 84-86
- Watts, Kathryn A. (2005). A Review of Unlikely Sources of Excess Carbohydrate in Equine Diets. *Journal of Equine Veterinary Science* 25, 338-344
- West, Christie (2007). Changing Carbohydrate Evaluations in Animal Diets. Article 9380, *The Horse.Com*. Retrieved April 23, 2007 from www.thehorse.com/ViewArticle.aspx?ID=9380

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