Carbohydrates important part of equine feeds

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By **JOE D. PAGAN***

CARBOHYDRATES are extremely important for horses because they comprise the majority of the dry matter and supply most of the energy in common equine rations. There are different types of carbohydrates in horse feed, and they vary considerably in their digestibility and utilization.

Recent research has shown that the source of carbohydrate may have a profound effect on performance and may also play an important role in the etiology of several equine diseases. Unfortunately, there is a great deal of confusion about how to characterize the composition of carbohydrates in equine feeds to reflect their functional significance.

The carbohydrates in equine feeds can be categorized by either their function in the plant or from the way they are digested and utilized by the horse. From a plant perspective, carbohydrates fall into three categories: (1) simple sugars active in plant intermediary metabolism, (2) storage compounds such as sucrose, starch and fructans and (3) structural carbohydrates such as pectin, cellulose and hemicellulose.

For the horse, it is more appropriate to classify carbohydrates by where and how quickly they are digested and absorbed. Carbohydrates can either be digested and/or absorbed as monosaccharides (primarily glucose and fructose) in the small intestine, or they can be fermented in the large intestine to produce volatile fatty acids or lactic acid.

The rate of fermentation and types of end products produced are quite variable and can have significant effects on the health and well-being of the horse.

A physiologically relevant system to categorize carbohydrates in equine diets would be:

(1) A hydrolyzable group (CHO-H) measured by direct analysis that yields sugars (mainly glucose) for metabolism. This includes simple sugars, sucrose and some starches that are readily digested in the small intestine and produce fluctuations in blood glucose post-feeding.

(2) A rapidly fermentable group ($CHO\text{-}F_R$) that yields primarily lactate and propionate. This group includes starches that escape digestion in the small intestine as well as galactans, fructans, gums, mucilages and pectin.

(3) A slowly fermentable group ($CHO\text{-}F_S$) that yields mostly acetate and butyrate. This group includes the compounds captured in neutral detergent fiber (NDF) such as cellulose, hemicellulose and lignocellulose.

Hydrolyzable carbohydrates (CHO-H) are an important component of equine diets, particularly for the performance horse, where blood glucose serves as a major substrate for muscle glycogen synthesis.

Too much blood glucose, however, may contribute to or aggravate problems in horses, including recurrent equine rhabdomyolysis, polysaccharide storage myopathy, Cushing's syndrome and developmental orthopedic disease. It may also adversely affect behavior in certain individuals.

The quantity of blood glucose produced in response to a meal is a useful measure of a feed's CHO-H content.

Table 1 contains the glycemic response of several equine feeds measured at Kentucky Equine Research (KER). When expressed as a percentage of a reference material, in this case oats, these measurements are often termed glycemic indexes.

Rapidly fermentable carbohydrates ($CHO\text{-}F_R$) such as pectin can yield propionate, which is an important gluconeogenic substrate for the horse. However, rapid fermentation can also produce lactic acid, which may lead to a cascade of events culminating in laminitis. Undigested starch from cereals and fructans from pasture are the most likely compounds contributing to lactic acidosis in the hindgut.

Slowly fermentable carbohydrates ($CHO\text{-}F_S$) from the plant cell wall are absolutely essential to maintain a healthy microbial environment in the horse. These carbohydrates alone, however, may not be able to supply enough energy to fuel a high-performance athlete.

Carbohydrates in horse feeds have traditionally been estimated by measuring cell wall components as NDF and calculating the remaining carbohydrate by difference as non-fiber carbohydrate (NFC), where NFC = 100 - water - protein - fat - ash - NDF.

More recently, laboratories have provided a direct analysis of additional carbohydrates in equine feeds. Table 2 contains the chemical composition of several common equine feedstuffs as analyzed by Equi-

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Feedstuffs presents equine column

***FEEDSTUFFS* is pleased to introduce a new equine column written by Dr. Joe Pagan, president and founder of Kentucky Equine Nutrition Inc.**

Pagan (pictured) received his bachelor's degree in animal nutrition from the University of Arkansas and master's and doctorate degrees in equine nutrition and exercise physiology from Cornell University. He formed Kentucky Equine Research in 1988 to be an international research, consulting and product development firm dealing in the areas of equine nutrition and sports medicine.

The column will appear four times each year.

analytical Laboratories in Ithaca, N.Y. In addition to NDF and the calculated values of NFC, Table 2 contains measured levels of water-soluble sugars (WSS) and starch. The sum of WSS and starch is considered the non-structural carbohydrate (NSC).

WSS in cereal grains and byproducts such as beet pulp are composed of simple sugars that produce a pronounced glycemic response and fit into the CHO-H category. By contrast, much of the WSS in temperate grasses are actually fructans, which should be included in the CHO-F_R fraction. Therefore, they would have little effect on glycemic response but may contribute to the development of hindgut acidosis and laminitis.

Starch is the predominant carbohydrate fraction in cereal grains. Although all starch is made up of glucose chains, how the starch molecule is constructed varies in different types of grain. These differences in the architecture of individual starches have a large impact on how well they are digested in the horse's small intestine.

Of the grains most commonly fed to horses, oats contain the most digestible form of starch, followed by sorghum, corn and barley. Processing can have a huge effect on prececal digestibility, particularly in corn. In a KER study, steam flaking corn caused a 48% increase in glycemic response compared to coarse cracking.

NSC is a mixture of CHO-H and CHO-F_R fractions. NSC tends to be higher in CHO-H in processed cereal grains and mixes but may be high in CHO-F_R in certain unprocessed cereals or high-fructan forages.

NFC represents an even more mixed group of carbohydrates because in addition to the compounds found in NSCs, they may also contain significant quantities of pectin and other fermentable compounds not captured in NDF. For instance, beet pulp contains only 12.1% NSC but 44.4% NFC.

In summary, the types and amounts of carbohydrates in equine feeds are important. At present, there is no satisfactory, commercially available analytical method to segment carbohydrates into categories that are physiologically meaningful for the horse.

1. Glycemic response and glycemic index of different feeds relative to oats

Feed	Glycemic response (AUC, mg/minute/dL)	Glycemic index
Sweet feed	2,073	129
Whole oats	1,602	100
Cracked corn	1,438	90
Fiber mix	1,378	86
Sweet feed + 10% corn oil	898	56
Alfalfa hay	733	46

2. Carbohydrate content of some common equine feeds

	Oats	Corn	Beef pulp	Soy hulls	Legume hay	Grass hay
WSS	3.9	3.5	10.6	3.6	9.0	10.7
Starch	44.3	70.5	1.3	1.7	2.4	2.8
NSC	50.7	73.1	12.1	5.3	11.4	13.3
NFC	50.9	76.4	44.4	19.8	30.8	19.5
NDF	27.9	9.8	41.9	61.7	38.5	63.8