Fiber Digestion in Horses

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Role of Forage

Horses have evolved as herbivores, which means they rely on forages to supply their nutrient requirements. Although there are a few exceptions, (i.e., high level performance horses) most horses can fulfill their nutrient requirements on a 100% forage diet. In addition to providing nutrition, forages also play an important role in gastrointestinal health of the horse, helping maintain normal gastrointestinal motility and function.

Digestion of Fiber

While forages provide a variety of nutrients (protein, vitamins, and minerals), they are a particularly important source of energy for the horse. Most of the energy found in forage comes from the digestion of carbohydrates. Forages are composed of several types of carbohydrates that can be divided roughly into two categories: nonstructural carbohydrates and structural carbohydrates. Nonstructural carbohydrates include simple sugars, starch, and fructans, and can be easily digested by enzymes produced in the stomach and small intestines of the horse. The primary structural carbohydrates, which constitute the fibrous portion of plant material, include cellulose, hemicellulose, and lignin. These fibrous carbohydrates play an important role in providing plants with their structural rigidity. However, this also makes them difficult to digest. Because of their complex chemical arrangements, these structural carbohydrates must be broken down into simpler forms to be absorbed by the gut. Unfortunately, the horse does not produce the necessary enzymes to break down and digest these complex molecules. Instead, the horse relies on microbes in the hindgut to excrete the enzymes necessary to break down these carbohydrates. While the microbes utilize the fiber to supply their own nutrient requirements, they produce volatile fatty acids that can be absorbed in the hindgut and utilized by the horse. Volatile fatty acids can provide a significant proportion of the horse's digestible energy requirements; fermentation in the cecum (one portion of the hindgut) alone can supply up to 30% of the required digestible energy.

It should be noted that microbes are found throughout the length of the gastrointestinal tract of the horse, and not all are responsible for fiber digestion. Other types of microbes assist in the degradation of nonstructural carbohydrates, fats, and proteins found in feedstuffs. Many of these microbes are found in the highest numbers in the stomach and small intestine. However, because of the horse's inability to break down structural carbohydrates on its own, the fiber digesting microbes found in the hindgut play a critical role in the digestive process.

Digestibility

Many of the nutrients in forages must be released from the plant material via digestion before they can be absorbed and utilized. Digestibility is used to describe how easily a feedstuff is digested or broken down. Highly digestible feedstuffs are easily broken down, while those of lower digestibility are more difficult to digest. Digestibility is important because it gives an idea of how available the plant's nutrients are for absorption. For example, two forages may contain the same amount of nutrients, however, if one is less digestible, the nutrients will remain bound in the plant material, unavailable for absorption, and will be excreted in the manure. The table shows the digestibility estimates of several forages commonly fed to horses.

Table. Composition and digestibility of forages commonly fed to horses.[1]

	Forages	Fiber Composition		Digestibility of NDF (%)	Digestibility of ADF (%)
		NDF (%)	ADF (%)		
More Digestible ↓ Less Digestible	Alfalfa Hay (mid-bloom)[2]	55	43	47	45
	Timothy Hay[3]	63	35	55	42
	Kentucky Bluegrass Hay[4]	73	46	51	40
	Tall Fescue Hay[2]	72	40	44	37
	Bromegrass Hay[4]	60	36	44	29
	Reed Canarygrass Hay[3]	65	34	38	24

[1]Values reported are estimates published in individual studies and are provided as examples. Estimates of digestibility are dependent upon several factors, including: forage species, chemical composition, maturity, particle size, and retention time, to name a few.
[2]Crozier et al., 1997; [3]Ordakowski-Burk et al., 2006; [4]Cymbaluk, 1990.

One factor that can determine how easily a feedstuff is digested is fiber, or structural carbohydrate, content. Not all fibrous carbohydrates are digested with the same efficiency. Hemicelllulose is more readily digested than cellulose, while lignin is completely indigestible by both the horse and microbes. Structural carbohydrate content is typically estimated using procedures for NDF or ADF. NDF measures hemicellulose, cellulose, and lignin, while ADF measures cellulose and lignin. Hemicellulose

is calculated as the difference between NDF and ADF. Grass species tend to have a higher proportion of hemicellulose than legumes. For example, at a similar stage of maturity, grass hay contains approximately 58% NDF and 37% ADF, while legume hay contains 43% NDF and 33% ADF (NRC, 2007).

A second factor that determines digestibility is plant maturity. Young vegetative plants are relatively high in readily degradable hemicellulose and low in cellulose and lignin. As plants mature, the proportion of lignin and cellulose increases while the proportion of hemicellulose decreases. The increased level of lignin associated with maturation interferes with the digestion of cellulose and hemicellulose by acting as a physical barrier to microbial enzymes, thereby reducing digestibility. Interestingly, horses are selective grazers, choosing less mature, more vegetative material; this material is also more digestible because of its higher hemicelluloses, lower lignin content.

Conclusions

The digestive system of the horse has been designed to efficiently utilize forages and most horses can fulfill their nutrient requirements on these types of diets. The digestibility of a forage is influenced by a variety of factors and determines the availability of nutrients for absorption by the horse. Carbohydrate composition, as well as maturity, are two plant factors that play a critical role in the digestibility, and subsequent quality of horse diets.