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FORAGE EVALUATION FOR HORSES

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Forages should always be the foundation of the equine diet due to the design of the equine digestive system. The horse is a nonruminant herbivore with a relatively small stomach in relation to body size. The stomach only makes up approximately 9 percent of the horse's gastrointestinal (GI) tract and holds 3 to 5 gallons. Furthermore, the stomach continuously secretes hydrochloric acid, which is an important component in the beginning of the breakdown of feedstuff. Because the horse is designed to be a continuous grazer, the stomach does not need to hold large amounts, and the hydrochloric acid is consistently absorbed and utilized by contents in the stomach. However, if forage is not present in an adequate amount, the acid can start to build up, potentially leading to stomach ulcers. Not only are forages important for gut health, but they can also promote dental health, discourage sterotypical behaviors, and contribute 100 percent of the nutrient requirements for some classes of horses. However, not all forages are created equal, and forage evaluation is an important skill for horse owners and managers to cultivate.

PHYSICAL EVALUATION OF HORSE HAY

Traditionally, color has been believed to indicate the presence or absence of some nutrients, but the evaluation of color can be misleading. The industry preference is for hay to be green in color, which is believed to indicate the presence of vitamin E and beta-carotene (vitamin A). However, the only true evaluation of nutrient presence is through chemical analysis, which is discussed later in this factsheet. If hay is harvested too late or mishandled, the forage will lose its green color due to processes like heating and bleaching. This leads to yellow or brown coloring and indicates reduced-quality hay. When evaluating color, it is important to open the bale and assess the color in the interior of the bale, which can be much different than the exterior. This is also why it is important to properly store hay once it is processed or purchased. Bales stored inside (under cover) retain 92 percent dry matter, bales stored outside on crushed rock retain 85 percent, and bales stored outside on bare ground only retain 76 percent over a 6-month period (Bade & Reeves, Jr., 2002). This indicates that bales are best stored under cover and raised off the ground in a well-draining area.

Texture can be an estimator of forage maturity. There is an inverse relationship between growth and nutrient density in grasses, meaning that as the grass matures and gets taller, the nutrient density and palatability of the grass decreases. This is important for both pasture and hay evaluation because the stage of maturity at which the forage is harvested is a strong indicator of nutrient quality. As grasses mature, they become more "stemmy," or higher in structural carbohydrates (fiber), which also makes them stronger and thicker. Conversely, younger grasses are lower in fiber and have a higher ratio of non-structural carbohydrates that the horse can use to generate energy. Through tactile evaluation of hay, it can be estimated that softer, more pliable hay is of higher nutrient quality. However, not all grasses are created equal. For example, Tifton 85 bermudagrass cut at the same stage as coastal bermudagrass has a lower leaf-to-stem ratio but is actually higher in nutritive value. Again, this leads to the conclusion that chemical analysis is the only sure way to evaluate forage quality.

Odor can signal the presence of toxins like mold in hay. Horses are more susceptible to some toxins than ruminant animals due to the location of fermentative digestion. The horse is a hindgut fermenter, meaning that microbes digest structural carbohydrates (fiber) in the cecum, which is part of the hindgut of the horse.

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Ruminant animals, like cattle, are foregut fermenters, which means any ingested toxins meet the microbes in the rumen, and those microbes can neutralize some toxins. In the horse, any ingested toxins first enter the stomach and then the small intestine, where most nutrient absorption takes place, and the toxin is absorbed into the bloodstream *before* meeting the microbes in the cecum. Furthermore, the horse is incapable of regurgitation, so anything that is ingested, including toxins, must go through the digestive system—it cannot be brought back up. These features make the horse more susceptible to some toxins, and it is important to evaluate horse hay for mold resulting in poor odor, discoloration, white powder, etc., to ensure the hay is safe for horses to consume.

Cleanliness of the hay, meaning it is free from weeds and trash, is also an important consideration when evaluating horse hay. Hay that contains a higher proportion of weeds will be of less quality because weeds are lower in nutrient density and palatability. Further, any trash could pose a risk to horse health. Horses are notoriously curious animals, particularly younger horses, and they could ingest harmful material that cannot be digested or regurgitated, leading to harmful intestinal blockage. Some other things to look out for in hay are feces and insects. Rodent feces, particularly opossum, can carry the protozoan responsible for equine protozoal myeloencephalitis, or EPM. If feeding legumes, such as alfalfa, watch for blister beetles in the hay. When crushed, the blister beetle emits a toxin that causes blisters externally and internally when ingested by animals.

These are methods that can be employed to estimate forage quality, but to make the most sound and economical nutritional decisions for the horse, a chemical analysis of forage quality is necessary.

TAKING AND SUBMITTING A FORAGE SAMPLE

Sampling can be conducted on pasture grasses intended to be cut for hay or used for grazing, or on bales of hay. When sampling pasture grasses, random samples should be taken from 10 to 15 areas within the pasture to be tested. The forage should be cut at normal haying height if the pasture is to be cut and baled, or at normal grazing height if the pasture is to be used for grazing. The samples can then be combined and placed into a paper sack or envelope. The use of plastic bags may lead to inaccurate results.

When sampling bales of hay, a hay probe can be used to get a core sample from round or square bales. When collecting samples, sample from 10 percent of the bales in a single load. Do not combine loads of hay, even if they are different cuttings from the same field or the same cutting from different years. When sampling round bales, the probe should be inserted from the rounded side of the bale to get a balanced sample through all layers of the bale (Fig. 1). Similarly, when sampling square bales, the probe should be inserted at the small end so the sample incorporates several flakes of hay (Fig. 2). Many county extension offices have a hay probe that can be made available for use. If access to a hay probe is not available, then grab samples can be taken. However, be sure to open the bales and take an interior sample.

For more information on taking a hay sample, see the YouTube video, *Feeding Facts - Forage Sampling*.

Several labs in the United States conduct forage testing, including the Texas A&M AgriLife Extension Soil, Water and Forage Testing Laboratory (*https://soiltesting.tamu.edu*). Sample submissions will need to be accompanied by an information/order form indicating what tests are being requested. A near-infrared (NIR) analysis will provide the information needed to make nutritional decisions for horses, but there are many other tests available if more specific or detailed information is necessary. It is very important to also indicate on the form what species the forage will be fed to. The nutrient availability of forage to a horse is much different than for cattle due to the differences in their

Figure 1. Taking a forage sample from a round bale of hay.

Figure 2. Taking a forage sample from a square bale of hay.

digestive processes. Samples can be mailed or dropped off at the lab, and the analysis will be emailed to the customer upon completion.

READING THE FORAGE ANALYSIS

Figure 3 is an example of a forage analysis received from a lab. Upon initial receipt, the analysis can be intimidating, but there are six key components to evaluate. Values are presented as "As Sampled" (or sometimes, "As Fed") and "Dry Matter." Either value can be used to assess forage quality. However, when comparing two different types of forage, the dry matter values should be used, as they remove the differences caused by the moisture content of the forage.

The moisture content of horse hay should be between 10 to 15 percent, and pasture samples will be much higher. If hay is too dry (low moisture content), the hay becomes brittle, and the leaves of the forage are easily lost. The highest nutrient density in forage is in the leaves, so leaf loss can significantly diminish forage quality. Conversely, if hay is too wet (high moisture content), it is more susceptible to mold growth and spontaneous combustion in the right circumstances.

Proteins are made up of individual amino acids, and those amino acids can be considered the building blocks of the horse's body, supporting growth, muscle development, and maintenance. Protein content in forages can fluctuate quite a bit due to forage species or stage of maturity at harvest. If the forage is the horse's only source of nutrients, a crude protein value of 12

Results

% Moisture	10.1			
% Dry Matter	89.9			
		As Sampled		Dry Matter
Digestible Energy (DE), Mcal/lb		.72		.81
	%	g/lb.	%	g/lb.
Crude Protein	11.5	52.1	12.8	58.0
Estimated Lysine	.40	1.8	.45	2.0
Lignin	6.0	27.0	6.6	30.0
Acid Detergent Fiber (ADF)	34.0	154.2	37.8	171.6
Neutral Detergent Fiber (NDF)	61.1	277.3	68.0	308.5
WSC (Water Sol. Carbs.)	3.7	17.0	4.2	18.9
ESC (Simple Sugars)	3.5	15.7	3.8	17.4
Starch	1.9	8.7	2.1	9.7
Non Fiber Carb. (NFC)	6.3	28.7	7.0	31.9
Crude Fat	1.9	8.4	2.1	9.3
Ash	9.1	41.3	10.1	45.9
	%	g/lb.	%	g/lb.
Calcium	.57	2.59	.64	2.88
Phosphorus	.23	1.06	.26	1.18
Magnesium	.15	.68	.17	.75
Potassium	1.50	6.80	1.67	7.56
Sodium	.047	.215	.053	.239
	ppm	mg/lb.	ppm	mg/lb.
Iron	419	190	466	212
Zinc	28	13	31	14
Copper	9	4	10	5
Manganese	47	21	52	24
Molybdenum	1.0	.4	1.1	.5
	As Fed		100% Dry	
RFV			81	

Figure 3. Example of a laboratory forage analysis.

percent or higher is recommended. If the diet is being supplemented with a concentrated feed, a lower value can be acceptable. Grass hays are typically in the 8 to 12 percent crude protein range, while legumes, like alfalfa, can have crude protein values upwards of 20 percent.

Digestible energy (DE) is a measure of the energy available to the horse to be used for maintenance of bodily function, exercise, reproduction, lactation, etc. A higher DE value indicates a higher quality forage. Grass hays typically range from 0.7 to .85 megacalories/pound (Mcal/lb.), while alfalfa can be over 1 Mcal/lb.

Acid detergent fiber (ADF) comprises the highly indigestible fractions of the plant: cellulose, and lignin. As plants mature and become more fibrous or "stemmy," the ADF value increases, and the plant becomes less digestible, meaning fewer nutrients are available to the horse. For horse-quality hay, an ADF value of 45 percent or less is recommended. The lower the ADF value, the more digestible the forage, and the more nutrients will be available to the animal.

Neutral detergent fiber (NDF) is a measure of insoluble fiber: hemicellulose, cellulose, and lignin. This value can be used as an indicator of palatability, or how readily horses will ingest the forage. Again, as plant maturity increases, so does the NDF value, making the forage less palatable to horses. Of course, some horses are "picky eaters," while others will ingest whatever is put in front of them, but NDF can provide an estimate.

Non-structural carbohydrates (NSC), like water-soluble carbohydrates, simple sugars, and starch, are utilized as quickly available energy sources for the horse and are particularly important for equine athletes, which require fast energy to perform work. Higher NSC values can be beneficial for this class of horse, but there are some cases where NSC should be limited. Horses that are prone to obesity, are laminitic, or suffer from equine metabolic syndrome or Cushing's disease will need to be provided a diet limited in NSC. It is recommended that the diet consist of less than 12 percent NSC for these types of horses. For horses suffering from polysaccharide storage myopathy (PSSM), the diet should be restricted to 10 percent or less NSC. It should also be noted that the NSC content of pasture forages is cyclical. In the early afternoon, when photosynthesis in the plant is at its peak, NSC is the highest as the plant is storing sugars in the form of starch. Conversely, when the sun sets, the plant moves from photosynthesis to respiration and NSC is utilized by the plant for energy, thus decreasing NSC content. If restricting NSC in the diet is required, grazing would best be allowed in the night and early morning.

There is much more information provided in a forage analysis, but the six values discussed can help inform decisions about forage and nutritional management. For help developing a comprehensive and individualized nutritional plan, an equine nutritionist can utilize a forage analysis and assist.

CONCLUSION

Forage should always be the foundation of the equine diet. At minimum, the horse should be provided 0.75 percent of body weight per day in roughage. If forage is the sole source of nutrients, the horse can be expected to consume 2 to 3 percent of body weight per day. When making forage decisions for a horse, consider forage quality and individual nutrient needs balanced with cost. For example, alfalfa is higher in quality than most grass hays. However, it can also be higher in cost in some locations, and not all classes of horses require the higher nutrient density. When considering the diet of the equine athlete, young growing horse, or lactating broodmare, alfalfa could be a good investment, as it provides more of the higher nutrient needs required by these classes of horses. A close look at these considerations can help to make nutritional decisions that are both beneficial to the horse and sustainable for management.

REFERENCE

Bade, D., & Reeves, Jr., S. (2002). *Hay: Making, storing and feeding.* Texas A&M AgriLife Extension.