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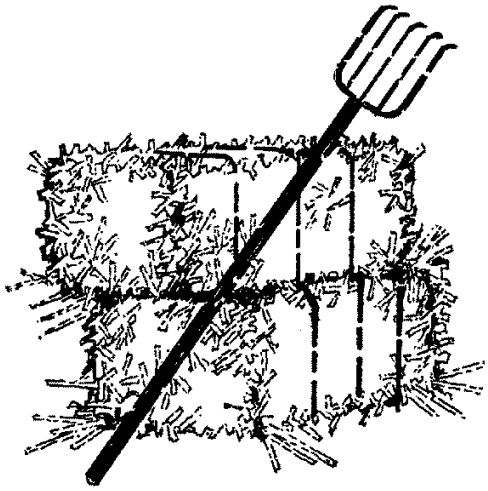
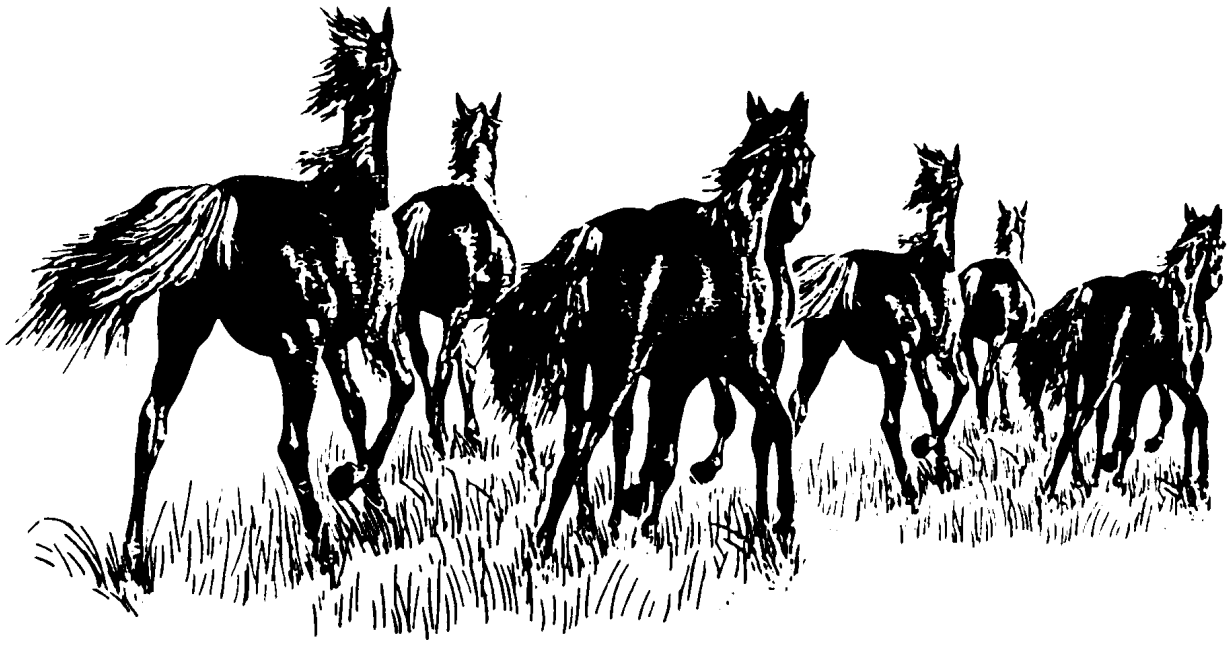
Nutrition News and Information Update

HORSE HAY



CHOOSING THE *RIGHT* HAY FOR YOUR HORSE



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Horse Hay: Choosing the *Right* Hay for your Horse

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With all of the feed products available for the horse, it is hard to decipher what your horse actually needs. Though there is a lot of information on supplements or pelleted feed labels, a horse owner does not usually get much information on the plant sources they are providing. Plants have different nutritional values in different parts (i.e. grain vs. leaf) within varieties of plants as well as geographical location the plant was grown. With all these variations, how do we know what to feed our horse? The intention of this article is to give a basic understanding of the plant, and how the horse digests hay in order for the horse owner to be able to work with their equine nutritionist to come up with the best feeding program for their horse.

Understanding plants:

In order to properly understand the nutritional properties of the hay we are feeding, a basic understanding of just how plants obtain these nutrients is required.

The plant uses its root systems to access water from the soil. Air is exchanged in the leaf by a structure called the stoma (Figure 1). This allows carbon dioxide to enter the leaf and oxygen, a byproduct of photosynthesis, to leave the leaf. Inside the leaf, there are two processes used to create energy; the light and dark reactions. The light reaction uses light from the sun to initiate a reaction in the chloroplast. This takes water, and carbon dioxide to create oxygen and energy that will be used in the dark reaction. The dark reaction uses this energy and several enzymes to create glucose molecules. These glucose molecules are the basic building blocks *for all carbohydrates*.

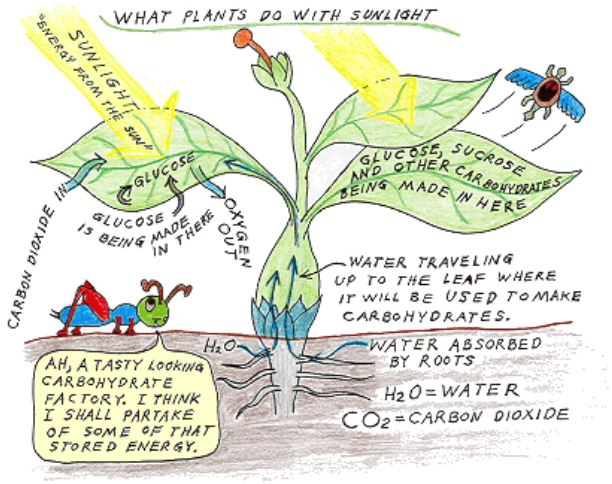


Figure 1: Overview of Photosynthesis. (1)

The glucose created during photosynthesis is how the plant stores energy for growth and development. Glucose, in turn, is used to create energy required for respiration and other metabolic processes. During respiration, the isomers of glucose are created; fructose and galactose (the other simple sugars). These simple sugars can then form bonds to build bigger and more complex sugars. Plants use these sugars for a variety of basic needs including growth, structural support, as well as other reactions taking place within the plant cells themselves. If the energy created from photosynthesis is in excess of these basic plant needs, the energy is stored and is then available for the animal that consumes it.

Understanding Equine Digestion:

As one would imagine, the first site of digestion begin straight from the horses' mouth. The teeth are flat and large, enabling the animal to grind its food fairly easily. Saliva, (approximately 10-12 liters per day in an adult horse) then not only moistens the food for a slippery travel to the stomach, but also carries the digestive enzyme amylase, and bicarbonate which will aid in buffering stomach acids as the feed travels down the esophagus into the acid filled stomach (2). This is important in order to keep the microbes which populate the hindgut from entering the stomach, causing fermentation. *If fermentation begins in the stomach, gasses are produced, which can build up resulting in pain and colic*. When looking at the stomach of the horse (Figure 2) one thing that stands out right away is the proportionally small size of the stomach. *This small stomach would suggest that this digestive tract was designed for several small meals*. In fact, if a horse is out at pasture, it will spend as much as 50% of its day-time hours grazing (4). These several small meals are also important to maintain the rate of saliva production, which is increased with food and chewing (2). Hydrochloric acid (gastric acid), not only makes the stomach acidic, but it also activates pepsin, a digestive enzymes that digests proteins (5). An empty stomach means less saliva and bicarbonate to buffer hydrochloric acid, and is therefore associated with a lower pH *leading to increased incidence of gastric ulcers* (2). This lower pH may also alter the microbial populations in the stomach, and further on in the digestive tract as well.

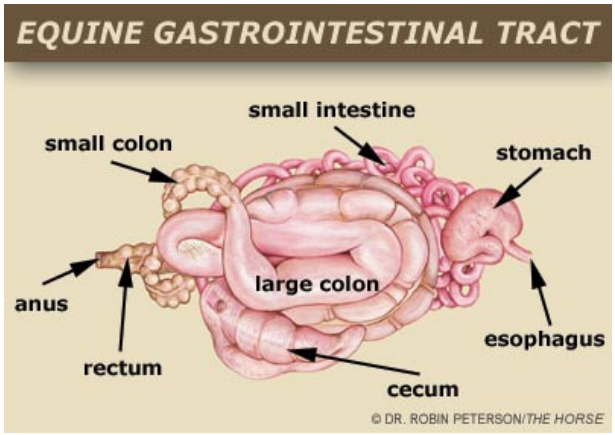


Figure 2: Equine Digestive Tract (3)

The small intestine is the main site of digestion, and absorption of these digested nutrients. Most mammals produce the enzymes which can digest protein, fat, starch as well as some sugars (4, 6). Even though the horse does not possess a gall bladder (5) to aid in the digestion of fat, they do secrete large amount of gastric lipase which enables them to digest quite large amount of dietary fats (2). Once the nutrients are broken down, they can be absorbed from the small intestine into the bloodstream. At this point, almost all of the amino acids from proteins, vitamins A, D, E, and K, some minerals and 30-60% of carbohydrates can be *digested* into glucose and absorbed into the blood stream (4, 5). Carbohydrates can be digested, and this means that the horse produces the enzymes required to break down the sugar bonds. If these enzymes are not available, then the carbohydrate passes into the large intestine.

Another notable trait in this system is the enlarged cecum. This simple stomached animal is able to act like a ruminant in that it can ferment large quantities of fibre. The microbial populations in the large intestine, including the cecum, are able to ferment some feeds and allow the absorption of more nutrients than the horse's own digestive enzymes are able to break down. *In fact, these microbes produce enough volatile fatty acids (VFA) from primarily insoluble fibres, to give 30-70% of the horses' energy needs* (7). After

fermentation in the cecum and large intestine, the food travels down the colon and out the rectum and anus.

The Horse's friend - Fibre:
As you can see, the horse has a very unique digestive system. The first half, saliva, simple stomach and small intestine function is very similar to most other monogastric animals. The second half, large intestine and cecum, are similar in function to the digestive system of a ruminant animal. Combining these digestive systems means that this animal has special needs.

Of the carbohydrates provided from a plant, typically, the cell contents are digested in the foregut (first half), and cell wall components fermented in the hindgut (second half). *The linkage between the simple sugars making up the carbohydrate is what determines if the horse's own enzymes are able to digest them or not*. As noted above, the horse produces enzymes able to digest (breakdown) starch, proteins, fats, and some sugars. Fibre, a term used to describe carbohydrates which are not digested by monogastric animal, includes cellulose, hemicellulose, pectins, lignins, gums, mucilages, cutins, and tannins (8). Though fibre cannot be digested by the horse itself, the microbes in the hindgut can break down the fibre bonds in order to access nutrients in a process known as fermentation.

The rate of passage through these systems also plays a significant role in how the animal digests its food. It determines how much time the ingested food will spend in the monogastric like foregut or ruminant like hindgut. This will determine the difference between digestion and fermentation (6). If the feed travels too fast through the foregut, stomach and small intestine, then some of the carbohydrates, proteins, fats, starch and sugars that could have been digested by the horse will end up in the hindgut and possibly be fermented. Fermentation of soluble carbohydrates (which should be digested in the foregut) can lead to a cascade of events including death of normal gut bacteria, inflammation, excess VFA production, and possible endotoxin release from the dead bacteria that is absorbed into the blood stream. This may then lead to pain, inflammation, digestive upset, as well as laminitis and colic (6). Consequently, the horse has a requirement for hay and feed that provides gut fill. *Fibres present in feeds such as hay slow the rate of passage, reducing the risk of fermentation of readily digestible nutrients in the hind gut.*

Horses will consume between 2 – 2.5% of their body weight on a dry matter basis. Of this, 50-100% should be hay (9). Contrary to popular belief, low carbohydrate hay is a myth. *Fibre is a form of carbohydrate storage*, which the microbes in both a ruminant animal and the hindgut of a horse can breakdown for energy use. The large amount of hay, and therefore fibre intake is important not only for providing the large amount of fermented energy from this fibre, but also for satiety, and to control the rate of feed passage through the digestive system.

Quality Hay
If all of this information has left you wondering what to look for in hay, here are the basics for finding quality hay.

- Maturity

This is probably the most important characteristic to look at when choosing a quality hay. As a plant matures, the stems strengthen, less leaves appear, and therefore the hay has a lower nutritional value due to poorer digestibility. (Figure 3 & 4). This is because leaves are the energy producers of the plant. They contain proteins and nutrients used for development and growth of the plant. As the plant matures, the need for growth and development are reduced, and more predominant storage of carbohydrates occurs. The stems strengthen and become more "woody", seeds are formed in order to give new life the nutrients they need, and leaves are less predominant. The level of ADF and NDF increase (12). An over-matured plant is often less palatable as well, often resulting in increased waste (4).

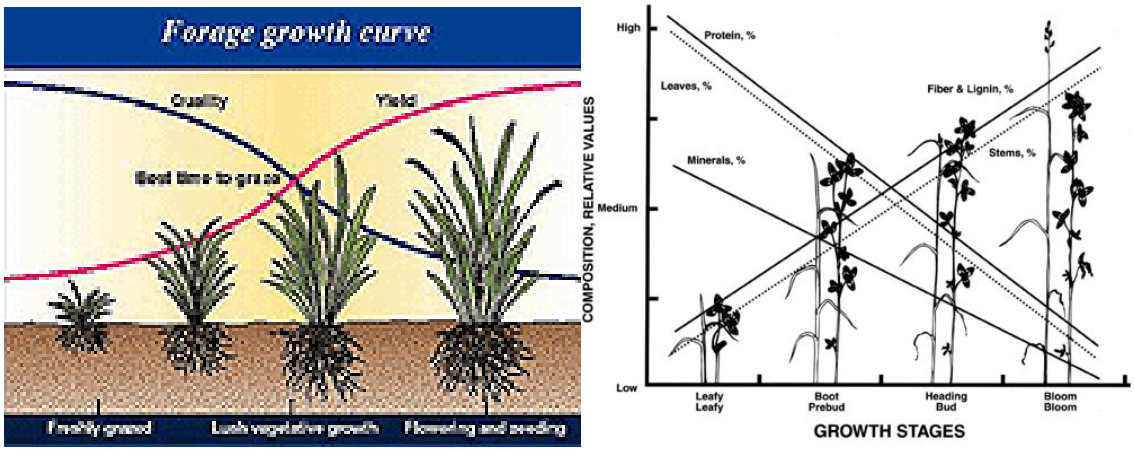


Figure 3: http://www.thisland.illinois.edu/60ways/images/10b-detail.gif (10)
Figure 4 : http://pubs.ext.vt.edu/418/418-012/L_Figure3.jpg (11)

- Type

Different plants, as we know, have different nutritional values. Grass hays tend to be lower in nutritional values than legumes, but there are also vast differences between them.

Grass: There are cool season grasses (Kentucky bluegrass, timothy, orchard grass, yegrass, smooth brome grass, tall fescue), as well as warm grass (Bermuda grass, bahia grass, pangola, and bluestem). The cool season grasses tend to be higher in nutritional value than the warm season, as the warm season grasses have a higher cell wall content which makes them less digestible. Grass hays should be leafy, soft (pliable), with few or no seed heads, and free of mold, dust or weeds (13).

Legume: Legumes, as stated previously, are higher in nutritional value with higher protein, vitamins, and minerals than grass hays. Though the nutritional value is higher on a dry matter basis, they are also usually higher in moisture content. Therefore, the horse may eat more.

- Growth Location

If all of this information was not enough, you must also consider where the hay was grown. Plants grown in different soils are able to sequester different minerals from the soil and water surrounding them. For instance, selenium is deficient in soils surrounding the Great Lakes, though there is an excess in the Rocky Mountains and plains areas. Not only does the soil have an impact on the nutritional properties, but also the location within the field. If the plant was grown under a shady tree compared to a plant grown in the hot sun, or a plant close to the road and winds, their nutritional properties will be slightly different. Knowing where your hay comes from as well as having it analyzed, will allow a feeding program to be developed with your equine nutritionist in order to ensure your horse is getting a balanced diet.

- Molds & Toxins

Not only can molds and toxins result in feed refusal, but even more devastating is that the horse may eat the feed, resulting in poisoning. The more common toxins in horse feeds include fumonisins (moldy corn poisoning), fescue toxicosis, ergot, aflatoxins, and tremorgenic mycotoxins (grass staggers). Molds, and the mycotoxins associated with them, most often occur when feeds are stored, though they can occur in the field as well. Several factors can contribute to the production of molds and toxins; however, moisture, including rain, is the number one factor leading to molds. Stress such as drought, or inappropriate fertilizer/pesticide use can also weaken the plants defenses to molds (7).

- Foreign material

Weeds and other garbage from the field not only reduce palatability of the feeds, but also its nutritional value. Foreign material is a potential problem, not only because the animal may ingest inanimate objects bailed with the hay, but also dead rodents which may be collected as well can lead to Botulism. Often termed “shaker foal syndrome”, the ingestion of bacterial spores, which grow in decaying plants and animal tissues, results in the blockage of neurotransmitter release, resulting in paralysis. Blister beetles may also be found in hay, leading to inflammation, and blisters due to Cantharidin toxicity (7).

- Carbohydrate characteristics

This is where hay quality can get especially confusing. Carbohydrate characteristics of hay changes with maturity, type, growth location, soil fertility, as well as environmental factors (13, 14). The cell contents (see figure 5) are highest in a vegetative state (early spring and during re-growth), as well as during periods of cool nights and warms days (Fall or early Spring). The storage of carbohydrates also varies by grass type. Cool season grasses tend to store more fructan, where

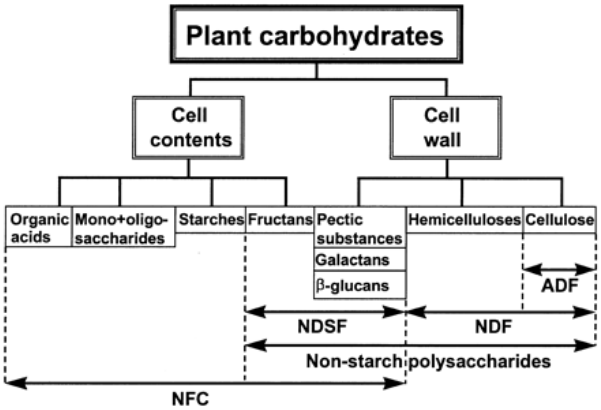


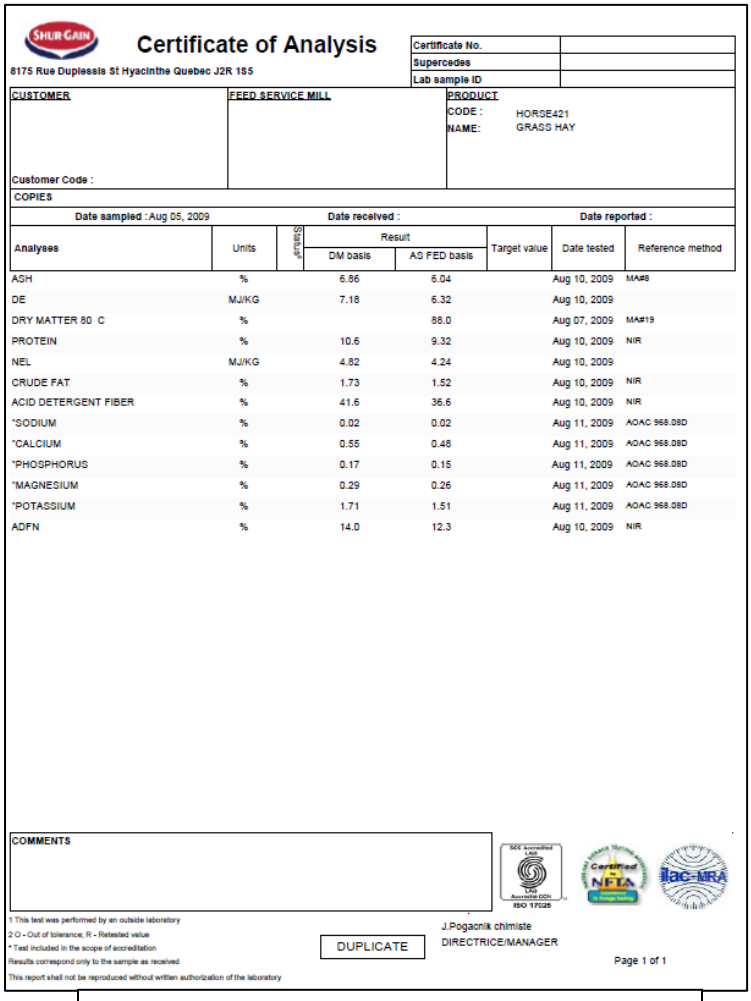
Figure 5. Plant carbohydrate fractions. ADF = acid detergent fibre, ß-glucans = (1 —¥3) (1 —¥4)-ß-D-glucans, NDF = neutral detergent fibre, NDSF = neutral detergent-soluble fibre (includes all nonstarch polysaccharides not present in NDF), NFC = non-NDF carbohydrates. (15)

as warm season plants store very little fructans, but instead store starch (16). Stress can also influence how a plant stores carbohydrates. After a hard freeze or during drought the plant holds on to its energy resources in the cell (17). Even time of day may influence the carbohydrate levels. Fructans, for example are highest in late afternoon and early evenings (18).

Choosing the right hay for <u>your</u> horse

With all of this information, how do you choose the right hay? Well the right hay really depends on your horse's needs. Young horses, horses heavily exercised, or lactating horses will have higher nutrient requirements than an adult, lightly used horse. Maturity and type of hay is important in selecting hay for the nutritional needs of a horse. Alfalfa hays at an early stage of maturity will be much more nutrient rich than late stage maturity grass hay (4).

Horses at risk for laminitis or who have insulin resistance are often sensitive to starch and sugar contents as they affect the glycemic index (indication how a food will affect blood sugar). Grains, rich in starch, should be avoided. A complete feed or supplement should be given to ensure proper mineral, vitamin and energy needs are met without creating a glucose level that may be inappropriate for these special needs horses. High levels of starch and sugars will increase the glucose level in the blood. For a horse with insulin resistance, a situation similar to human diabetes occurs where the typical response to glucose (insulin release) is not functioning properly. This leads to persistent high blood sugar which may result in a variety of aliments: laminitis, equine metabolic syndromes, equine cushings, recurrent exertional rhabdomyolysis (RER, "typing up"), polysaccharide storage myopathy (PSSM) (17). Though most hay is typically low in starchs and carbohydrates, which are digested and absorbed as glucose (4), some horse owners still worry about the level of glucose their horse may get from these hays. Fructan, a carbohydrate made up of glucose to multiple fructose molecules, has also been linked to laminitis (14). This carbohydrate is not digested in the foregut, but is fermented in the hindgut. If *large* amounts are present, it is believed that this increases the level of lactic acid. If



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Certificate of Analysis

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Certificate No.	
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Lab sample ID	

CUSTOMER	FEED SERVICE MILL	PRODUCT
Customer Code :		CODE : HORSE421 NAME: GRASS HAY

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Date sampled : Aug 05, 2009 | Date received : | Date reported :

Analyses	Units	Result: DM basis	Result: AS FED basis	Target value	Date tested	Reference method
ASH	%	6.86	6.04		Aug 10, 2009	MA#8
DE	MJ/KG	7.18	6.32		Aug 10, 2009	
DRY MATTER 80 C	%		88.0		Aug 07, 2009	MA#19
PROTEIN	%	10.6	9.32		Aug 10, 2009	NIR
NEL	MJ/KG	4.82	4.24		Aug 10, 2009	
CRUDE FAT	%	1.73	1.52		Aug 10, 2009	NIR
ACID DETERGENT FIBER	%	41.6	36.6		Aug 10, 2009	NIR
*SODIUM	%	0.02	0.02		Aug 11, 2009	AOAC 968.08D
*CALCIUM	%	0.55	0.48		Aug 11, 2009	AOAC 968.08D
*PHOSPHORUS	%	0.17	0.15		Aug 11, 2009	AOAC 968.08D
*MAGNESIUM	%	0.29	0.26		Aug 11, 2009	AOAC 968.08D
*POTASSIUM	%	1.71	1.51		Aug 11, 2009	AOAC 968.08D
ADFN	%	14.0	12.3		Aug 10, 2009	NIR

COMMENTS

1 This test was performed by an outside laboratory
2 O - Out of tolerance, R - Retested value
* Test included in the scope of accreditation
Results correspond only to the sample as received
This report shall not be reproduced without written authorization of the laboratory

DUPLICATE

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DIRECTRICE/MANAGER

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Figure 6: Standard Shur Gain Hay Analysis

this lactic acid is produced in large enough quantities, this will increase the pH of the hindgut, altering the microbial population, which may exacerbate laminitis (17). Other studies have shown that a small amount (up to 2%) of fructans may act as a probiotic, improving cecal fermentation as well as feed intake. The important thing to remember is that different horses may have different sensitivities to different feeds. Maintaining a proper body condition, sufficient exercise for the animal, as well as feeding a balanced diet that does not exceed the horses requirements will help maintain proper insulin sensitivity.

Though a standard horse hay analysis (Figure 6) will not analyze the sugar contents of hay, as hays do not contain high levels of starch or sugars, special requests may be made to indicate the level of sugars as well as starch in hay. Requests for water soluble carbohydrates may provide an indication of fructans, glucans and pectins. Sugar analysis of the hay is also available, providing levels of fructose, glucose, lactose, maltose, and sucrose. A request for starch may also be made. When looking at your results, keep in mind that these simple sugars are the basic building blocks of carbohydrates. Consideration of all results, including fibre, ADF, NDF, as well as the sugars should be thought of when looking at these levels. Other methods used to ensure low sugar levels may include soaking of hay, as fructans are water soluble. Care must be taken to ensure the hay is fed and consumed within a short time after soaking to avoid molds.

Other Feedstuff

Grains are also used as a common horse feed. They have high energy content with low levels of fibre. This high level of energy may be advantageous when trying to put weight on a horse, or keeping the level of calories up required for a high performance horse. However, care must be taken when feeding grains as they often have 3-20 times more phosphorus as compared to calcium. This unbalanced level of minerals, as well as excess energy in a grain, may lead to developmental orthopedic disease in young horses. It may also lead to behavioral problems in adult horses resulting from the high levels of starch. Another concern when feeding grains is that they have a quick rate of passage through the digestive tract. Care should be taken to ensure that small amounts of grain are given at a time along with a fibre source to slow the rate of passage so that the feed may be properly digested.

Pasture characteristics change similar to hay. The difference is that unlike hay, pasture does not lose any of its nutrients to drying. This means that paying attention to the cell wall contents becomes more important. Practices to control carbohydrate intake include; using grazing muzzles to ensure the horse does not eat the carbohydrates in the lower plant (higher in starch and sugars), rotating pasture grazing depending on time of year and location of pasture, controlling time of day the horse is on pasture, and planting specific types of pasture.

Balanced EQUILINE Substitutes for hay

If all of this information has you worried about feeding the right hay to you horse, there are some alternatives. Shur-Gain produces three products that can be used as a substitute for poor quality hay or to reduce the daily quantity of hay consumed. *EQUILINE All in*

One is a pelleted ration that contains not only high levels of fibre allowing it to reduce the amount of hay consumed, but it also contains balanced vitamins and minerals. For those horses prone to consuming pelleted feeds rapidly, *EQUILINE 12.5% Cool Energy Cubits* as well as the *new* and *exciting* product just recently added to our *EQUILINE* product line *EQUILINE Fibre Nuggets* have been designed to encourage slower consumption. These products are corn-free (great for horses with allergies). They also have a low glycemic index, perfect for those horses prone to laminitis, and insulin resistance. These products boast all the benefits of the *EQUILINE All in One,* with its high fibre levels, and balanced minerals and vitamins, but also come in different textures to encourage slower consumption. *EQUILINE 12.5% Cool Energy Cubits* come in a pelleted wafer cubit form. *EQUILINE Fibre Nuggets* come in a very large cube form. All of these products may be beneficial to horses that have concerns with dust or hay belly.

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