

Does Sugar Concentration Determine Hay Preference by Horses?

Kathryn Watts, Rocky Mtn. Research & Consulting, Inc.

Horse owners often suggest that horses select the highest sugar hays as their favorite forage. This premise invites study into whether samples of various hays can be presented to a horse, and the least palatable hay will emerge as the one lowest in sugar. Owners of horses with abnormal glucose metabolism must rely on low sugar hay for the bulk of their horse's diet. This requires testing of hay before purchase to assure its suitability. Not many hay producers have appropriate tests available, putting the burden of testing onto horse owners. Purchasers may not have the proper equipment and sampling hay without a hay probe may not provide accurate results. Delay in getting hay test results complicates making informed decisions while the hay is still available for purchase.

Previous studies looking at the correlation between sugar content and palatability to horses show conflicting results. When the only difference between choices of an alfalfa/wheatgrass mix was 12 hours difference in time of cutting, horses preferred the hay cut in evening that had higher sugar concentration (MacKay *et al*). Yearlings preferred alfalfa over bromegrass and Bermuda in spite of being the lowest choice in Non Structural Carbohydrates (NSC=sugar, starch and fructan)(LaCasha *et al*). In Australia, researchers also found a negative correlation to Water Soluble Carbohydrate (WSC=sugar and fructan) content when offering different selections of oat and alfalfa hays to horses (Pain and Revell). Those authors suggested that horses chose to avoid consuming "too much" soluble carbohydrate thereby reducing the risks for laminitis. These authors never studied the eating preferences of laminitic horses, and most anecdotal evidence confirms that horses are quite willing to eat more soluble carbohydrates than is good for them.

When horse owners are shopping for hay they often have several selections to choose from that may vary in species as well as having wide variations in both quality and nutritive characteristics. This study was conducted to see if horses pick out hays with higher NSC content when given a wider variety of choices than in previous studies. The hay that horses are accustomed to may affect preference (Pain and Revell) (LaCasha *et al*), therefore data from the two herds in this study was also analyzed separately to detect any differences.

Procedure:

Six different bales of hay were probed and tested for Crude protein, WSC, ESC, starch, ADF, NDF, DE and TDN. Six ounces of each hay was weighed and placed in identical plastic trays, and placed in a line before a single, loose horse. Thirteen different horses were allowed access to the hay. Video was taken to review eating behavior. Some horses just ate what was in front of them, so hays were shuffled for the first 5 minutes, until the horse started seeking out particular hays, even when moved to a different place. After 15 minutes, trays were removed and remaining hay weighed. Palatability ranking was based on hays that had the least amount remaining (averaged across all horses), and when everything in a tray was consumed, the order at which they were cleaned up. The most palatable was ranked 6 and the least palatable was ranked 1.



Test subjects ranged from 16 H warmbloods and QH crosses to 12.2 h Welsh and New Forrest ponies on 2 different farms. Tests were conducted before mid-day feeding to eliminate satiety as a factor. The amount of hay eaten in 15 minutes out of a total 36 oz offered ranged from 19.5 oz by the 12.2 h Welsh pony to 31 oz by a 14 H New Forrest/WelshX pony.

Both of these ponies ate very fast, but the smaller pony had a very small muzzle and was limited to bite size compared to the larger horses. Animals came from 2 different farms. At farm one, Hay # 4 and 5 were both fed. At the second farm, all the hays offered were novel, but similar to hay #4.

When given a choice of 6 hays, horses would pass over some trays without tasting. Other times they might taste a hay, then move on to another tray. Most often, when they found a hay they liked, they would eat it all before trying another tray, even following that tray if moved. Generally, 2 hays were completely eaten, 2 were partially eaten and 2 were mostly ignored in the time allotted.

Early in the study, it was apparent that something other than NSC content was determining which hays the horses ate first. Zip lock bags of each hay were presented to 4 different horse owners with instructions to guess which hays their horses would prefer, and why. The hays the owners chose as most palatable were fragrant; smelling like "fresh mown hay". The 3 other hays were described as smelling "blah", or "having no smell", but this trait could not be quantified for analysis. None smelled bad or moldy. All six were pale green in color, loose and put up very dry. Moisture content ranged from 6.7 to 8.5%.

	CP	NDF	Horse DE	WSC	starch	ESC	WSC+starch	palatability rank
1 Meadow Foxtail	8.9	55.5	1.03	17.4	0.3	10.5	17.7	4
2 Harmon 2008 3rd	15.7	44.6	1.14	13.8	0.1	10.6	13.9	6
6 Strom 2008 3rd	19.2	49.8	1.08	9.7	1.4	9.1	11.1	5
4 Strom 2008 1st	12.6	58.0	0.99	9.2	1.5	9	10.7	3
5 Strom 2008 2nd	12.0	57.4	1.00	7.4	1.7	7	9.1	1
3 Blue Grama 2007	10.7	69.6	0.87	6.8	2.3	4.5	9.1	2

Description of hays used in the study:

1. Garrison Meadow Foxtail (*Alopecurus pratensis*)/ Carex sp. native grass mix grown in Gunnison, CO; a high mountain irrigated valley known for its cool climate. Green, fine stemmed, pale green, not much smell.
2. Harmon: fescue/orchard/clover mix. 3rd cutting in late fall, 20% clover. Aromatic smell, green.
3. Blue grama (*Bouteloua gracilis*). Pure stand of native grass planted for seed, headed out, mature, stored in barn for 2 years. Pale green, no smell.
4. Strom: fescue/orchard/clover mix. First cutting, headed out, cut June. 5% clover. Nice smell, green.
5. Strom: same field as above. Second cutting in Aug. after cloudy weather, light rain in windrow but turned and dried with no mold. 10% brown leaves, mostly green, not much clover in this cutting. No smell.
6. Strom 3rd. Same field as #4 and #5, but more clover (10%) and cured bright green with no rain. Aromatic smell.

Results

11 / 13 horses emptied the tray with hay #2 first, sometimes licking the tray afterwards. The other two horses cleaned up hay #1 and hay #6 as their first choice.

Only 4 /13 horses cleaned up hay #1, which was the highest in WSC, and NSC (WSC + starch) and nearly identical in ESC content to the hay most preferred. While in the top 3 of the most palatable, having the highest sugar concentration was clearly not the most important factor in horse preference. This hay was a native/improved grass mix from a high mountain valley. It was often passed over by the horses without tasting. This hay had very little smell, and no clover.

The 2 hays most preferred by the horses had 21% and 37% less WSC than the highest, and similar ESC. The top 2 hays preferred by the horses were correctly predicted by the owners; they were the hays that smelled good. These hays also contained the most clover.

The only difference between preferences of the 2 herds was to switch ranking for Hay #1 from 3 to 4 and Hay#4 from 4 to 3. All the rest of the hays were ranked the same by both herds.

Palatability was positively correlated to ESC ($r = 0.7624$), WSC ($r = 0.6383$) and Digestible Energy($r = 0.5005$) in these 6 different hays, yet other factors were more important; presumably smell and texture. Palatability was strongly negatively correlated to fiber content; $r = - 0.81925$ for ADF and $r = - 0.79379$ for NDF. The lowest in fiber was the first 2 chosen by the horses, although these were also the 2 hays highest in clover content, medium in sugar content, and both were considered aromatic by the owners. The 2 hays with the lowest palatability ranking had the highest fiber content and no discernable smell to the owners. The least preferred (#5) had the highest ADF of 38 % dm and a 'blah' smell. 7/13 horses ate 1 oz or less of this hay. The second lowest palatability ranked hay (#3) had the highest NDF of 69.6 % dm, the lowest sugar, and little smell.

Correlation coefficient (r)

Correl Pal rank to ADF	-0.8192	CORREL NSC TO ADF	-0.4945
Correl Pal rank to NDF	-0.7938	CORREL NSC TO NDF	-0.4614
Correl Pal rank to CP	0.5808	CORREL NSC TO CP	-0.2212
Correl Pal rank to NSC	0.5942	CORREL NSC TO NEM	0.2708
Correl Pal rank to WSC	0.6383	CORREL NSC TO DE	0.5005
Corel Pal rank to ESC	0.7624	CORREL NSC TO NFC	0.6121
Correl Pal rank to DE	0.8001	CORREL WSC TO ESC	0.8182

Other correlations between these 6 hays

NSC (WSC + starch) was negatively correlated to fiber content, as is commonly assumed, but this was a rather weak correlation; -0.49 for ADF and -0.46 for NDF. Other studies conducted by this author have found this association to be weaker than usually assumed by equine nutritionists. NSC content is more closely associated with cool growing conditions than maturity or fiber content. Indeed the highest in NSC of these 6 hays was grown in Gunnison, CO (7700 ft evaluation) where summer night time temperatures average in the low 40's F. NSC content was better correlated with Digestible Energy, and Non Fiber Carbohydrates, but the correlations were not strong enough for these calculated values to substitute for direct measurement of WSC, ESC and starch when choosing hay for carbohydrate intolerant horses.

There was a weak, negative correlation to crude protein, as is usually found in other studies. When nitrogen is limiting, both protein production and growth are limited, leading to accumulation of sugars that cannot be used for growth. Therefore when protein is low, especially in grass hay, sugar is often high.

Discussion

Many factors are involved in palatability of hay to horses; smell, texture, and taste. In this study, neither WSC, ESC, nor total NSC was most important to horse preference over a wide variety of hay types. In one study linking sugar content to preference in horses, the hay was cut from the same field, on the same day. The only difference was whether it was cut in AM or PM. (MacKay et al) Hay cut in PM is known to be higher in NSC. In this scenario, the hay would have been comprised of the same species. It would have smelled the same. The texture would have been the same.

When given 6 choices of different hays of widely variable species, smell, taste and textures, the horses passed over some samples without tasting. It seemed that smell was important to their choice of which ones to taste. After they sampled the hay, the texture seemed to matter as to which hay they choose to continue chewing.

By definition, Nonstructural Carbs are found in the inside of fibrous plant cell walls. Sugars cannot be a factor in palatability until the horse chews the hay well enough to release and dissolve the sugars inside the cells. While hay is often considered 'sweet

smelling' sugar itself has no smell. If smell determines which hay they choose, and texture determines which hay they chew, it is understandable that sugar content may have little impact on preference when offered choices that vary widely in these factors.

Hay contains volatile aromatic compounds that smell good to both humans and horses. Some of those that smell 'sweet' to humans, and are palatable to livestock are potentially toxic (Aston, Jones). Coumarin is what makes sweet vernal grass, sweet clover, chamomile and other pasture plants smell so good, but mold can change it to a toxic anticoagulant. Various volatile compounds are being studied as a way to increase forage intake and maximize efficiency of animal production (Pain and Revell). These are important in food choices as it can be observed that horses passed by some hays without tasting. Previous studies show that clover is highly palatable to most livestock, including horses. Savory may be as important to horses as sweet. From the evidence gathered in this study, assuming that horses prefer sweet tasting foods may be a case of anthropomorphizing the equine diet.

Summary

This study demonstrates that the premise suggested by horse owners that horses select hay first on the basis of sugar content is an oversimplification of the forage selection process. When horses were allowed six different selections of hay that varied widely, most did not select hays with the highest sugar content as their first choice. Horses first tasted hays that smelled good. Once a hay was tasted, horses chose to eat the hays that had lower fiber content. Novelty seemed to have little influence on hay preference among the two herds tested.

References

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