Feeding for Health Problems and Metabolic Diseases (Relationship to Soluble Carbohydrates)

The term "low carbohydrate" as used in reference to equine feeds is actually a misnomer. All equine diets are "high carbohydrate"! The primary intention when using the term "low carbohydrate" is to differentiate nonstructural carbohydrates (NSC) from fiber carbohydrates. Structural carbohydrates make up the majority of the carbohydrates found in forage products such as hay or beet pulp and are commonly referred to as fiber. Nonstructural carbohydrates make up the majority of the carbohydrates found in grains such as oats, barley and corn and are commonly referred to as starch or sugar. Nonstructural carbohydrate or "NSC" values for feedstuffs are now being included in laboratory analysis by several commercial laboratories and provide a measure of the amount of starch and sugar contained in a forage, grain or mixed feed.. One should realize that when thinking in terms of a "low carbohydrate" feed for use in equine diets, a low "NSC" (NSC = starch + sugar) is what is actually being considered.

Research completed over the past several years has identified genetic anomalies in certain horses that leave them with a flaw in their ability to metabolize glucose primarily during exercise. Additionally, as more horses are retired and cared for into their later years there has been an increase in the number of horses suffering from Cushing's syndrome or insulin resistance. A reduction in the dietary NSC level is consistent in the treatment recommendations for all these situations.

Exertional Rhabdomyolysis:

Exertional rhabdomyolysis can be sporadic or chronic. Sporadic forms can affect any breed of horse participating in any type of activity and are usually related to basic nutritional deficiencies (vitamin E, selenium, calcium, trace minerals and/or electrolytes and/or electrolyte balance). However, these horses usually show improvement when switched to a low NSC diet even though many can be effectively managed with modifications to training schedules and corrections of dietary shortfalls. Chronic rhabdomyolysis is usually related to heritable myopathies and is often classified as either polysaccharide storage myopathy (PSSM), equine polysaccharide storage myopathy (EPSM), or recurrent exertional rhabdomyolysis (RER).

Polysaccharide storage myopathy primarily affects Quarter Horses, Quarter Horse type breeds, Warmblood breeds and Morgans. Other breeds can also be affected, but appear to be to a lesser degree. PSSM is characterized by the accumulation of glycogen and abnormal polysaccharide complexes in skeletal muscle fibers; glycogen concentrations in affected horses are 1.5 to 4 times greater than normal. The increase in muscle glycogen appears to be a result of increased insulin sensitivity rather than a decrease in glycogen or glucose utilization. This characteristic results in PSSM affected horses having abnormally high levels of muscle glycogen; why this feature increases their incidence of myopathy is not completely understood at this time. Based on breeding trials, PSSM appears to be an autosomal dominant trait.

Equine polysaccharide storage myopathy (EPSM) is similar to PSSM, but seems to primarily affect draft breeds. While there are some critical and significant differences between the two, both are best managed via dietary modifications including a low dietary NSC intake.

Recurrent exertional rhabdomyolysis primarily affects Thoroughbreds, Standardbreds and possibly Arabians and is also considered to be an autosomal dominant trait. The most severely affected individuals tend to be nervous type fillies. More is known about the cause of RER compared to PSSM or EPSM. RER is caused by abnormal intracellular calcium concentrations; however, the condition is completely independent from dietary calcium concentrations. RER is best managed from a dietary standpoint by ensuring 1) an adequate intake of protein, energy, minerals and vitamins, 2) reducing NSC intakes and 3) increasing dietary fat intakes. Exactly how the increase in dietary fat levels and the reduction in NSC levels improve the performance of horses with RER is not well understood, but the effect has been demonstrated in both controlled and field studies.

Dietary Recommendations for Exertional Rhabdomyolysis:

Current dietary recommendations for horses with all types of rhabdomyolysis include increased dietary fat and reduced dietary NSC levels. The exact level and balance of dietary fat and dietary NSC may vary somewhat depending upon the type of rhabdomyolysis (sporadic versus chronic, PSSM, EPSM or RER), but generally speaking NSC should contribute less than 20% of the total dietary digestible energy intake and fat should contribute approximately 15 - 20% of the total digestible energy intake. As the exercise level of an individual horse becomes more intense and/or longer the more important it becomes for the horse's dietary intake to fall within these recommended ranges in order to reduce the incidence and/or severity of rhabdomyolysis. NSC levels of selected common feedstuffs are listed in the appendix.

Laminitic, Cushing's syndrome and Insulin Resistant horses:

Laminitis is a systemic disease; however, the major and most devastating symptoms include inflammation of the sensitive laminae in the hoof. Many horses have lost their life to laminitis since a horse that cannot support himself structurally cannot survive; Secretariat was a victim of laminitis. Cushing's syndrome is caused by pituitary malfunction. In all cases it will eventually be lethal and the general approach to treatment is to make the horse as comfortable as possible and to slow down the advancement of the condition as much as practical. Insulin resistance is related to Cushing's, however, horses suffering from insulin resistance are usually obese whereas most horses with Cushing's are underweight.

Even though the causes, symptoms and affects of laminitis, Cushing's syndrome and insulin resistance are quite different, the dietary approach to their management is similar. Horses suffering from these conditions should receive a reduced NSC intake. Increased fat intakes are not necessarily warranted since energy demands are not that high, relative to performance horses, and body condition is usually maintained on the light side

intentionally. The same guidelines for NSC intake for horses suffering from exertional rhabdomyolysis can be applied to horses suffering from laminitis, Cushing's syndrome or insulin resistance.

Implications for commercial feed composition:

Upon studying the NSC levels listed in the appendix it should become quite obvious that a special formula is required to meet the NSC and fat recommendations discussed above. Any grain in the formula at all will raise the NSC level above recommended thresholds. The inclusion of certain ingredients that are considered to be high fiber by-products also contain NSC levels well above 20% (ex. Almond hulls @ 45.6%).

Keep in mind the overall objective of formulating diets for horses suffering from exertional rhabdomyolysis, besides meeting their protein, mineral, vitamin and electrolyte requirements, is to meet their energy requirements without feeding a lot of starch and/or sugar. This requires that low NSC feedstuffs be chosen that also provide as much energy as possible. Feedstuffs that are commonly used to accomplish this include beet pulp, soybean hulls, distiller's grains, linseed meal, heat-processed soybeans, soybean meal, and rice bran. Meeting the energy requirements for these horses also requires that fat be included in the diet at relatively high levels (high as it relates to equine diets; in other words 10 - 15% of the grain mix). From a commercial feed standpoint, these parameters are very hard to do to meet both the NSC requirements and the fat requirements and still make a product that is marketable. A new product from Triple Crown, called Triple Crown Low Starch, meets the hardest parameter, the NSC level, but falls short on fat. That is easily corrected by adding additional fat as a top dress using Triple Crown Rice Bran Oil Plus at a rate of 4 oz. or 8 oz. per day for a total 10% or 15% fat diet, respectively, while feeding 6 lbs. per day of the Low Starch feed.

Diets for laminitic, Cushing's syndrome and insulin resistant horses should follow the same guidelines in regard to sugars and starches, but the need for high fat is not as great since most of these horses do not have the same high level requirement for digestible energy as performance horses suffering from rhabdomyolysis.

Summary:

Controlled and field studies have demonstrated that equine diets low in NSC and high in fat are beneficial to horses that suffer from exertional rhabdomyolysis. Similarly, current dietary recommendations for horses suffering from laminitis, Cushing's syndrome and insulin resistance include low NSC levels. Triple Crown is responding to this need by manufacturing feeds that are low in NSC and label them as being "low starch". Unfortunately, in the absence of any current guidelines to specify what is "low carbohydrate" and what is not, some commercial feeds are being presented as low carbohydrate that do not fall within the recommended guidelines discussed previously.

NOTE: Information related to the causes and descriptions of exertional rhabdomyolysis was taken from a paper presented by Stephanie Valberg DVM PhD Diplomate ACVIM,

Professor Large Animal Medicine, Department of Clinical and Population Sciences, University of Minnesota, St. Paul, Minnesota at the Conference on Equine Nutrition Research, Texas A&M University, Equine Science Section, Department of Animal Science, May 22-23, 2004.

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Typical 14% Sweet Feed

Oats, Barley, Corn, Vegetable Oil, Molasses, and a premix pellet made up primarily of Soybean Meal, Wheat Midds, Vitamins and Minerals.

Crude Protein	min	14.0%
Crude Fat	min	6.0%
Crude Fiber	max	6.0%

NSC = 48.0 %

Pelleted grain based rations would still have a NSC equal to an average of 45.0%

Triple Crown Low Starch

Soybean hulls, Shredded Beet Pulp, Distiller's Dried Grains, Wheat Midds, Vegetable Oil, Flaxseed Meal, Rice Bran, Vitamins, Minerals, and Digestive Aids

Crude Protein	min	12.0%
Crude Fat	min	6.0%
Crude Fiber	max	16.0%

NSC = 15.0 %

For a 6 lb. Feeding, add 4 oz. of Rice Bran Oil Plus to make a 10% Fat ration, and add 8 oz. to make a 15% Fat ration.

Appendix: NSC Values of Selected Feedstuffs

Feedstuff Class	Feedstuff	No. Samples	Average	Low Range	High Range
Pasture					
	Alfalfa	11	**15.477**	15.477	15.477
	Bermudagrass	6	**10.203**	6.743	13.663
	Grass	189	**9.047**	5.899	12.194
	Fresh Oat Forage	28	**16.303**	15.57	17.037
Hay					
	Alfalfa	3996	**11.394**	9.961	12.827
	Bermudagrass	374	**13.256**	9.145	17.366
	Grass	1712	**13.263**	11.116	15.409
	Oat Hay	377	**23.087**	16.293	29.88
	Straw	52	**11.968**	6.278	17.658
Dry Feeds					
	Almond Hulls	2	**45.564**	45.564	45.564
	Barley	15	**63.08**	61.289	64.872
	Beet Pulp	34	**12.243**	9.438	15.048
	Brewer's Grain	8	**10.791**	2.153	19.428
	Citrus Pulp	28	**29.048**	21.919	36.176
	Corn, Steam Flaked	14	**75.589**	72.807	78.372
	Corn Germ Meal	9	**37.375**	21.053	53.697
	Corn Gluten Meal	11	**17.142**	17.142	17.142
	Cottonseed Meal	11	**10.669**	8.669	12.67
	Distillers Grains	242	**10.667**	7.691	13.643
	Flaxseed	0			
	Grain Screenings	7	**51.391**	44.168	58.613
	Hominy Feed	16	**54.373**	41.978	66.768
	Linseed Meal	1	**15.038**	15.038	15.038
	Molasses	10	**58.406**	42.484	74.328
	Oat Hulls	0			
	Oats	8	**50.667**	50.667	50.667
	Peanut Meal	1	**24.041**	24.041	24.041

	Rice Bran	13	**19.881**	4.597	35.165
	Soybean Hulls	20	**7.169**	5.185	9.154
	Soybean Meal	59	**16.319**	13.395	19.243
	Soybeans, Heat Proc	9	**16.089**	16.089	16.089
	Wheat	9	**67.506**	67.506	67.506
	Wheat Bran	20	**30.192**	20.923	39.46
	Wheat Midds	10	**33.671**	26.136	41.206
Source: DairyOne Forage Lab, Ithaca, NY					