

## Evaluating Carbohydrates in Equine Nutrition

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Energy is an important nutrient in the horse's diet, and carbohydrates are the primary source of this energy. One initially thinks of carbohydrates as sugar and starch, yet fiber is the primary carbohydrate providing energy to the horse. The digestive system of the horse was designed primarily for the continual, slow intake of fiber such as grass hay and pasture. Consequently, the horse has a relatively large and highly developed hindgut (cecum and colon) containing a vast microbial population for the fermentation or breakdown of large amounts of fiber. Unfortunately, energy obtained from fiber fermentation alone may not be adequate to maintain weight in performance horses or horses with high-energy metabolisms.

Feeding horses non-fiber carbohydrates (starch, sugar) will provide the additional fuel needed for performance or weight gain and will be metabolically more efficient in energy production than fiber fermentation. However, the horse's digestive tract, which is better geared for processing fiber, is limited in its ability to process large amounts of starch. In other words, feeding diets high in starch or sugar may present a potential risk of metabolic and digestive disorders such as colic, founder, and "tying-up."

It is important to determine and quantify the different types of carbohydrates in a horse's ration to help evaluate and select a feed that best fits the needs of horses with different energy requirements or carbohydrate sensitivities. Fortunately, there are laboratory assays that can provide information on different carbohydrate fractions in feed. Unfortunately, these laboratory assays (see figure 1) are sometimes confusing and don't always match what goes on digestively in the horse (see figure 2).

The following defines and attempts to clarify the different carbohydrate fractions listed above and their importance in equine ration evaluation:

- 1. Neutral Detergent Fiber (NDF)** is a measurement of the Insoluble Fiber in a ration. NDF includes hemicellulose, cellulose, ligno-cellulose, and lignin. These components of NDF are resistant to digestion by enzymatic hydrolysis but may be fermented to varying degrees by the microorganisms in the hindgut of the horse. NDF is an indicator of the total bulk in the ration and can thus be used as an indicator of intake potential.
- 2. Acid Detergent Fiber (ADF)** is a sub-component of NDF containing the cellulose, ligno-cellulose, and lignin portions. Acid Detergent Fiber is less digestible (fermentable) than NDF. Because of the relationship between digestibility and available energy in a feedstuff, the ADF percentage of forages or

other fiber sources is often used to predict energy content. The lower the ADF the higher the energy potential of the feed.

- 3. Neutral Detergent Soluble Fiber (NDSF)** is not a sub-component of either ADF or NDF. In laboratory procedures the NDSF is a sub-component of Non-Fiber Carbohydrates (discussed below). This fiber fraction, however, is rapidly fermented in the hindgut of the horses and does not result in excessive acid production or subsequent digestive disturbances, as does the fermentation of non-fibrous carbohydrates (starch, sugar). Therefore, feedstuffs high in NDSF (i.e., soy hulls, beet pulp, rice bran) can be incorporated into equine rations to compensate for low energy, poor quality forages while providing additional energy in the form of fiber. Additionally, feedstuffs high in NDSF have been used in situations where forage inventories are limited, and can help maintain a healthy fermentation environment.
- 4. Non-fiber Carbohydrate (NFC)** is a calculated (rather than analyzed) carbohydrate component. The most common equation to calculate NFC is:  $\text{NFC (\% of DM)} = 100 - \text{Crude Protein (\% of DM)} - \text{NDF (\% of DM)} - \text{Ether Extract (\% of DM)} - \text{Ash (\% of DM)}$ . Included in the NFC portion of a feedstuff are starch, sugars, and NDSF. As previously discussed, the starch and sugar portions are readily digestible in the stomach of the horse while the NDSF is rapidly fermented primarily in the hindgut. Although the amount of starch and sugar in a feed relative to NDSF can be quite variable depending on type of feed (i.e., hay, pasture, grain-mix), the NFC value is often used as an indicator of the level of starches and sugar in an equine grain ration. This value, however, should be interpreted with caution when a feed contains a high level of NDSF (ex. soyhulls, beet pulp, rice bran).
- 5. Non-structural Carbohydrate (NSC)** is an analyzed carbohydrate component consisting of starch and sugars. The NSC percentage has been the source of much confusion in interpreting analysis results and evaluating carbohydrates in feeds. In the past, the term NSC has been used interchangeably with NFC. More recently, the term NSC has been used interchangeably with starch. Thus, when interpreting laboratory results, it is important to know whether the NSC refers to a calculated “by difference” analysis (NFC) or an analyzed by hydrolytic methods (NSC). Since some horses can be very sensitive to dietary starch and sugar, the NSC level can be helpful in selecting an optimal feeding program.
- 6. Starch** is a sub-component of the NSC. Starch is determined using laboratory procedures that are not well standardized. The lack of a standard approach to analyze starch increases the variability of starch values within a feedstuff; this problem is most apparent when analyzing commodity ingredients that can contain a number of components that interfere with the starch assay. The variability becomes greater when analyzing a complete feed with various ingredients. Despite

this variability, a starch analysis can provide an idea or estimate of the amount of starch in a feed, but can be expensive and is not a routine procedure.

In general, carbohydrate analysis of an equine ration can be very useful in helping to select a suitable feed for horses, especially those that show sensitivity to starch or require a specific balance of the carbohydrate fractions. The key to interpreting carbohydrate analysis of feed is to realize that the assays used for feed analysis are not perfect, especially in how they relate to what goes on inside the animal. Certain ingredients, especially those that contain a high level of soluble fiber (NDSF), often contain carbohydrates that end up in various analytical fractions depending on the assay procedure used, resulting in contamination. Caution should be used when evaluating carbohydrate assay values of different ingredients or products from different laboratories.

Figure 1: Laboratory Analysis of Carbohydrates

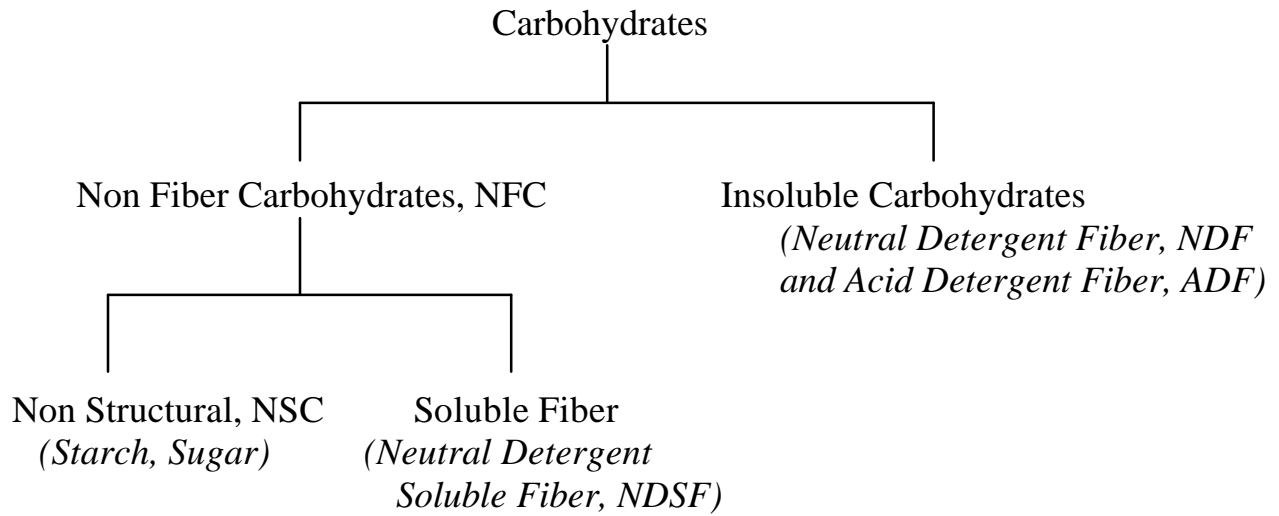


Figure 2: Equine Digestion of Carbohydrates

