CARBOHYDRATES
The largest source of energy for your horse

Horses need energy to function; to move, eat, breathe etc. This energy is derived from different energy sources, such as carbohydrates, fats and protein.
We will take a closer look at carbohydrates as the main component in energy supply to the horse.

What are carbohydrates?

Essentially, carbohydrates are sugars. They can be composed of 1 or multiple 'sugar' components and can be divided into groups depending on their molecular structure and length:

1. Monosaccharides: some monosaccharides of importance are glucose, fructose, galactose and arabinose
2. Disaccharides are composed of 2 monosaccharides: lactose, maltose and sucrose
3. Oligosaccharides: composed of short chains of monosaccharides (3-10 components)
4. Polysaccharides are chains of >10 components. Some examples are fructan, starch, cellulose, hemicellulose and pectin.

Often, these are grouped together and the terms ESC, WSC, Starch, Fiber and NSC are used. We will look into those grouping in a moment.

Where and how are carbohydrates digested?

Remembering the digestive system of the horse, it all starts in the mouth when the horse chews and mixes food with saliva. Enzymes will start to work on the food components there. (Amylase starts to break down starches)
Mono- and di-saccharides can be further digested by enzymes in the foregut (stomach and small intestine) and there, molecules are already small enough to be absorbed into the bloodstream.
Most of the oligo and polysaccharides (such as fiber) however can only be broken down by bacterial activity (fermentation) in the hindgut.
One exception for example is starch, a polysaccharide, which must be digested in the foregut.

How much energy do they provide?

All carbohydrates contain similar amounts of Gross Energy. However, when utilized by the horse, they provide variable amounts of Digestible Energy. Carbohydrates digested and absorbed as monosaccharides in the small intestine with the help of enzymes, will yield more digestible energy than those digested by microbial fermentation in the hindgut. It is important to note that if the longer chains of sugar end up in the hindgut, bacteria will break them down into volatile

fatty acids which are converted into energy, but also a byproduct called 'lactic acid'. This will play an important role in the health of the hindgut of the horse, as it has very negative effects on the microbes and bacteria, which reside there.

Terms and groups to identify and classify carbohydrates

A variety of systems have been developed to classify plant carbohydrates. Some systems classify them according to their role in the plant, while others classify them according to their significance to animal or human nutrition. They are also different in terms of where they are being digested in the digestive system.

Ethanol-soluble carbohydrates (ESC)
This gives you a measure of the simple sugars, which are present.
These carbohydrates are the mono and disaccharides and are digested by enzymes in the foregut and converted in glucose, which delivers immediate energy to the horse. Too many simple sugars in the foregut will raise blood glucose and insulin levels too much which can lead to laminitis in metabolic horses.

Water-soluble carbohydrates (WSC)
This tells you the ESC combined with levels of Fructan. Fructan is are mostly present in hay and grass, less so in grains. Fructan (polysaccharide) is mainly found in fresh grass and hay. Cool season grasses such as orchard, timothy, and brome can have a high level of fructan. Fructan is not digestible in the foregut thus needs to be digested in the hindgut, where if present in high doses, will likely cause changes in pH of the hindgut (hindgut acidosis) and again can cause colic and laminitis.

Non-Structural Carbohydrates (NSC)
NSC's are the sugars and starches that are stored inside the cells of plants; they do not offer any structural component to the plant to literally 'construct' it.
NSC groups together WSC with starch but sometimes fructan is not included in this value. When fructan is included, NSC is ideally <14%; without fructan, the ideal number is <10%
It is imperative that the digestion of starches is kept in the foregut. If starches travel to the hindgut, the fermentation there will result in acid production and killing off the bacteria needed to perform digestion in the hindgut. This will often lead to colic and even laminitis.

Digestibility of starch depends on a number of factors:
The source of starch, the processing of starch (has it been ground to access starch more easily), amount of starch given, source and timing of forage fed along with starch source.
Oats are highly digestible (84%); corn and barley are not very digestible (29% and less)
If > 0.4% of BW in starch is given, there will be a portion that ends up in the hindgut with the risk of causing hindgut acidosis and laminitis.

Dental health will play a role in this process as well, determining how well the feed is ground down before travelling to the stomach and small intestine.
Then we come to a group of poly and oligosaccharides which all need to be digested in the hindgut:

Structural Carbohydrates or Fiber
Crude Fiber is often mentioned on feed labels. This includes cellulose, hemicellulose, pectin and lignin.
These different components are not all equally useful to the horse, so it is more important to know the composition of the "Crude Fiber" than that number by itself.

- Pectin is water-soluble and much more digestible, easily fermentable and safe, with a very low insulin response. Pectin is found in beet pulp and legume hays. (It comes from the 'liquid' portions of the plant, such as resin, saps etc.)
- Cellulose and hemicellulose are polysaccharides that need to be broken down in smaller units to be absorbed. They come from the non-seed and non-fruit portions of a plant (leaves, stems, hulls) and are known as the insoluble fiber.
- Lignin is not digestible and useless as an energy source. The amount of lignin increases as a plant matures.

The fiber content can be measured in different ways

ADF or acid detergent fiber
This measures cellulose and lignin, and doing so, it underestimates its actual fiber content because hemicellulose and pectin are missing and it overestimates its energy value as lignin is included. Ideally this value is less than 31%

NDF or neutral detergent fiber
This measures cellulose, lignin and hemicellulose. It does not include soluble fiber (such as pectin), which is the useful type.
It overestimates usable fiber content since lignin is included. Ideally this value is less than 40%

The higher the ADF and NDF values, the more lignin is in the hay, which will end up undigested in the manure. The horse will have to eat more hay to get the desired energy.

Generally speaking if a horse is sensitive to sugar or starch, one wants to keep the NSC low. However, there is no way to know which substance predominates. If the majority comes from fructan, it can lead to laminitis. If the majority is sugar and starch, it can cause problems for horses sensitive to insulin.
A better indicator for the actual content of fiber is through additional measurements as discussed above and by further reading the actual ingredients to understand the quality of the feed.

We need to remember that fiber remains the first and most important ingredient in every equine diet for several reasons

- It provides all the energy horses need for everyday maintenance metabolism
- It keeps the digestive system functioning properly (not causing bad pH changes and killing bacteria)
- It prevents high-carb feeds from packing in the gut (leading to dehydration, colic etc)

Unfortunately feed manufacturers are required by law to declare some uninformative numbers and it takes some calculating and further reading of actual ingredients to understand the quality of the feed.

References

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