Nutrition 101: Carbohydrates I

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All animals require energy to exist. Energy can be derived from several sources, including carbohydrates, protein, and fat. However, carbohydrates, or carbs, provide most of the energy needed by ruminants and pseudo-ruminants. These nutrients are the end product of photosynthesis, which is the process by which plants change solar energy into chemical energy.

Carbohydrates are divided into two main groups: simple and complex. The simple carbs include such familiar items as sugars and starches. Complex carbohydrates include fiber, and will be discussed in the next article.

The base units are single molecule sugars or monosaccharides. These include glucose and fructose. Disaccharides (two sugars chemically bonded) include lactose or milk sugar (glucose and galactose) and sucrose, otherwise known as common table sugar (glucose and fructose).

Starches and glycogen are polysaccharides (long chains) of glucose. However, the former is produced by plants, and the latter is branched and is made and stored in animal tissue.

Ruminants and carbohydrates

Although ruminants and pseudo-ruminants can digest simple carbohydrates, the microorganisms in the rumen are so efficient that 5% or less usually escapes microbial digestion. Glucose is a preferred energy source for microbes. This is because it does not require any enzymatic modification before use. Both microorganisms and animals utilize a biochemical pathway known as “glycolysis” to break glucose down to smaller units. Energy is released when chemical bonds are broken.

Although all animals and microorganisms use glycolysis, higher animals have evolved additional steps that wring even more energy from glucose. Certain organs, including the brain and heart, require glucose for energy.

When sugars or starches are fed to ruminants, they produce a rapid burst of energy. This can be harmful to the ruminant if sugar or starch (as in grain) is consumed in a large quantity. One problem associated with over-consumption of grain is laminitis or “founder”. This may leave an animal permanently lame. If treated promptly, the damage to the hooves or digits can be minimized. Founder can also result from the grazing of lush pasture. Fast-growing forage, as in the spring or after a lot of rain (especially after a dry spell or drought), is high in simple carbohydrates. Limit grazing time during peak pasture growth to avoid founder. Symptoms include hooves or digits that are hot and/or sensitive to the touch.

Ruminants and pseudo-ruminants should only be fed grain, or supplements that contain grain, when they need extra energy. Lactation and the period after weaning are two such examples. The feeding of grain in excess of requirement will also result in the storage of the extra energy as fat.

It is important to note that most (60 to 75%) of the energy utilized by ruminants and pseudo-ruminants is actually derived from a by-product of microbial metabolism. Volatile or short-chain fatty acids (VFA or SCFA) are not carbohydrates, and are not processed through glycolysis. These mammals have evolved a symbiotic relationship with the mi-

croorganisms that inhabit the rumen. Energy production is just one of the benefits of this relationship.

Rumen microbial populations are determined by what the animal eats. Feedlot cattle have a microbial landscape which differs from that of an alpaca on pasture. However, both derive most of their energy from VFA, despite the fact that the feedlot steer consumes a diet that can be 95% grain or more.

Although all nonruminant species (including humans) depend on microbial digestion to some extent, the bulk of their energy is derived from glycolysis and additional biochemical cycles. The exceptions are nonruminant herbivores such as equine species. These animals depend to a much larger extent on VFA generated by the microorganisms in their hindgut.

About the author:

Lark Burnham received a B.S. in Animal Science (1979), from Kansas State University and a M.S. in non-ruminant nutrition (1995) from Kansas State Universtity, Manhattan, and a Ph.D. Doctorate in ruminant nutrition (2004) from Texas Tech University, Lubbock. Her special interests are comparative nutrition, the role of the micro flora in all mammals, fiber digestion, and probiotics. Lark currently works for Natur's Way. Inc., Horton, KS, which produces MSE probiotics.