Excerpt from Revised *Understanding Equine Nutrition*: Energy and Carbs

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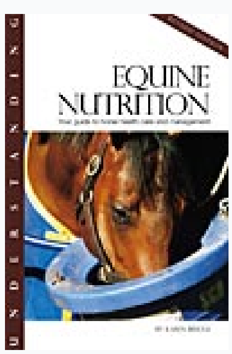
If forages provide the "maintenance" energy horses need for the workings of everyday life--grazing, sleeping, wandering from pasture to pasture, maintaining internal temperature--then cereal grains are the turbo-charged portion of the diet. Their main function is to provide higher concentrations of energy, in the form of carbohydrates and starches, so that the horse can do the work we ask of him.

The amount of energy your horse needs rises in direct proportion to how fast, how long, and how hard you expect him to perform. At the lowest end of the spectrum are horses that are idle, or perhaps work only a few times a week at a very slow pace. Most pleasure horses and school horses fall into this category. At the opposite end are racehorses, which probably work harder than any other category of equine athlete (particularly because they're often asked for peak performance while they're still physically immature). Somewhere in between might be your equine athlete--whether he's a Western pleasure horse, a Grand Prix jumper, a polo pony, or one of a four-in-hand driving team. His energy requirements will more than likely not be completely met by hay or pasture alone.

Work isn't the only thing that can raise a horse's energy requirements above the maintenance level. Environmental conditions, his physical fitness, and his degree of fatigue all play roles. Even when all of these factors are identical, individuals can vary in their energy needs. We all know of high-strung horses that are "hard keepers" and their metabolic opposites, the easy-going types that maintain weight easily, even in hard work. Both breed type and temperament play roles here.

Understanding Equine Nutrition



What are the nutritional needs of your horse? Misconceptions abound about how much food horses actually require to remain healthy and perform their designated jobs. ***Understanding***

Equine Nutrition (Revised Edition) helps horse owners sift through all the ingredients and decide on the best nutritional plan for their horse. The revised edition of ***Understanding Equine Nutrition*** contains the latest information from the National Research Council on nutrition requirements for horses.

Author Karen Briggs discusses the different equine food groups in an easy-to-understand manner. Whether the horse is a growing yearling, a high-performance athlete, a weekend pleasure mount, or an in-foal mare, this essential guide will help owners cut through the jargon, sort out the ingredients, and make a feeding plan and menu that is best for their horse. Briggs, a horsewoman and equine nutritionist, resides in Roseneath, Ontario, Canada. She has been a frequent contributor to *The Horse: Your Guide to Equine Health Care* magazine.

Pregnancy also places increased energy demands on the mare, especially in the latter half of gestation, when the fetus is developing most rapidly. Lactation and growth are two other situations in which energy needs are higher than usual.

Even a horse's size can have something to do with energy requirements. Studies have indicated that the energy requirement of horses at rest is proportional to the horse's bodyweight--so in theory, the energy requirement of a 500-pound pony is about half that of a 1,000-pound horse.

Unlocking the Energy

Carbohydrates and starches, contained in grains, are the most convenient ways to provide extra energy to your horse. A carbohydrate molecule is composed of simple sugars (also called monosaccharides) such as fructose, glucose, galactose, mannose, arabinose, and xylose. There are also disaccharides, which are two sugars bonded together. Lactose, made up of one glucose and one galactose molecule, is an important one for foals of nursing age.

Many glucose molecules, attached together by "alpha bonds," form the polysaccharides called starch (present in plants), and glycogen (present in animals). These two are sometimes called soluble or non-fiber carbohydrates, and both are readily used by the horse, providing much of his dietary energy. But other forms of carbohydrates contribute a substantial amount of "juice" as well. As we saw in the previous chapter, glucose molecules that are attached together by "beta bonds" instead of alpha bonds, form the polysaccharide cellulose (insoluble fiber). Likewise, hemicellulose is constructed of many molecules of the monosaccharide xylose, connected by beta bonds. So while we consider fiber and carbohydrates to be two entirely different things, they are really very closely related.

Monosaccharides are the only form of carbohydrate that can be absorbed from the intestinal tract, so the alpha or beta bonds of polysaccharides must be broken down in the gut before the horse can begin to use (or store) the simple sugars. The digestive enzyme amylase is responsible for this important job. All animals secrete amylase, primarily from the pancreas, into the small intestine. Amylase takes care of the first step of carbohydrate digestion, breaking the polysaccharide molecules down into a disaccharide (a two-sugar molecule) called maltose. After that, the disaccharide enzyme maltase takes over and further breaks down maltose into its monosaccharide components. Two other digestive enzymes, lactase and sucrase, also might be called into play if lactose (milk sugar) or sucrose (table sugar) is present in the gut. (Lactase is usually present only in young, nursing horses and later becomes scarce enough that adult horses have difficulty digesting milk products and usually end up with diarrhea.) Because these enzymes emanate from the interior intestinal wall, any damage to that area (as from enteritis, for example) results in impaired carbohydrate utilization. Large amounts of carbohydrates can remain in the gut, again causing diarrhea.

The simple sugars that pass through the intestinal wall are almost immediately available for energy use. Often, however, the energy isn't needed right at that moment, so the body busily begins re-assembling the sugars in the form of glycogen so they can be stored. Storage depots in the liver and muscles (and to a lesser extent, the kidneys) give the horse a substantial energy warehouse, and if these storage areas become full, any extra monosaccharides are then converted to and stored as fat. Both glycogen and fat can be drawn on for energy whenever they're needed (**read more on fats**). The hormone insulin acts as a glucose regulator in the bloodstream, determining how much sugar remains there and how much gets stored.

Determining Dietary Energy

Not all the energy contained in a feed is accessible to the horse. A significant portion of it is lost in the conversion process of digestion. The Digestible Energy (DE) is the value most often used to describe the usable portion of the total energy, or Gross Energy. It consists of the portion of energy NOT lost in the feces. However, like many things in the nutritional world, it isn't perfect: The DE value doesn't take into account energy lost in urine (and to a lesser extent, in gastrointestinal gases such as methane), nor energy lost as heat in the actual digestion and absorption of the food. Nonetheless, DE values for foods are far easier to come by than values that do take these minor factors into account (which are far more difficult to calculate), so DE is the unit in common usage. Just keep in mind that when you see a DE value, it's likely to be a little generous.

Another way of calculating the energy content of feeds is by the familiar Calorie, the amount of heat generated by oxidation (burning) to raise the temperature of a kilogram of water by one degree Celsius. (The capital-C calorie is actually shorthand for a kilocalorie; the original small-c calorie unit is the amount of heat required to raise the temperature of one gram of water one degree. It's too small a unit to be of practical use when discussing nutrition.) When dealing with horses and other large animals, nutritionists usually switch to the Megacalorie (Mcal), which is 1,000 kilocalories. It saves writing a lot of zeros.

A third unit in common use is TDN, or total digestible nutrients, a measure of digestible energy expressed in either weight or percentages. TDN is the sum of a feed's digestible carbohydrates, its digestible protein, and its digestible fats multiplied by 2.25 (because fats provide about 2.25 times more energy than carbohydrates or proteins). One kg TDN is approximately equal to 4.4 Mcal. (If you use TDN as the basis of your ration formulating, make sure you have a TDN value for horses, not ruminants, such as cattle. Ruminants are much more efficient, digestion-wise, than horses, so calculations for energy available from forages are generally 5% to 15% higher. If you formulate a ration for a horse based on ruminant TDN, you will likely be providing too little feed in the long run.)

A couple of formulas can help you calculate how much digestible energy your horse needs for his daily maintenance needs (without weight change).

For the average horse weighing less than 600 kg (1,320 lbs), use this formula:

Mcal DE/day = 1.4 + 0.03 x (kg body weight)

So for example, if your Standardbred mare weighs 450 kg (that's 990 pounds), she would require 1.4 + (0.03 x 450) Mcal ... which equals 14.9 Mcal of digestible energy per day for her maintenance metabolism.

If your horses weigh more than 600 kg, they will have lower energy needs per kilogram than smaller animals. So they have a slightly altered formula:

Mcal DE/day = 1.82 + (0.0383 x kg body weight)--[0.000015 x (kg body weight)2]

Using this formula, a 750 kg Belgian gelding, for example, would require 1.82 + 28.73--8.44 = 22.11 Mcal/day.

You also can do rough calculations for how much additional energy your horse will need for various kinds of work. For ponies and light horses, the Mcal DE/day for light, medium, and intense work has been estimated at (respectively) 1.25, 1.5, and 2.0 times the amount needed for maintenance. What constitutes light, medium, or intense work? It depends, of course, on a number of factors, but generally speaking, light work includes such activities as Western or English pleasure, trail riding, quiet pleasure driving, and acting as a beginner level lesson horse. Medium work encompasses functions like ranch work, roping, cutting, jumping, barrel racing, and dressage; and intense work includes race training, polo, endurance riding, and upper-level three-day eventing.

Given the opportunity and good health, horses will choose to consume enough feed to meet their energy needs as a rule. Four things can contribute to a horse's not getting enough energy:

1) A sufficient quantity of food is not available;

2) His gastrointestinal tract will not hold enough of the available feed because the DE density of the feed is too low (as with poor-quality hay, for example);

3) He can't consume enough because of a physical problem (such as an injury or dental problem);

4) He doesn't want to consume the feed because illness, stress, unpalatable feed, or inadequate water intake has left him with no appetite.

Regardless of the reason, the first sign of inadequate energy intake is a depressed attitude. Eventually, hormonal changes will decrease the body's energy utilization, shutting down growth in youngsters or milk production in broodmares, and reducing physical activity. These changes also will call on the system to draw on stored fats and carbohydrates, resulting in weight loss. The horse's stores of carbohydrates are depleted within the first few days of total food deprivation, and within a week, the body adapts, drawing on body fat and conserving the body protein.

But if starvation continues, the horse will have no choice but to turn to his structural protein for energy once the fat stores are depleted. First, proteins in the blood, intestines, and muscle are drawn on, followed by those lending structural support to bones, ligaments, tendons, and cartilage. By the time muscle wasting or weakness is evident, feed-deprivation-induced changes in other body functions are already well under way. The good news is that providing adequate calories usually can reverse the damage over time.

Far more common, fortunately, with domestic horses at least, is an energy excess. Horses that routinely receive too much feed will develop increased fat stores for a start. Some of the excess energy will also be given off as heat (a mechanism used by many animals, including humans); but the horse is unique in that he also compensates for excess energy intake by increasing his physical activity. The result is familiar to many of us: a snorting, shying, bucking explosion looking for a place to happen! In the young horse, excess energy also contributes to rapid growth, which can sometimes increase the risk of developmental orthopedic (bone and joint) problems. Reducing the amount of feed, especially grains, in the diet and providing more outlets for exercise will usually take care of this problem.

Carbs and Work

As we've noted, one of the best reasons for feeding your horse concentrated carbs is to fuel his ability to work over and above his normal maintenance metabolism. He can store the energy from grains in long glucose chains called glycogen, and call on these chains to power his performance.

During exercise, the horse's muscle fibers can tap into energy from muscle glycogen stores, from circulating blood glucose, or from stores in the liver. The longer the exercise interval, and the more intense the exercise, the more glycogen gets used up. When strenuous exercise continues for some time, the horse's muscle and liver glycogen stores can become seriously depleted, so maintaining carbohydrate availability is important, particularly for horses asked to do sustained work, such as endurance racing. Being asked to work hard with depleted glycogen stores hastens the onset of fatigue in these horses, though the effects of diminished glycogen stores on the performance of short-term, high-intensity athletes is less well understood.

The ability to replace depleted glycogen stores following exercise can be important for succeeding performance efforts, and some evidence suggests that the best time to do that is in the first few hours following an athletic effort. (Feeding both hay and grain post-exercise seems to do a better job of refilling glycogen stores than feeding hay alone.)

Delivering the Goods

Supplying your horse with energy-rich carbohydrates is as easy as running down to the feed store and picking up a bag of grain. Or is it? All grains contain large amounts of carbohydrates and starches, but not all grains are equivalent. Here's what they have in common: They are four to eight times as heavy as baled hay (per unit volume); they're low in fiber and about 50% higher in dietary energy than average-to-good quality hay; and starch makes up 55% or more of their total dry matter.

Grains with seed coats, like oats, tend to be somewhat lower in carbohydrates and higher in fiber than hull-less seeds like corn, which are very carbohydrate-dense. On the whole, starch digestibility by the horse is high--researchers estimate that the average horse uses from 87% to 100% of the starch he's given. And therein lies a problem. When a large grain meal hits the horse's small intestine, some of the starch is digested and absorbed as simple sugars, as it's meant to be, but the rest, instead of passing through the system undigested, is converted by the microflora in the cecum to volatile fatty acids and lactic acid. If the production of these acids is rapid enough (as can happen when a horse gets a large grain meal at one sitting--or when he breaks into the feed room and gorges), cecal acidosis can result--a condition that can trigger diarrhea, colic, and laminitis.

To reduce the risk of this reaction, it's wise to follow the old horseman's credo of "small meals, often." This gives the small intestine time to process the carbohydrates before the system moves everything along to the cecum. The more carbohydrates get in the small intestine, the less cecal acidosis. Because forage in the system can decrease the amount of grain processed in the small intestine, it's best not to feed hay for an hour or more before feeding grain, or for three or more hours afterward -- though this rule is more important for high-performance horses routinely receiving large amounts of carbohydrates than for the average pleasure horse eating only a small amount of supplemental grain.

Other approaches that can help include giving preference to grains with fiber-rich hulls, such as oats, or choosing grains processed by grinding, rolling, flaking, or heat treatment to improve the digestibility of the starches.

Readers are cautioned to seek the advice of a qualified veterinarian before proceeding with any diagnosis, treatment, or therapy.