High-Energy Feeds

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The importance of nutrition for optimal athletic performance, regardless of the level of competition, cannot be over-emphasized. We should on occasion refresh our understanding of some basic concepts and look at ways to meet the nutritional needs of the athletic horse. The first key concept seems obvious, but nonetheless is critical to understanding feeding the performance horse--the energy needed to run and jump ultimately comes from the food the horse eats. The old adage "you are what you eat" rings true when we think about feeding for performance.

The second important point is that energy is by far the most important consideration when designing a diet for a performance horse. Yes, the diet must supply all of the essential nutrients in appropriate quantities, and it is often necessary to supply various additives or supplements to ensure that the horse receives adequate amounts of vitamins and minerals. Nonetheless, it is the number of calories eaten that has the greatest bearing on a horse being able to perform to the best of its ability. If there is inadequate energy in the diet of a horse in training, he will lose weight and his performance will be subpar.

The daily energy needs of the high-performance horse (e.g., a racehorse, a three-day event horse, or an endurance athlete) can be more than twice those of the average "couch potato" horse. You need to provide your horse with adequate "groceries" so that he can maintain body condition during the rigors of training and competition. Here's where it can get tricky--the horse's digestive tract is primarily designed to extract energy from the feedstuffs available in its natural habitat--green grass. However, the high-performance horse simply cannot consume enough forage (pasture or hay) to meet his daily energy requirements. Therefore, we reach for more energy-dense feeds such as grains and fats to correct the energy deficit. All too frequently, however, the tendency is to overfeed grain and underfeed forage, the end result being increased risk for digestive upsets and, in some horses, recurrent problems with the muscle disorder tying-up (exertional rhabdomyolysis).

How Much Energy?

Energy isn't a nutrient. Rather, it is a measure of a feed's potential to drive body functions. Nutritionists refer to dietary energy in terms of kilocalories (kcal, equal to 1,000 calories) or megacalories (Mcal, where 1 Mcal=1,000 kcal) of digestible energy. Digestible energy (DE) refers to the amount of energy in the diet that is absorbed by the horse. Digestible energy requirements are calculated based on the horse's maintenance energy requirement--the amount needed to fuel all basic body functions--plus the additional energy needed for activity, such as running and jumping. The main sources of energy in the diet are starch, fat, protein, and fiber. All of these sources should be used in the diet of athletic horses, but they should be combined in specific ratios for optimal performance--more on this later.

Just how much energy does the performance horse need? The 1989 National Research Council recommendations state that daily energy intake should be increased by 25%, 50%, and 100% above maintenance requirements for horses engaged in light, medium, and intense exercise, respectively (see "Energy Requirements for Working Horses" on page 98). Light work might include equitation and other forms of pleasure riding, while horses engaged in racing, hunting, three-day events, and endurance activities would fall into the intense category. As a guide, a non-working, 1,100-lb (500-kg) Thoroughbred needs roughly 16 Mcal of DE per day. In contrast, that same horse in race training would require 32-33 Mcal of DE per day. These recommendations are backed up by practical experience. Studies of horses in race training have estimated that DE intakes of 28 to 32 Mcal/day are needed for Standardbreds, and 31 to 36 Mcal/day are needed for Thoroughbreds (see Gallagher et al. 1992; Southwood et al. 1993).

To understand why the performance horse cannot thrive on forage (pasture or hay) alone, let's do some simple arithmetic. A medium-quality timothy hay provides about 0.8 Mcal of DE per pound. For our Thoroughbred racehorse to meet his DE needs (32 Mcal), he would need to consume 40 pounds (18 kg) of hay per day--an impossible scenario! For one, the horse is not physically able to eat that amount of hay. In fact, he cannot eat even half that amount. As well, high forage intakes result in development of a "hay belly," which is an undesirable characteristic in a high-performance horse.

From Mouth to Muscle

Ultimately, the chemical energy obtained from the diet must be converted into mechanical energy in muscle. During exercise, there are two primary sources of energy--glucose and fatty acids. The horse's body uses these fuels in different forms and at different sites. Fats are stored in adipose tissue, as well as in and around muscle fibers, while glucose is stored as glycogen in muscle and in the liver. The type of fuel used during exercise will depend on work intensity, the muscle fiber makeup of the horse, conditioning status, and to some extent, diet.

More detail on these issues can be found elsewhere (see "Pre-Exercise Feeding" in the May 2000 issue of *The Horse*, online at **http://www.thehorse.com/ViewArticle.aspx?ID=177**). However, a few points need emphasis here. For galloping exercise, muscle glycogen is by far the most important fuel for muscle contraction. In fact, during racing muscle glycogen probably provides more than 80% of the horse's energy. Conversely, minimal energy will be contributed by fat during all-out galloping. Fat is a much more important fuel during lower intensity exercise, such as trotting and cantering.

Also realize that a horse's body can't synthesize glycogen from fat--he needs carbohydrates from grains or fiber sources to replenish liver and muscle glycogen stores. Regardless of exercise discipline, muscle glycogen is an important energy source. Horses will use a substantial amount of fat during endurance exercise where trotting and cantering are the primary gaits. However, glycogen is still vitally important because depletion of muscle glycogen stores will result in premature fatigue. Similarly, there is evidence that low muscle glycogen will impair high-intensity exercise performance (see Lacombe et al. 1999). Therefore, although there are some real benefits to adding fat to the diet of a performance horse, there must be an adequate supply of carbohydrates to allow restoration of glycogen stores.

Dietary Energy Sources

Energy in the diet is provided by four components--starch, fat, fiber, and protein:

- ***Starch***, a carbohydrate, is the primary component of cereal grains (oats, corn, and barley). Oats are about 50% starch, while corn and barley have more than 60% starch. Starch is the dietary energy source of choice for glycogen synthesis. During digestion, starch is broken down into glucose, which is then absorbed into the bloodstream and made available for glycogen synthesis in muscle and in the liver.
- ***Fats***, such as corn oil, soybean oil, or the fat contained in stabilized rice bran, are the most common sources of fat in the performance horse's diet. On a weight-for-weight basis, fat contains roughly 2.25

times as much energy as corn, oats, and barley. In particular, vegetable fats are very palatable and highly digestible.

Fat is particularly useful for horses which cannot or will not eat enough of the more traditional feedstuffs (hay and grain), the result being a steady decline in body condition and performance. Adding fat will increase the energy density of the diet so that a lower feed intake is required to maintain body weight. Adding fat also allows you to feed less grain, thereby helping to reduce the risk of digestive upsets associated with excess grain feeding. (For more information on feeding fat, see "Fat Burning" in the November 2000 issue of The Horse, online at **http://www.thehorse.com/viewarticle.aspx?ID=96&dpt=13**.)

- ***Fiber***, found in hay or pasture, is an energy source that is often overlooked in horse nutrition. The horse's hindgut is designed to ferment plant fiber, the main products of this process being volatile fatty acids (VFA). In the liver, these VFA can be used directly for energy, or converted to fat or glucose. Adequate dietary fiber is also essential for maintaining gut health and, in endurance horses, the large water and electrolyte reserve created by a high-fiber diet (which soaks up a lot of water that can be utilized later) can be used to stave off dehydration and electrolyte imbalances during exercise.

  However, not all fiber sources are created equal. Poor-quality hay contains large amounts of lignin, a non-digestible fiber. At the other end of the spectrum are the so-called "super fibers," such as beet pulp and soybean hulls. These fiber sources have the same beneficial aspects as forage fibers for maintaining gut health, but contain more energy. In fact, beet pulp or soy hulls provide as much energy as oats. Therefore, use of these super fibers gives us another means for reducing a horse's grain (starch) intake without compromising overall energy in the diet. (For more on fiber sources, see "Forage Alternatives" in the January 2001 issue of The Horse, online at **http://www.thehorse.com/ViewArticle.aspx?ID=74**.)

- ***Protein*** is not a primary energy source and, unlike fat and carbohydrates, is not stored in the body. However, if dietary protein is in excess of the horse's needs for synthesis of body proteins, some protein will be used for energy. For several reasons, though, very high-protein diets are not recommended for horses. First, water requirements increase with increased protein intake. Second, metabolism of protein in excess of requirements causes a build-up of nitrogen end-products (ammonia and urea) that can contribute to health problems. For example, high urinary ammonia can irritate the horse's lungs, contributing to chronic airway diseases.

Feeding Strategies

Enough of the theory--how do you safely meet the energy needs of the performance horse? One of the first considerations is how much feed we expect a performance horse to eat each day. The 1989 National Research Council text Nutrient Requirements of Horses (online at www. nap.edu/books/0309039894/html) provides guidelines for both the total amount of feed (hay and grain) that should be consumed by working horses and the ratio of forage to grain in the diet (see "Energy Requirements for Working Horses" on page 98).

The intake estimates are reasonable. For example, a working horse in the intense category (the high-level performer) will be expected to consume somewhere between 2% and 3% of its body weight as feed per day (22 to 33 pounds for a 1,100-pound horse or 9.9 to 14.9 kg for a 500-kg horse).

However, the ideal ratio of forage to concentrate will vary depending on the availability and energy content of the forage. Remember that alfalfa, on average, has a higher energy content than grass hay. Therefore, when alfalfa is the predominant forage (which is common in California), it is possible to feed more forage and less concentrate compared to a situation where lower-quality grass hay is fed.

Forage must form the foundation of the diet, as adequate fiber intake is essential for maintenance of proper gut function. A general recommendation is that the horse should receive at least 1% of its body weight per day as hay (or an alternative forage)--that's 11-12 pounds for our 1,100-pound horse. Feeding below the minimum forage amount might increase the risk of gastrointestinal problems such as colic and gastric ulcers. It is also desirable to give the horse free access to forage--the saliva produced when a horse nibbles on hay helps buffer gastric acidity. Allowing the horse to snack on pasture or hay throughout the day might reduce the incidence or severity of gastric ulceration. Feeding one of the newer grain concentrates that contains a super fiber, such as beet pulp, is another way to increase fiber intake.

Most commercially available grain concentrates contain all the major energy sources--starch, fat, fiber, and protein. As mentioned, don't view protein as a primary energy source. Protein requirements are around 10% of the total diet, although in most cases protein intake will be higher given the protein contents of common feed ingredients--oats at 11.5%, corn at 9%, timothy hay at 6-10%, and alfalfa hay at 15-20%. A concentrate with

10-12% protein is fine in most circumstances.

As much as possible, make use of fat and one of the "super fibers" to raise the energy content of the diet. Yes, some starch is required to provide glucose for synthesis of liver and muscle glycogen. However, there is an upper limit on the amount of grain that should be provided in a single meal. As a general rule, a single meal should contain no more than five pounds of grain. If larger amounts of starch are fed, the capacity of the small intestine to digest and absorb the starch can be overwhelmed such that a substantial amount of the starch passes into the large intestine. Within the large intestine, this starch will be rapidly fermented to lactic acid by bacteria, with the attendant risk for development of colic or carbohydrate overload-induced laminitis.

One way to reduce excessive starch in the diet is to feed beet pulp or soy hulls, which are low in starch. Soy hulls are used in pelleted feeds, while beet pulp is often incorporated into "sweet feed" mixes. Both of these fiber sources are quite palatable. A grain concentrate with added fat also helps reduce the starch content of the diet--those with a fat content between 7-10% are optimum for most performance horses.

Some commercial grain concentrates contain both fat and a super fiber. Currently, feeding this type of feed is the best approach to meeting the high-energy requirements of the performance horse.

The amount of dietary starch will need to be more drastically restricted when dealing with a horse which has recurrent tying-up problems, particularly Thoroughbreds with recurrent exertional rhabdomyolysis (RER). In those horses, high-starch diets appear to contribute to tying-up problems. Diets for those horses should emphasize the use of good-quality hay, highly fermentable fibers (beet pulp or soy hulls), and fat, with a smaller amount of starch (not more than five pounds of grain per day).

Water and Electrolytes

Other important dietary considerations for the performance horse are water and electrolytes. An average size non-working horse needs about six to eight gallons (20-30 liters) of water per day. Daily workouts can greatly increase water needs, as sweating followed by evaporative cooling at the skin surface is the primary means by which horses rid themselves of excess body heat. In hot weather, sweat fluid losses can be in excess of 10 liters per hour of exercise. As a result, the daily water requirements of a performance horse might be 50-60 liters or more. Ensure that plenty of fresh water is available at all times, and take advantage of the horse's desire to drink after exercise.

Sweat is also rich in electrolytes, particularly sodium, potassium, and chloride. As most forages and grain concentrates are relatively low in salt, some form of electrolyte supplementation is necessary for high-performance horses, particularly in the summer months when sweat electrolyte losses can be high. Be aware that not all electrolyte supplements are created equal. Some supplements contain a great deal of sugar (as sucrose or dextrose) and only small amounts of actual electrolytes. As an alternative, you can use common table salt or a 50:50 combination of table salt and "lite salt" (potassium chloride). Feed up to two to three ounces per day, divided into the morning and evening feeds. (For more information on electrolytes, see "Fluids and Electrolytes" in the April 2000 issue of The Horse, online at **http://www.thehorse.com/ViewArticle.aspx?ID=214**.)

Keep your performance horse's diet within these parameters, and he'll have the nutritional tools to do whatever you need him to do.

FURTHER READING

Briggs, K. Nutrition: Feeding the high-octane horse. *The Horse,* August 1998, 73-80. **http://www.thehorse.com/ViewArticle.aspx?ID=525**. Briggs, K. Nutrition: Feeding racehorses. *The Horse,* August 1999, 61-74. **http://www.thehorse.com/ViewArticle.aspx?ID=37**.

Gallagher, K.; Leech, J.; Stowe, H. Protein, energy and dry matter consumption by racing Thoroughbreds: A field survey. *Journal of Equine Veterinary Science,* 12, 43, 1992.

Geor, R.J. Body Fuel: What fuels the engine, and how does it run? *The Horse,* January 2000, 49-56. **http://www.thehorse.com/ViewArticle.aspx?ID=237**.

Lacombe, V.; Kinchcliff, K.W.; Geor, R.J.; Lauderdale, M.A. Exercise that induces substantial muscle glycogen depletion impairs subsequent anaerobic capacity. *Equine Veterinary Journal, Supplement 30, 293, 1999.*

Southwood, L.; Evans, D.; Hodgson, D.; Bryden, W.; Rose, R. Nutrient intake of horses in Thoroughbred and Standardbred stables. *Australian Veterinary Journal,* 70, 164, 1993.

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