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3910 Delaney Ferry Road
Versailles, Kentucky 40383
Phone 859.873.1988
Fax 859.873.3781

Observations and Recommendations for Feeding the Endurance Horse

KATHLEEN CRANDELL
Kentucky Equine Research, Inc., Versailles, Kentucky

"Riding a horse is not a gentle hobby, to be picked up and laid down like a game of solitaire. It is a grand passion. It seizes a person whole and, once it has done so, he will have to accept that his life will be radically changed."
–Ralph Waldo Emerson

Emerson most certainly understood the endurance rider. Anyone with the desire to spend hour upon hour in the saddle must have a "grand passion." Endurance riding is a form of "extreme" trail riding—long but fast-paced trail rides. The attraction of endurance riding over other equine competitions could be considered a combination of the desires to develop a strong relationship with an equine companion and experience nature, often in remote locations. It is a sport that appeals to any age group, with many competitors older than the top athletes of other equine sports. Endurance competitions are races over designated trails that cover 50 to 100 miles in one day or multiday challenges of 30 to 50 miles each day for two to five days. "Limited distance" (LD) is a milder version of endurance riding consisting of shorter distances like 10, 25, or 35 miles that is becoming popular in the United States. LDs are usually run at the same time as traditional endurance rides and are particularly useful for breaking in young or inexperienced horses (or riders) to the sport. The winner for either type of endurance race is the first to cross the finish line with a horse that is "fit to continue."

Training and competing horses for endurance is different than most other horse sports because of the type of effort and the amount of time spent working. Training involves many hours and many miles on the trail, usually maintaining either a trot or a canter with occasional walking when the terrain dictates slowing down. Rarely is there an all-out gallop, as in Thoroughbred racing, except maybe in a race for the finish (or when the horse runs away with the rider). Type of effort could be categorized as a combination of aerobic (using oxygen) and anaerobic (not using oxygen), but mostly aerobic. Aerobic work burns mostly stores of glycogen and fat with some direct-source utilization from circulating volatile fatty acids (VFAs) or glucose. With spurts of anaerobic exercise, lactic acid will build up in the muscle tissue. As the horse slows down into aerobic speeds, the accumulated lactic acid can be recycled as an aerobic fuel source. Thus, buildup of lactic acid is rarely a cause for fatigue in an endurance horse. With training, the threshold between aerobic and anaerobic will change, making more intense work still aerobic in these horses. The following discussion is on the types of feeds that are appropriate for fueling the work of the endurance horse on a daily basis and at a competition, and any other nutrients that might aid in their endeavors.

Daily Feeding

Forage and other fibrous feeds

Forage is perhaps the single most important ingredient in an endurance horse's diet. Not only is it a major source of energy and essential nutrients, but also the presence of fiber in the digestive tract provides bulk to keep the tract functioning properly, keeps blood flowing to the tract even during exercise, stimulates thirst, and holds water and electrolytes in a reservoir. Without the marvelous milieu of innumerable microbes populating the cecum and colon of the horse, forage would be indigestible. These microbes are not only responsible for breaking down the fiber in the forage but the end products of their fiber digestion are VFAs, which are sources of energy for the horse. The reason why the endurance horse is able to keep going for hours upon end has to do with the ability of these microbes to keep making VFAs that are absorbed into the bloodstream and distributed either to the liver (for conversion to glucose) or directly to the muscle cells to be used for aerobic energy formation. This, combined with the breaking down of glycogen stores in the muscle cells and the triglycerides from muscle and adipose tissue, makes for steady energy generation in the endurance horse. This type of energy generation is efficient for aerobic metabolism, but it is not sufficient to fuel a horse that is going at high speeds in an anaerobic state for very long. Adequate forage intake and a healthy microbial population are essential for proper fiber digestion, fuel production, and the successful performance of the endurance horse.

Most of the endurance horses in the United States have the advantage of 24-hour turnout on pasture, which even when forage is sparse has several advantages for the horse. First, free-choice access to nibble all day long is healthiest for horses since it is what their digestive tracts were designed to do and greatly reduces the risk of nutritional disorders like colic and ulcers. Second, the ability to move about freely is better for the joints, particularly if horses are starting to get arthritic, and for the muscle tissue, reducing risk of muscle cramping or tying-up. Third, grazing with the head down to the ground, milling around looking for tasty morsels, is relaxing to a horse—therapeutic and soothing. Green grass is more nutritious than hay because some nutrients are lost during the drying and storing of hay. Fresh grass is higher in the fat-soluble vitamins like vitamin A (as carotenes) and vitamin E; has more sugars and digestible fiber; and because of its high water content, aids in keeping the horse hydrated. Perhaps the only drawback to keeping the horses out all day is catching them when it is time to ride; they somehow know when time is short and choose that moment to refuse to be caught. Most of the pastures in the United States produce quality grass, but it is more difficult in tropical countries where the grasses contain antifactors that jeopardize quality (such as oxalates, bitter taste, mycotoxins, etc.). For those horses, getting fresh grass may mean it comes in the form of green chop fed to them in a stall or small paddock.

In many parts of the world, keeping an endurance horse out on pasture is not an option. In those cases forage will primarily be in the form of hay. For others, hay may be fed in addition to the pasture, especially in dry or winter seasons. There have been lengthy discussions on the right type of hay to feed an endurance horse, but what it all boils down to is getting the best hay that is accessible. This will vary between regions and from country to country. In general, daily use of legume hays like alfalfa (lucerne), clover, peanut, and pea is less desirable than grass hays because of their high protein and calcium content. However, legume hays are very desirable on the day(s) of the race for the same reasons as well as

for their palatability. In the United States, grass hay seems to be the hay most commonly fed to endurance horses with a small percentage of riders feeding some alfalfa. Feeding only legume hay to an endurance horse increases the risk of having metabolic problems like thumps during a race because of the effect of chronic high calcium intake on parathyroid hormone mobilization. Feeding alfalfa, especially in California, increases the risk of developing enteroliths, stones that form in the intestinal tract. Some endurance riders have no choice of what to feed because of the lack of availability of grass forages, and live with the risk. Many riders in traditionally alfalfa areas are paying significantly higher prices than those in grass-growing regions just to be able to get grass hay for their horses. Feeding mostly grass hay with some legume is still a very reasonable diet for an endurance horse, especially if the horse has no access to pasture. By feeding less legume hay, owners remove the risk of high-calcium complications because the total amount of calcium ends up significantly less.

A common practice around the world is to include some type of chaff in the horse's daily diet. Chaff is forage that is cut into fine (1-3 cm) pieces that can be made from alfalfa, grass hay, or straw, and commonly has a bit of molasses and/or oil sprayed on it to increase palatability and decrease dustiness. Chaff can also be fed at vet checks as an easy-to-chew source of fiber. It is common to mix the concentrate meal with some type of chaff, which serves two purposes: to get more fiber into the horse and to slow down the intake of the meal, which in turn will moderate the glycemic response. When chaff is not available, hay pellets (alfalfa or grass) serve the same purpose. Mixing with the grain or concentrate can improve intake, slow grain consumption, and reduce the risk of choking on the hay pellets. Hay pellets can be fed whole or softened in water and mixed with beet pulp or wheat bran.

The feed industry has contributed a couple of food by-products that have become fibrous staples in the endurance horse's diet. The most common of these are beet pulp and soy hulls, and sometimes these are called "super fibers" because they are higher in digestible fiber than hay and can supply a significant amount of calories by microbial fermentation. Soaked beet pulp is commonly fed alone or mixed with the concentrate portion of the diet. Beet pulp is also used in commercial horse feeds to increase the fiber content. Soy hulls are usually found in high-fiber commercial horse feeds and are rarely used as a stand-alone ingredient in the diet. Super fibers are very useful in getting more fiber into the diet when hay and/or grass is not adequate or giving the digestive tract a different type of fiber that may be broken down at a different speed than forage fibers. A combination of fiber types is important in developing a healthy microbial population that can contribute significantly to consistent energy generation.

Starchy feeds and sugars

While forage is a staple of the equine diet, alone it may not be able to provide enough calories for a hard-working horse. There are endurance horses that never see grain until they get to a competition, but they are becoming rarer. Traditionally, grains (such as corn, oats, barley, wheat, and sorghum) have been used to fill the need for additional calories. Further, for the missing nutrients in the forage, commercial concentrates (mixes of grains plus vitamins and minerals) have become the means of balancing out those needs. Grains are concentrated sources of calories for the horse because of their high starch levels. Starch is easily digested in the small intestine by enzymatic action and results in glucose which can be used immediately for cellular energy generation. Excessive glucose, can be stored away for use when

needed as glycogen (muscle or liver) or converted to fat in adipose tissue. Glucose is the only fuel that can be used by the brain, so some glucose is necessary in the diet. Fortunately for those horses that live on complete-forage diets, one of the VFAs produced by fermentation of fiber, propionate, can be converted to glucose in the liver. Providing some other source of glucose, such as starch, is a more dependable method of making sure the horse has an adequate supply of glucose for the brain and for building glycogen stores in muscle and liver.

Sugars are very simple in structure when compared to starches, but after digestion they result in the same fuel, glucose. Sugars are found in grasses to some extent but the most commonly recognized source of sugar is molasses. Molasses is used in concentrate feeds to increase palatability and in some countries is added to the horse's drinking water to encourage consumption and to hide the taste of different water when traveling. Honey is another source of sugar that is used occasionally in endurance horses because of its fructose content. Fructose is another simple sugar that has a slower absorption rate, which may be beneficial to a horse during a competition to give a steady supply of energy between meals on the trail.

Feeding straight grains can be done with endurance horses if there is a bias against commercial feeds. Horses generally like the taste of grains and seek them out, so it is an efficient way to get calories into them. The starch content and the digestibility of that starch will determine the amount of calories that the grain provides. Of the commonly fed grains, oats have the lowest amount of starch but the best starch digestibility. Corn and barley have higher starch contents but poor enzymatic starch digestibility unless heat treated in some way, so it is recommended to use steam-treated barley or corn. High amounts of whole, cracked, or ground corn can play havoc with the pH and eventually the health of the hindgut. This is because so much starch escapes enzymatic digestion in the small intestine and gets fermented by lactic-acid-producing microbes in the hindgut. Along these lines, any large grain meals in general should be avoided for similar reasons. To sidestep this problem, grain should not be fed in meals larger than 5 lb (2.5 kg) per feeding. Feeding smaller, more frequent meals may be the best solution for horses that have higher caloric requirements.

The largest difference between feeding a commercial concentrate and straight grains is the vitamin and mineral content. Even though grandfather fed straight oats, we have come a long way in our knowledge of vitamin and mineral requirements and now know that the balance of vitamins and minerals with forage and straight grains can be lacking for the sport horse. If straight grains are fed, then some type of vitamin/mineral supplement should also be fed to balance out the deficiencies of the diet. This can be done in a couple of ways, depending on the calcium and phosphorus balance of the grass/hay/grain diet. The truly adventurous can have the forage and grain analyzed, and then make a homemade mix to balance out what is missing. This requires excellent knowledge of requirements and skill with a calculator as well as contacts for finding the individual nutrients in available sources. For those not interested in going through the trouble, the easier way to balance is to buy either a vitamin/mineral supplement (if the calcium, phosphorus, and protein are adequate in the forage and grain) or a ration balancer pellet to mix with the grain. Ration balancer pellets are designed to supply additional protein, calcium, phosphorus, and other minerals and vitamins in a manner that balances out almost any forage-plus-grain diet. Ration balancer pellets are available from numerous feed manufacturers and are designed to be fed with grains or by themselves for a low-calorie diet.

Feeding commercial concentrates takes the guesswork out of trying to balance the diet if the feeding directions are followed. Commercial concentrates include sweet feeds (coarse mix, textured feeds, etc.), pelleted feeds, and extruded feeds, and all of these serve the same purpose: to supply additional calories, protein, vitamins, and minerals to complement the forage in the horse's diet. Calories in commercial concentrates come from starch sources (grains), sugar (molasses), fiber from super fibers (soy hulls and beet pulp), and fat (oil, rice bran, and flax). The amount of starch and sugar, collectively called NSC (nonstructural carbohydrates), in today's commercial concentrates varies greatly, from high (with greater than 50%) to extremely low (less than 10%). Therefore, different feeds will be capable of delivering varying amounts of glucose for the horse. The balance between the amounts of starch, fat, and fiber needed for a horse will depend on the individual and preferences of the owner, as well as the speed at which the horse is being trained or competed. Keeping the starch to a minimum is not only helpful for horses that are not in hard training (they do not need the extra calories), but high-fiber, high-fat feeds have been found to have a dampening influence on excitability. In the United States, many endurance riders are looking for feeds that will give the most fiber and fat and the least starch, but in countries where the horses are training faster and harder, the high-fiber, high-fat feeds will not keep weight on the horses as well, so they are fed greater amounts of feeds with higher starch values. The average concentrate consumption for an endurance horse in the United States is usually less than 5 lb (2.5 kg) per day, whereas in countries where horses are in training for faster speeds, they are fed more like Thoroughbred racehorses with grain intakes of 5-15 lb (2.5-7 kg) per day. The size of the meal can be a problem for the easy keeper if the commercial concentrate is fed below the recommended feeding rate and the horse does not get the right amount of protein, vitamins, and minerals. For this type of horse, using the ration balancer alone or mixed with a small amount of straight grains, commercial concentrate, or beet pulp would be the way to give a balanced diet.

Fat and fat sources

Fat is also becoming a popular staple in the endurance horse's diet because of its advantages over starch as an energy source, among other reasons. Fat is a more concentrated source of calories than starch, sugar, or fiber, thus decreasing bulk in the diet. When fat is digested it is absorbed in the form of triglycerides, not glucose, so it does not cause swings in glucose or insulin and has no effect on increasing excitability. Because fat is more energy dense, issues from high intakes of starch can be diminished. Research has shown that animals adapted to a higher-fat diet adjust their fuel usage accordingly, switching on the mechanism for burning fat as a fuel more effectively and sparing glycogen. The glycogen-sparing effect of fat has been the rationale for recommending to endurance riders that they feed their horses some fat for energy. To utilize fat as a fuel physiologically, it needs to have some carbohydrate to burn with, which underscores the importance of using diverse energy sources for the endurance horse. Fat can only be used in limited quantities, but it makes an excellent addition to any well-balanced diet for the endurance horse.

Fat suitable for use in horses comes in many different forms: vegetable oils like corn, soy, canola, sunflower, safflower, and linseed; powdered hydrogenated vegetable fats; high-fat grain by-products like rice bran; or seeds like flax, sunflower seeds, and roasted soybeans. The maximum level of tolerance for

fat in the diet has been found to be close to 15% of the total diet, but very few equine diets ever exceed 8%. Extremely high-fat diets may have an adverse affect on the horse, but usually there will be feed refusal before the physiological problems of too much fat manifest. Time to adapt to utilizing fat as an energy source is necessary for the horse to get the most benefit of a high-fat diet, and giving the horse at least 5-8 weeks of feeding fat daily before competing is recommended. Since fat is used as a source of aerobic energy generation, a high-fat diet may not be ideal for horses that are competing at higher speeds. Those horses will be much more dependent on the glycogen stores than fat stores and readily available glucose coming from the feed in the digestive tract.

Traditionally, fat has been fed to add calories to the diet but recent focus has been on other physiological benefits of different types of individual fatty acids found in fats. Omega-3 and omega-6 fatty acids and the balance between the two in the diet are being scrutinized because of their complementary/antagonistic effects. An optimal ratio of omega-3 and omega-6 in the diet appears to have effects on more than just giving a shiny, healthy-looking coat; it has been found to have an influence on the immune system and healthy joint tissues. Specific omega-3s such as alpha-linolenic (ALA) found in plant tissues like flax, and docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) found in marine oils are showing promise. The endurance horse may benefit from supplementation of omega-3 fatty acids because hay and grain diets tend to be high in omega-6, especially if oils like corn oil or sunflower oil are added. Rich omega-3 sources include flax (whole or ground but not meal because most of the fat has been removed), chia seeds, and fish oil supplements. Fish oil has the highest omega-3: omega-6 ratio of any supplement, and because it contains DHA and EPA, it is a superior source of omega-3. Flavored fish oil has been found to have excellent acceptance in horses in studies done at Kentucky Equine Research.

Protein

Protein needs for the mature endurance horse will usually be easily met by the forage, with additional amounts coming from grain or commercial concentrate. Protein requirements will be highest after a hard workout or a competition, but as intakes increase the amount of protein will rise proportionately and supply the elevated requirement. Chronic consumption of excessive protein could possibly be a problem when a horse is competing because of the associated heat production from the breakdown of protein for energy and the increase in blood urea nitrogen (BUN) that needs to be filtered out by the kidneys, causing increases in water requirement. Normally, except during starvation, proteins are of little importance as energy sources. Keeping with a commercial concentrate that has 10-12% protein or a balancer pellet with 25% protein (higher protein justified because of lower intake) will maintain protein well within the safe range. If a horse has poor muscle development, a lack of energy, and inability to focus, a dietary analysis may be necessary to see if more protein is needed.

Supplements

As we learn more about the requirements of athletic horses we find that, in general, forage is good at providing the majority of nutrients and energy. There is, however, a lot of variation between forages as to how much and which nutrients are supplied. Supplements may help to fill in the gaps by providing

certain nutrients required by the horse. Energy is usually the first thing noted as inadequate if the horse cannot maintain its weight on the forage. Additional energy is supplied by the starch, sugars, and fats discussed previously. Some supplements may have an influence on the way the energy is used or aid in the utilization of energy. More subtly, the differences between certain nutrients found in varying quantities in the forage may have an effect on the horse's ability to finish races, be competitive, fare well during competitions, and stay focused and sound. If the appropriate good-quality commercial concentrate or supplement is fed in recommended amounts to the horse, many of these nutrients will be supplied on a daily basis. Still, there may also be certain nutrients not found in the right quantities in forage or in commercial concentrates that may be beneficial to the successful endeavors of the competition horse.

It is important to point out that not every horse will respond dramatically to any specific supplement and that there may be variation in which supplements work best for each individual. Before deciding whether to use a supplement, it is always a good idea to check the list of acceptable substances from the governing organization (AERC, FEI, etc). With most organizations, the use of any drugs or performance-enhancing supplements is not acceptable because endurance horses are expected to compete using their own natural abilities. If it is a substance that is naturally occurring in the body or in the feed, or if it is a nutrient required by the body, it most likely will be acceptable. Several supplements commonly given to endurance horses are listed below, and the rationale behind how they might be beneficial to endurance horses is provided.

Probiotics and yeast. Beneficial bacteria and yeasts that occur naturally in the digestive tract of the horse live in delicate balance. Stress and any factor that affects feed intake can upset that balance. Giving supplemental beneficial bacteria (probiotics) and/or yeast mixes can aid in rebalancing the microbial population and maintaining gut health. Further, they may help with fiber digestion. Probiotics and yeasts can be used daily or just around the time of the competition.

Antacids and buffers. Endurance horses may benefit from the use of stomach antacids because of the abuse the stomach must endure from the high salt content of electrolytes, erratic intakes caused by the stress of traveling, and the possibility of the presence of ulcers. Products for stomach buffering can contain minerals that have a coating action and other minerals that buffer the acid content of the stomach. Mineral-containing antacids are acceptable substances, while drugs affecting acid production are not. Some riders mix antacids into the electrolyte mixture that is being syringed into the horse. Antacids can be used on a daily basis for horses prone to ulcers or solely at the competition.

Antioxidants like vitamin E, vitamin C, selenium, and lipoic acid. All of these antioxidants are present in the horse's diet in varying amounts (vitamin C can be made by the liver from glucose). Each antioxidant works in a different way, but as a whole they may have a beneficial effect on scavenging free radicals and preventing cellular damage. Supplementation should be on a daily basis but some acute supplementation can also be done at the competition (especially vitamins E and C).

B-vitamins. These are important components in enzymes in almost every step of cellular energy generation. B-vitamins are normally supplied by the diet or from microbial fermentation by-products, but supply may be inadequate in stressful situations like competition, decreased appetite, digestive problems, or periods of fasting—all of which can occur during an endurance competition. B-vitamins are not stored in

the body and need to be fed at the time of need. Generally, B-vitamins do not need to be supplemented on a daily basis and would be most useful as a supplement during travel and at the competition.

Branch chain amino acids (leucine, isoleucine, and valine). These are important muscle amino acids and supplementation with additional branch chain amino acids may reduce muscle breakdown and muscle wasting that occurs during competition and possibly prevent muscle soreness after the race. They should be given before and during the race. Further benefit might occur after the race to help restore damaged muscle tissue. Research on the effectiveness of branch chained amino acids in endurance horses has been ambivalent.

Joint supplements. Chondroitin sulfate, glucosamine, and hyularonic acid are compounds commonly found in joints and function as building blocks in cartilage and joint fluid to keep joints performing optimally. Oral supplementation of additional amounts of the compounds aims to supply more of the building blocks and minimize inflammation and discomfort. Joint supplements should be fed on a daily basis to have an effect. The AERC has these three substances listed as allowed substances but disallows some other common ingredients in joint supplements like MSM and yucca.

Electrolytes. These are needed for replacing sodium, chloride, potassium, calcium, and magnesium lost in sweat to help maintain fluid balance. Significant amounts of electrolytes are found in the normal feed of the horse (hay and concentrate) and should be supplemented if the horse is sweating heavily, as is common during an endurance ride, particularly in the warmer months of the year. Only oral supplementation is permitted by the AERC at an endurance competition by dosing syringe or mixed into the feed or water.

Carnitine. Carnitine is a naturally-occurring vitamin synthesized from the amino acids lysine and methionine in the body of the horse. It shuttles free fatty acids into the mitochondria for energy. In the exercising horse, supplementation would theoretically facilitate the use of fatty acids as a muscle fuel, sparing glycogen. Supplementation is still more conjecture than fact when it comes to its effectiveness. If there is a protein (lysine) deficiency, it would affect synthesis of carnitine and affect fat utilization. For supplementation to be effective, carnitine should be fed daily, not just during the race. This nutrient is in the grey zone of prohibitive substances because it is a naturally-occurring substance but may be perceived to have a performance-enhancing effect.

Energy supplements like corn syrup, honey, commercial carbohydrate loaders. Used to keep a steady supply of glucose going to the muscle cells for energy, these substances can be mixed in feed or dosed by syringe. Timing is crucial for effectiveness of this type of supplementation because of the dangers associated with insulin spikes and subsequent glucose crash.

Whether any of these supplements may be of any assistance to a horse will depend on the individual and/or the existing supply in the diet. Care should be taken in not overdosing the supplements because some of them are toxic in high amounts. Some may need to be fed on a daily basis to have an effect while others may be most suitable when fed during a competition. When it comes to supplements, it is important to have realistic expectations of what supplements can actually do and not to expect miracles.

Feeding at the Competition

Traveling can be stressful for the endurance horse. Just how much it affects the horse depends on the length of the trip and the temperament and experience of the horse. Hydration can be an issue for those traveling longer distances especially in heat, because most horses do not drink well on trailers and the horse may have been sweating from nerves and/or heat. Upon arrival at ride camp, getting fluids into the horse should be a priority so that the horse starts the race hydrated. Until the day that endurance horses are allowed to receive intravenous fluids before a race, riders will have to settle for having to figure out how to get the horse to hydrate itself. Grazing is advisable if at all possible because of the high water content of fresh grass and the palatability is very enticing to a stressed horse. Offering plenty of forage should trigger the thirst response; if grass is not available, then hay will have the same effect. Giving a dose of electrolytes to make the horse thirsty and drink is an additional option as long as it does not put the horse off its feed. Pouring water over a concentrate meal just before serving or making mashes is another way to sneak water into the horse. The taste of the water at the ride location could deter a horse from drinking. Bringing water from home or adapting a horse to drink water with slight flavoring (molasses, apple juice, cider vinegar, stirring in a handful of sweet feed, etc.) at home before coming to the ride may ease the adjustment period to strange water at the camp. When flavored water is offered, an additional bucket of plain water should always be offered just in case the flavoring keeps the horse from drinking at that time.

It is advantageous to give the horse an opportunity to settle into the new environment by arriving with enough lead time to the race. Getting into a regular feeding routine helps the horse unwind from the travel and mentally prepare for the upcoming competition. Food is a priority in the life of a horse and eating is comforting and relaxing. Feeding at the same times as at home, and if more meals are necessary adding them in at in-between times, will keep the horse from fretting about when it is going to get fed. Of course, if there is no regular routine at home then the horse will already be adapted to an irregular delivery of feed but may be looking for the more subtle signs, like when the rider approaches the feed container. Getting a concentrate meal into the horse shortly after the forage meal would be helpful to top off the glycogen stores before the race. Feeding sloppy meals with as much water as the horse will tolerate the whole time at the competition will help with hydration.

Meals commonly fed to endurance horses can have any combinations of commercial concentrates, beet pulp, grains, wheat bran, rice bran, sliced apples and/or carrots, and anything that the rider thinks will entice the horse to eat. Ideally, the horse should have been having similar meals at home before coming to the ride so that the enzyme production and gut microbes are adapted. Feeding the same feed as at home is not only easier on the digestive tract, it is also more comforting to the horse because of the familiarity. However, the priority is to keep the horse eating and drinking especially prior to the start of the race, so if the horse gets finicky, finding what it will eat or drink will be important. What the horse eats the day before the ride will build up energy stores and could still be fueling the horse during the ride. Therefore, fueling up the 24 hours preceding the race is important so that the horse will have "gas in the tank" for the race. Timing of the last meal before the race is important. Feeding a grain/concentrate meal within four hours of starting the race is not advisable, because it may cause a spike in insulin at a time when insulin's action is counterproductive to performance.

Unlike sports in which the effort is over in a matter of minutes and the amount of forage in the gut is detrimental because of additional weight from fiber and water, having fiber in the gut is an advantage in endurance riding. The horse that does not eat is in danger of the digesta movement slowing, thereby developing metabolic problems or running out of fuel for athletic output. The fiber in the gut is undergoing fermentation whether the horse is sleeping or running, so there is a steady release of VFAs into the bloodstream as the horse is traveling down the trail, which can be used readily by the muscle tissue for energy. As for the added weight, in the really fast races it may make a difference in the speed of the horse (to be carrying less gut fill), but it does increase the risk of running into problems.

During the race, perhaps the single most important key to successful completion of the race is the ability of the horse to eat whenever it has a chance. This puts many endurance riders in a panic at the pit stops, as they try to find something that will entice the finicky racer into eating. Ideally, whatever is going to be fed at the ride camp or during a race should be introduced to the horse before it ever steps on the trailer. Actually it is better for the horse if the feed received at the rest stops is something that is normally being fed at home. Drastic changes in feed ingredients can cause digestive upset at a time when the horse can least afford the stress. However, every endurance rider has experienced the pull of their horse over to the neighbor's feed tub, and if it is just a few bites of a strange feed it may do little harm. If there is to be a smorgasbord at the rest stop, then a week or two before the race all the things that are going to be offered could be introduced in small amounts. For example, if the horse has a normal daily diet of a pelleted feed but will be offered a sweet feed at the race, then during the week before the race mix in a little of the sweet feed to the normal feed. Also, if a horse is not used to eating its concentrate meal wet, then starting with a small amount of water added to each meal and gradually increasing over a week or two will accustom the horse to eating a sloppy wet meal.

Type of forage appropriate at the race may differ from what is customary at home. The horse that normally gets only grass hay may benefit from some legume hay (alfalfa, peanut, clover, pea, etc.) at the ride and during the competition. Legumes are palatable and higher in calcium than grass hays, which aids in the work of muscle and nervous tissue and may have a buffering effect in stomach. Offering a little of the legume hay at home the week before the race will help the microbial population adjust to the different types of hay and reduce digestive upset. Even adding alfalfa pellets into the concentrate feeding would be of some assistance in the rebalancing of the microflora if feeding legume hay is not practical.

The faster the speed of the competition, the greater the need for glucose as a fuel. Sources that quickly supply glucose in the form of soluble carbohydrates are grains and sugars (molasses, honey, carb-loading supplements). Therefore, meals during the race, primarily at the pit stops, should emphasize grain intake over forage so that the horse can go out with a stomach full of something to supply glucose while the horse is on the trail. Further, high intakes of forage will increase the weight of the individual making it work harder to get down the trail. This strategy is not without risks; colic or dehydration are always potential problems. A glucose crash is also possible when glycogen levels get dangerously low in muscle tissue and circulating fuel is not keeping up with the muscular demands, causing the horse to "hit the wall." If insulin gets released after a high starch/sugar influx, then the horse will try to pull the glucose out of the bloodstream and store it away at a time when it is needed for energy generation. Timing is everything with the hormonal regulation of glucose. Knowing the horse is key to avoiding problems with feeding meals high in soluble carbohydrates. For safety's sake, some forage

should always be offered to horses at rest stops regardless of the speed they are traveling, especially if they are seeking it out.

How does fat in the diet fit into the energy picture during a competition? The current recommendation of avoiding feeding any type of fat on the day of the ride because it is not utilized may be oversimplifying things. Horses accustomed to added dietary fat have all the enzymes in place to digest fat efficiently and have a well-developed delivery system to get the fat (as fatty acids) to the muscle cells. There is some use of dietary fat during exercise, and even though it is slower to be metabolized, it can be an additional source of energy to glucose, although it cannot be the sole source. One adaptation that occurs with training is the increased use of fatty acids for fuel over glycogen. The proportion of free fatty acids used at any speed is higher in the fit horse because of an adaptive increase in the enzymes responsible for the uptake and breakdown of this fuel. In fact, fat utilization is the major energy system for aerobic exercise but mostly from the stored forms of fat (muscle triglycerides and mobilization of adipose tissue). This adaptation occurs particularly well when a horse is on a high fat diet—this is the glycogen-sparing effect. However, it is not a good idea to pour cups of oil over the horse's feed the day of the race and expect a result. Adaptation occurs over time and a horse will need to be on a high-fat diet for at least eight weeks to benefit from the changes in metabolism.

At the competition, if the horse has had a daily high-fat diet, then there is no reason to change the feed unless the horse refuses to eat it. Granted, higher-fat feeds tend to have higher rejection rates when the horse is tired and finicky or when a horse has a sour stomach from high intakes of electrolytes. As long as the horse is eating well, he may benefit from the additional energy. The fear of high-fat feeds slowing gastric emptying should not be a problem during a race with an endurance horse because they are not as affected by having food in the tract as humans. In fact, the presence of food in the tract is beneficial by keeping blood flowing to the digestive tract and helping with hydration.

After the competition when the horse has depleted glycogen stores, timing of feeding can be very important for refueling. There is a narrow window of just a couple of hours after the cessation of exercise when the body is most efficient at rebuilding the glycogen stores. For this reason, it would be important to give the endurance horse a grain meal after cooling out completely to help the horse recover more quickly. This is an especially important concept to employ if refueling for multiday rides. Complete repletion of the glycogen stores will actually take three to four days of rest to accomplish. Frequent small meals for the next couple of days will go a long way to rebuilding stores. Metabolism shifts into high gear during the race and takes a few days to wind down. During that time it is possible for a horse to lose a lot of weight if sufficient calories are not resupplied. Some riders fear that if they feed too much, the horse will be more susceptible to tying-up, but the chances of that happening are most unlikely. There may be a problem in getting the horse to regain weight lost during a ride, especially if the horse remains in training and is preparing for the next ride.

Feeding the endurance horse properly may make the difference in whether the horse can complete the ride and how well the horse recovers from the competition. Finding the right combination of feedstuffs for optimal performance is easier if the rationale for why each ingredient might be important is understood.