Nutritional Concerns for Exercising Horses

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The horse is a unique specie of livestock because its primary purpose is for pleasure or work. Equine nutritionists have long been concerned with supplying the correct amounts and types of nutrients to achieve maximum exercise performance. It is the nutritionists' goal to maximize the nutritional impact on exercise, so owners can prioritize exercise and breeding programs that produce and maintain the desired equine athlete.

Categorizing Different Types of Exercise

Different uses require horses to perform different types of exercise. Exercise types differ in duration and intensities, and these differences affect usage of energy. In general, exercise is classified into two categories: aerobic and anaerobic. Aerobic exercise is typical of low intensity, long duration performance in which the horse's heart rate stays below the range of 150 beats per minute. Walking would be an example of a nearly pure aerobic exercise. On the other end of the exercise spectrum are those types of high intensity, short duration such as sprinting or draft work. These types of exercise are termed anaerobic and are characteristic of heart rates above 150 beats per minute.

Most horse uses are combinations of aerobic and anaerobic exercise or fall between the intensities and durations to be classified as purely one type or the other. While it is evident that different types of exercise impose distinctive demands on the horse's body, exercise in general will increase energy use for muscular activity, increase protein use if actively increasing muscle mass, increase the loss of minerals through sweat and increase the use of vitamins for catalyzing energetic pathways.

Energy Needs for Exercising Horses

Exercising horses have unique nutritional needs imposed on their bodies. Exercise creates changes in requirements for all nutrients; however, energy demands are affected the largest. In general, energy needs increase about 20 percent for light exercise. Light exercise can be described as exercising one to three hours per week with a mixture of walking, trotting and cantering. Energy needs increase as exercise frequency, length and intensity increase. Increasing exercise to three to five hours per week with small increases in intensity will increase energy requirements an additional 20 percent. Energy needs for very heavy exercise, i.e. one hour of speed work with six to 12 hours of slow work, can approach needs twice the energy required for a similar horse at maintenance with no exercise.

Feedstuffs contain compounds that supply energy. Feedstuffs are broken down into smaller compounds, and the body uses the energy containing compounds to supply fuel to the body. Different types of exercise affect how and which compounds are broken down to supply energy. Aerobic levels of exercise, those eliciting heart rates of 150 beats per minute or less, allow for production of energy through pathways that require the presence of oxygen to break down energy containing compounds. Because the rate of energy needed for aerobic exercise is relatively slow, the cardiovascular and respiratory systems can supply sufficient oxygen for pathways to function. A large variety of energy-containing substances can be broken down to fuel aerobic exercise. Also, some substances can be broken down for energy by combining aerobic and anaerobic pathways, so energy production is larger when aerobic metabolism can occur. Oxygen-dependent pathways will not meet energy needs in times of intense or prolonged work. The additional amount of energy needed at levels of exercise that elicit heart rates above 150 beats per minute will be supported by anaerobic pathways. The variety of substances that can be broken down for and the efficiency of energy production is less at these higher rates of exercise.

Energy Containing Compounds in Feedstuffs. Energy containing compounds are produced through nutrient breakdown to simpler forms such as glucose and fatty acids. Glucose can be broken down aerobically and anaerobically; fatty acids rely on aerobic pathways. Energy is supplied to the body through the metabolism of dietary non-fibrous and fibrous carbohydrates, fat and protein. Non-fibrous carbohydrates are supplied mainly from grains, include starches and sugars and are broken down to supply glucose for use in energetic pathways. Fats supply fatty acids. Fats are found mainly in grains and grain by-products. Protein is not considered a primary energy source in horses consuming adequate energy from other sources; however, net energy deficiencies, such as fasting, can cause large amounts of protein to be degraded to supply glucose to the body. Protein will also be used for energy or stored as fat if fed in excessive quantities as amino acids cannot simply be stored in the body.

Fibrous carbohydrates are supplied in large amounts from hays, pasture and grain by-products. Fiber is processed by the microbes in the horse's large intestine to produce volatile fatty acids. Volatile fatty acids are absorbed through the large intestine of the body and are used in various energy pathways in the body. Some types of these fatty acids are used exclusively aerobically, while others are processed by the liver to produce glucose, which can be used anaerobically.

Use of Energy Containing Compounds. Exercise increases the demand for energy, which is supplied from the breakdown of energy containing compounds in the body. Glucose stored as glycogen in the liver and muscle will be broken down to supply energy by aerobic and anaerobic pathways. The horse will also mobilize fat stores and break down protein stores to supply energy to maintain the body and replenish losses occurring from increased use for exercise.

How much the different types of compounds are broken down for supplying energy depends partially on the intensity of exercise. Fats and carbohydrates supply the majority of energy needs during highly aerobic exercise as both these types of compounds can be broken down by oxygen-dependent pathways. As intensity of exercise increases, so does the demand for immediate sources of energy. The ability of the body to break down fat stores as an energy source becomes limited because of the need for oxygen in pathways that breakdown fat. In addition, these pathways are relatively longer and more complex, resulting in a lower rate of energy conversion, thus a sudden increase in energy demands will result in a shift to anaerobic metabolism.

Carbohydrates can be partially metabolized from pathways that do not require oxygen. Carbohydrates, or more accurately the stored forms of glucose from carbohydrates, are the main source of energy during highly anaerobic exercise. The intensity of exercise, which cause the oxygen-dependent pathways to become overwhelmed varies among horses and the physical conditioning of the horse. Horses that have been adequately conditioned will be able to utilize aerobic energy systems to a much greater extent, even with heavy demands. Horses will vary in the capacities and genetic makeup of the various body systems that facilitate energy use during exercise.

The dietary supply of different types of energy containing compounds, i.e. carbohydrates and fats, can affect energy usage. Research has shown that rations containing fat at levels up to 15 percent can be utilized by horses. Typical examples of commercially available grain mixes with added fat contain about half that amount. However different processing methods, such as extrusion, allow for higher concentrations of fat. Even though some specialized fat supplements may be as high as 30 percent fat, forages typically have low levels of fat and, when fed together, do not exceed the recommendation of 15 percent total fat in the diet.

Fat added rations have benefits in supplying large amounts of energy per pound. The energy concentration in fat is about 2.5 times that of carbohydrates. Moreover, some evidence exists that fat added rations will assist in maintaining higher levels of glucose-containing compounds for exercising horses because of increased use of fat during the aerobic part of exercise. By using more fat during the aerobic phase of exercise, the amount of available glucose for use during anaerobic exercise would be greater. It is important when using this strategy to still offer sufficient quantities of carbohydrate in the diet.

Ration Analysis of Energy Containing Feedstuffs. Feedstuffs not only differ in energy concentration (i.e. Megacalories of Digestible Energy per pound-Mcal DE/lb), but also in the concentration of starch, fat and fiber. For example, corn is expected to contain about 1.6 Mcal DE/lb, 70 percent starch and 3 percent fiber, while oats are expected to contain around 1.3 Mcal DE per pound, 45 percent starch and 10 percent fiber. These relative concentrations are useful when analyzing the total intake of different rations fed at levels to meet the same digestible energy needs.

Table 1 provides a comparison of how energy supplying compounds can vary with different rations. The rations are estimated to supply the same amount of digestible energy, and contain different grain mixes with the same hay fed at the same ratios (70/30 ratio of hay to grain). The diet will meet the energy needs of an 1,100-pound horse in moderate exercise. The oats and hay ration in Table 1 requires the highest amounts to be fed to meet energy needs and the horse would have to reach its upper limits of dry matter intake at 2.5 percent of body weight. Addition of corn to the oats-hay ration requires 1 pound less per day in feeding and increases the nonfibrous carbohydrates (NFC). Nonfibrous carbohydrates are mainly starch and sugar compounds. Adding corn to oats increases the energy concentration of the second ration so less can be fed. The additional non-fibrous carbohydrate from corn may enhance the metabolic efficiency to replenish glucose supplies when workloads are large or intense. Or, it simply may be more advantageous than the oat-hay ration because less ration intake is needed to supply the needed energy. Adding fat to the grain mix, as in the last ration, increases the amount of fat and decreases the amount of NFC fed per day. In addition, adding fat at 6 percent of the concentrate now requires only 27.4 pounds of feed and brings our total dry matter intake to 2.2 percent, which may be more easily achieved.

Both fat and nonfibrous carbohydrates can be efficiently used as energy substrate, but the ability of each to replenish different fuels for muscular exercise is specific (i.e., fat cannot produce glucose). The added fat diet has the benefit of supplying larger amounts of a safer energy type in smaller ration amounts, thus aiding as a guard against weight loss from net negative energy load during intense conditioning programs. Whether or not athletic performance is negatively affected by the lower starch content of the added fat ration depends on the type of athletic performance, the intensity of exercise and probably individual horse differences in utilizing different substrates. The exact needs for different energy components of rations designed for horses performing different types of exercise are not fully agreed upon by nutritionists. However, it is generally assumed that exercise of short, high intensity is better fueled by adequate concentrations of sugars and starches, while higher fat and fiber support the slower, longer term energy pathways needed for moderate or prolonged exercise.

Table 1. Comparison of energy content of three sample rations.

Ration Description[a]	*As fed intake Lb/day*	*NFC*[d]		*CFiber*[e]		*Fat*	
		%	*Lbs/day*	*%*	*Lbs/day*	*%*	*Lbs/day*
Oats + Hay	30	24.2	7.2	23.8	7.1	3.4	0.7
Oats + Corn +Hay[b]	29	27.1	7.8	23.0	6.6	3.2	0.9
Oats/Corn/Fat + Hay[c]	27.4	25.9	7.1	22.8	5.9	4.9	1.4

a All rations fed in a 70 – 30 ration with grass hay at levels to meet an example digestible energy requirement for a 1100 lb horse in Heavy Exercise of 27 Mcals per day

b Corn will now be substituted for oats, and the entire concentrate will be 60% oats and 40% corn. Grass hay will still comprise 70% of the diet.

c Concentrate is now supplemented at 6% fat.

d NFC – Non fiber carbohydrates which include sugars and starches.

e Crude fiber is one estimate of fibrous carbohydrates, but may underestimate total fiber of the ration.

Feeding Energy. There are several considerations for supplying energy to exercising horses. First, ideal body weight and condition for maximizing performance varies between individuals and conformation types. Most successful trainers condition horses into fitness and body condition through exercise programs, while maintaining generous supplies of energy instead of restricting energy intake to keep body weight off. Nonfibrous carbohydrates supply the horse with a source of glucose, the energy source for anaerobic exercise. Large amounts of nonfibrous carbohydrates at a single feeding increase the incidence of colic and founder, so three-a-day feedings are recommended when feeding horses large quantities of grain. Ideally, meals with high levels of starch should be limited to 3 to 4 pounds per feeding. Fat supplies large amounts of energy per unit weight and is used as an energy source for aerobic exercise. Fat may have its best benefit by maintaining the horse in energy balance during the long hours of conditioning, thus sparing the amount of glucose containing compounds in the muscle for the day of performance. Mixed grain diets with and without added fat have been used successfully to meet energy demands for exercising horses. Oats used alone with hay may be deficient and adversely affect athletic performance.

Protein Requirements

Long yearlings and two-year-olds need protein for maintenance and growth of muscle tissue. Exercise may increase the rate of muscle deposition, thus increasing the protein demand in young, exercising horses 10 to 20 percent above amounts needed for maintenance and normal growth. Proteins are large compounds made of individual amino acids. Several of the amino acids necessary for muscle deposition cannot be synthesized by the horse's body, and must be supplied by the diet. As such, the balance of these amino acids or protein quality is an important consideration for exercising horse diets. Lysine is the amino acid thought most limiting for growth in horses. Comparisons of protein and lysine requirements for different classes of horses are given in Table 2. As with energy, the protein and lysine content of different feedstuffs vary (Table 3).

Most commercially prepared grain mixes are formulated for exercising horses to contain between 12 and 14 percent protein with soybean meal supplementing the protein in the grain mixes. Protein deficiency in exercising horse diets should not be a concern if adequate amounts of grain mixes and hays are fed to meet energy needs. Protein quality rather than total protein content should be of more concern when formulating rations for exercising horses. Low-quality hays combined with grain mixes low in lysine can restrict muscle deposition in young horses, limiting athletic performance.

Table 2. Protein requirements for different classes of exercising horses with mature weights of 1,200 pounds.

Class of Horse	*Protein lb/day*	*Lysine gm/day*
Mature, maintenance	1.4	27
Mature, light work	1.5	30
Mature, moderate work	1.7	33
Long Yearling, no work	1.8	37
Long Yearling, light work	1.9	37
Long Yearling, moderate work	2.0	39

Table 3. Protein and lysine content (% as fed) of selected feedstuffs.

Feedstuff	*Protein (%)*	*Lysine (%)*
Oat	12	.39
Corn	9	.25
Prairie Hay	6	——
Alfalfa Hay	18	.80
Soybean Meal	44	2.87
Cottonseed Meal	41	1.68

Vitamin Requirements

Vitamins are probably the least understood, but most supplemented class of nutrients in horse rations. There are two general classes of vitamins, fat soluble and water soluble. The fat-soluble vitamins are stored in the horse's body for long periods of time. Vitamins A, D and E are the fat-soluble vitamins of concern in horse rations. Exercise and growth increase the estimated requirements for most vitamins; however, increasing the vitamin concentration in rations for exercising horses may not be necessary (Table 4). The increased need for vitamins may be more than met with the increased intake of ration in response to meeting energy needs.

The B vitamins are classified as water soluble. Thiamin and riboflavin are the two B vitamins most recommended to supplement in horse rations. The microbes in the horse's large intestine produce large quantities of B vitamins, and supplementation of most is considered unnecessary. Nonetheless, because of the close relationship of B vitamins with energy supplying pathways in the body, most trainers supplement B vitamins to exercising horses.

Many commercially prepared grain mixes have vitamin premixes added at levels to meet or exceed requirements for all classes of horses. If desired, an orally administered B vitamin supplement may be added to the feed. Most supplements have combinations of vitamins and minerals, so selection and use of only one supplement is desired to decrease the chance of excess feeding. Although practiced commonly, the routine use of injectable sources of vitamins has not been shown to be warranted.

Mineral Requirements

The need for additional minerals in rations formulated for exercising horses is largely related to the increased mineral loss through sweat. Sweat contains appreciable amounts of sodium, potassium, chloride, calcium and magnesium. As such, recommendations call for increases in these minerals for horses in environments or exercise conditions that promote sweating (Table 5).

Table 4. Recommended daily vitamin requirements for exercising horses with mature weights of 1,200 pounds.

Class of Horse	*Vit. A IU*	*Vit. D IU*	*Vit. E IU*	*Thiamin mg*	*Riboflavin mg*
Mature, maintenance	15000	3300	500	30	20
Mature, moderate work	22500	3300	900	56	22
Long Yearling, no work	16600	7400	740	28	19
Long Yearling, light work	16600	7400	740	28	19

Table 5. Recommended daily mineral requirements for exercising horses with mature weights of 1,200 pounds.

Class of Horse	*Calcium gm*	*Phosphorus gm*	*Sodium gm*	*Potassium gm*	*Magnesium gm*
Mature, maintenance	20	14	10	25	8
Mature, moderate work	35	21	18	32	11
Long Yearling, no work	37	21	8	19	6
Long Yearling, light work	37	21	11	22	11

In general, many of the mineral needs increase slightly with exercise. The need for additional salt (sodium chloride) is of most concern. Unlike most minerals, horses can self regulate salt needs by access to salt blocks as long as there is free access to water. However, salt intake can vary widely between horses, and should be monitored to ensure an adequate level of intake. The form of salt offered may also affect intake, with loose salt typically resulting in greater intake than salt blocks. If consumed at the recommended level of intake, trace mineralized salt blocks should supply most, if not all, the additional mineral needs for exercising horses. Some types of intense, prolonged work such as endurance riding may necessitate oral supplementation with liquid or paste electrolyte mixtures. A sample daily electrolyte mix would contain approximately 4 grams sodium chloride, 2 grams potassium chloride and 0.2 grams magnesium sulfate.

Special Concerns for Feeding Exercising Horses

How nutrients are supplied to exercising horses can be more of a factor to success than what is being fed. Changes in environment, hauling and other factors that disrupt the horse's normal schedule can cause the horse's appetite to be depressed. As such, the potential for weight loss and poor performance is increased.

Starch Overload. One area of concern when feeding large amounts of grain daily is the potential for starch over-load. Large amounts of starch or NFC at one time overwhelm the capacity of the horse's stomach and small intestine. The undigested starch passes into the large intestine where the normal microbial flora digest it. Large amounts of microbial digestion of starch can lead to colic and founder. As a general rule, grain mixes should be limited to levels of 0.5 percent of body weight at one feeding, with some researchers recommending only 0.2 to 0.4 percent of body weight at one time. However, it must be remembered that these values depend on the amount of starch contained within the feed, not simply that the feed is considered to be "grain." Many current feeds actually contain a higher concentration of fiber, and may be safer to feed than traditional concentrates. Therefore, if high levels of grain are needed for heavily exercising horses to meet energy demands, it should be split into multiple feedings.

Timing of Feeding. Another concern among trainers is the timing of feeding in relation to exercise, especially in relation to high-intensity, single bout exercise, such as racing. It is good management to allow the horse to digest its ration at least two to four hours before beginning any physical exertion. This delay would allow the majority of nutrients to pass from the stomach to the intestines of the horse. It is not recommended to restrict the horse's ration prior to the day of exercise. Restriction of diet for longer than 6 to 12 hours prior to exercise may decrease the availability of energy and hence decrease athletic performance. Trainers should be careful not to make abrupt changes in the composition of the ration by restricting grain or hay or changing feeding times immediately prior to exercise. It is likely that the horse's schedule will become disrupted on the day of performance, and the added change of diet may cause digestive tract disorders. For horses competing in less strenuous activities, time of feeding may not be as critical and normal routines should be maintained.

Body Weight Regulation. Horses, like other athletes, are individuals and must be managed as such if maximum athletic performance is to be achieved. Horses can be expected to have an ideal performance weight, and body condition will vary slightly between individuals maintaining their ideal weight. Every trainer has a subjective ability to visually determine body weight, however unnoticeable changes may be large enough to cause differences in performance. For that reason, some race tracks and training facilities provide scales. Comparisons of athletic performance at different body weights, weight changes before and after performance and general trends of weight changes through a conditioning program assist the trainers in regulating the nutritional and conditioning programs for each horse.

Water. Although water was not previously discussed, it is a nutrient of vital concern to horses. Dehydration leads to decreased performance or more serious health problems causing shock and death. The only time it is recommended to restrict water intake is immediately prior to exercise and during immediate recovery from exercise when heart and respiration rates are elevated. At these times small amounts of water given frequently will guard against dehydration without increasing the potential for digestive upset. Ensuring adequate water intake rather than water restriction should be more of a concern, especially in hot, humid environments or prolonged bouts of exercise.

Quality of Feedstuffs. Exercising horses must consume large amounts of feed per day to meet nutrient needs. Feedstuffs must be of high quality, clean and fresh. It is not sufficient to feed large amounts of low quality or unbalanced rations in hopes that requirements will be met.

In summary, exercise can have a dramatic effect on the nutrient requirements of horses. Exercising horses can be expected to be highly individual in their needs for different nutrients and their acceptance of different rations. Exercise can place large nutrient demands on the horse, and intense management is necessary to ensure adequate intakes of balanced rations for exercising horses. Decreased athletic performance and feed related health disorders are significant problems that must be guarded against through proper ration selection and feeding management. Nutrition is but one part of athletic performance. It may be the easiest part to control; however, it will not overcome poor genetics or conditioning programs. On the other hand, it can be optimized and should not be limiting to athletic performance.

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