PHOTOGRAPHS | MARK LLEWELLYN

Racehorses require nutrients that allow them to reach maximal speeds within just a few strides and to sustain athletic effort.

FEEDING Performance Horses

Horses are superior athletes. Physical adaptations through evolution have given horses speed and endurance. Selective breeding has narrowed and refined desirable athletic abilities in modern horses. Some of the physiologic adaptations include high maximal aerobic capacity, large intramuscular stores of glycogen, specific ratios of muscle fiber types within breeds, splenic contraction to increase circulating red blood cells, efficient gaits, and the ability to regulate heat stress through sweating.

The inherent athletic ability of the horse is impressive. However, to achieve optimal performance in any equine sport, a conditioning program must be designed that improves cardiovascular function, capillary density in muscle, flexibility, bone strength, increased muscle mass, increased energy substrate storage, and more efficient utilization.

CARBOHYDRATES AND FATS

Performance horses require water, protein, minerals, vitamins and, most importantly, energy. Energy can be supplied by carbohydrate, fat, and protein. Protein is used very inefficiently for energy. Carbohydrates can be categorized by how they are digested. Grains such as oats, corn, and barley contain high levels of starch that are digested by enzymes in the stomach and small intestine. Forages and high-fiber by-products are composed primarily of cellulose, hemicellulose, pectins, and indigestible lignin. These structural carbohydrates vary tremendously in energy level, from beet pulp that has the same digestible energy as oats to mature grass hay, which can provide 65-75% less digestible energy.

The horse's hindgut is populated by microbes that can digest the fibrous structural components of roughages that cannot be digested by enzymatic digestion. Microbes ferment carbohydrates. Fermentation of structural carbohydrates in forage can help meet the energy needs of adult horses. When the microbes digest structural carbohydrates, they generate volatile fatty acids (VFA).

All horses require a minimum intake of roughage in their diet to maintain a healthy hindgut. The minimum daily forage intake is 1% of their body weight, but 1.5% is a more acceptable level. For example, an 1,100-lb (500-kg) horse would require 15 pounds of hay per day.

Balancing high energy needs of hard-working performance horses and providing adequate fiber are important goals. Maintaining active

The power and speed necessary to compete in show jumping classes cannot usually be derived from a basic diet of oats and grass hay. Advances in feeding performance horses have allowed equine athletes to perform at levels once thought impossible.

fermentation of structural carbohydrate in the hindgut is one of the most complex aspects of feeding horses. Rules for feeding horses—don't feed more than 5 lb (2.27 kg) of concentrate at one meal (more frequent small meals are better), don't change concentrates or hay quickly, feed the same time every day, and so on—are designed to help horses maintain a healthy hindgut.

When horses are fed significant amounts of grain—more than 3 lb per meal—some of the soluble carbohydrate will escape enzymatic digestion in the stomach and small intestine (collectively called the foregut) and pass into the hindgut. The type of starch is also important. The starch in different grains is digested in the foregut to different extents; for example, oat starch is digested mostly in the foregut with very little (less than 10%) passing into the hindgut. However, corn starch is not efficiently digested by horses and up to 70% of the starch of cracked corn can enter the hindgut. The digestion of corn starch can be improved by steam-flaking. Therefore, processing is one way to reduce the amount of starch entering the hindgut.

Why is starch in the hindgut a concern? Horses fed significant amounts of grain have dramatic changes in the hindgut pH; it becomes acidic. This is the result of very rapid fermentation of the starch yielding significant concentrations of VFA. VFA are efficiently absorbed through the hindgut epithelium and, while they are considered "weak" acids, they will still cause a drop in pH. The problem with starch fermentation in the hindgut is that lactic acid-producing anaerobes favor the low pH. Furthermore, lactic acid is a stronger acid than VFA and is not easily absorbed from the hindgut. The lower pH can cause subclinical acidosis and lead to other more serious problems.

Reducing the amount of starch in feed by formulating it with highly digestible fiber sources is good for the hindgut. The most digestible fiber sources for feeds include beet pulp, soybean hulls, dehydrated alfalfa (lucerne), and almond hulls. Other fiber sources that are not as desirable include oat hulls (a by-product of oatmeal milling) and peanut hulls. Feeds formulated with high fiber (greater than 10% crude fiber) may be lower energy feeds if fat is not added.

Performance horses that are required to be calm might benefit from fat as an energy source.

Fat has 2.25 times more energy than grain, so added fat can replace starch in the feed and help maintain energy levels. Fat has also been used in feeds because it is characterized as a "cool energy" source. Research has shown that in horses adapted to fat (fed from 5-12 weeks) glycogen sparing is improved. Glycogen is the energy source that fuels around 80% of the exercise that horses perform. This allows more glycogen to be kept on reserve.

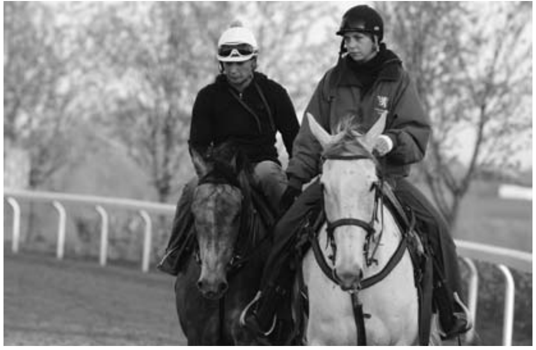
MINERALS

Calcium (Ca) and phosphorus (P) are critical for the constant bone-remodeling process in performance horses. The amounts and the ratio of Ca:P are both important. The ideal ratio of Ca to P is 2:1. When alfalfa hay is the primary source of forage, ratios can become much higher, up to 7:1, and over long periods of time may result in weaker bones. When horsemen feed plain oats and either poor-quality hay or pasture, which at times may have Ca:P ratios of 1:1, an inverted Ca:P ratio can be created. This is a serious problem that must be corrected. Commercial feeds are usually balanced for calcium and phosphorus, thereby removing any guesswork in considering calcium and phosphorus levels.

The National Research Council (NRC), in its *Nutrient Requirements of Horses*, Sixth Edition, recommends 0.1%-0.3% magnesium (Mg) for

Activity*	**Example**	**DE requirement (Mcal/day)**	**Energy increase above maintenance (%)**	**Amount of concentrate per day**	**Amount of hay per day (lb)********
Maintenance	Horses at pasture	15-18	0	1 lb balancer pellet**	17
Light	Recreational riding Beginning of training Show horses (occasional)	20	20	5 lb performance*** feed	17
Moderate	School horses Recreational riding Show horses (frequent) Polo (occasional)	23.3	40	7 lb performance feed	18
Heavy	Ranch work Polo (frequent) Low-medium level eventing Race training (middle stages)	26.6	60	9 lb performance feed	18
Very Heavy	Serious race training Endurance riding Elite three-day eventing	34.5	100	13 lb performance feed	19

*According to *Nutrient Requirements of Horses*, Sixth Edition. **Balancer pellet contains 27% crude protein, 2% fat, 5% crude fiber, 4.5% calcium, 2.5% phosphorus, 1466 IU/kg vitamin E. ***Performance feed contains 13% crude protein, 7% fat, 13% crude fiber, 0.9% calcium, 0.6% phosphorus, 220 IU/kg vitamin E. ****Hay refers to Bermudagrass hay.



Proper nutrition of the racehorse in training is paramount for top performance, but the reliable pony horse must also have adequate nutrition to be healthy and productive.

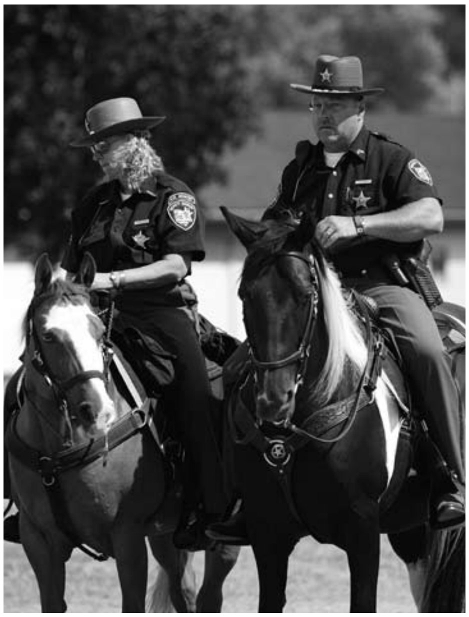
maintenance. This is equal to approximately 10-15 g per day based on at least 20 lb (9 kg) of dry matter intake. Most feedstuffs will easily meet this, and commercial feeds have magnesium added to the formulas.

Kentucky Equine Research (KER) has demonstrated an increase in the requirement for zinc in exercised horses. Because copper, zinc, and manganese compete for absorption, all three minerals should be increased in feeds for exercising horses. Electrolytes are lost in sweat and must be replaced. Forty to fifty grams of salt or one to two ounces will usually meet the needs of most horses. If the horse sweats excessively, then an additional one to two ounces of electrolytes should meet requirements.

VITAMINS

When horses do not have access to pasture and must rely on stored forage, there will be a decline in B vitamin status in the tissues and blood. B vitamins are produced in large quantities during fermentation in the hindgut. However, they are not efficiently absorbed from that section of the digestive tract, particularly when high-grain diets are fed and horses are under the stresses of training and showing. The NRC has published thiamin and riboflavin requirements that are based on body weight and affected by stage of production and level of work. Thiamin requirements increase from 30 to 62.5 mg in an 1100-lb (500-kg) horse in light exercise versus heavy exercise. Riboflavin requirements ranged from 20-25 mg respectively in the aforementioned horse. While requirements have not been established for niacin, biotin, folate, B_{12}, B_6, and pantothenic acid at this time, a well-balanced commercial feed for performance horses should contain these vitamins.

The energy requirements of these police horses differ considerably from those of racehorses.



Vitamins A, D, E, and K should be included in the feeds. Vitamin E deserves some special attention as an important antioxidant. Vitamin E is a component of a group of antioxidants that can “recycle” each other in the process of disabling reactive oxygen species (ROS). These peroxides and oxides are produced when horses exercise. They damage any cells they come into contact with including muscle cells and immunoglobulins. Other components of the system include lipoic acid, glutathione peroxidase, vitamin C, and ubiquinone. This system provides protection for muscle cells and enhances immunity. With the exception of vitamin E, the other “recycling” antioxidants are produced by the horse. One other limiting dietary nutrient essential to the system is selenium (Se). Selenium is part of glutathione peroxidase so adequate levels need to be included in feeds. In general, commercial feeds will contain around 0.3 mg/kg Se.

FEEDING PROGRAMS

Feeds are formulated based on the amount of energy a horse will receive for a given activity. The table on page 8 provides a starting point to help owners establish feeding programs and is adapted from *Nutrient Requirements of Horses*, Sixth Edition and *Equine Exercise Physiology* by K.W. Hinchcliff, R.J. Geor, and A.J. Kaneps. Remember that energy is the most important component of the ration and body condition score is the best way to monitor energy balance.

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