FATS AND PROTEINS RESEARCH FOUNDATION, INC.

Director's Digest

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NUTRITION FOR THE HIGH PERFORMANCE HORSE

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Owners and managers of competitive horses feed for physical performance, not for sheer growth or carcass qualities. So although there maybe many parallels between equine and food animal nutrition, the nutrition of the equine athlete remains a highly specialized field. The right feeds and feeding strategies can improve performance of the equine athlete dramatically.

Any athlete's physical exercise depends on the conversion of energy into various types and intensities of motion. But the total nutritional needs of the athlete require a more intensive analysis. Like the human athlete, the equine athlete has additional nutritional needs that include nutrients to support the biochemical conversion of energy to physiologic work-muscle contraction- and the maintenance of the mechanical load bearing system-the body- in which the work occurs. This is why total nutritional management is vital to optimum athletic performance of the horse. However, the greatest emphasis remains on energy metabolism-transformation of feed into physical motion.

The amount of motion that cam be applied to a given amount of weight is called endurance. Endurance depends on the amount of energy available for conversion to work. Likewise, the rate at which that weight can be moved-speed-depends in part on the rate at which energy can be metabolized. Thus, both energy reserves and the rate of mobilization of those reserves are important limiting factors. They determine both the speed and endurance limits of an individual equine athlete.

Energy reserves in the horse consist of either tissue-bound nutrients or blood-borne nutrients. Tissue-bound nutrients include muscle glycogen and protein and the fatty acids in adipose tissue. Blood-borne nutrients include glucose, free fatty acids and amino acids. The relative importance of these reserves is reflected in their proximity to muscle. Thus, intracellular glycogen stores are the most important energy source to an animal initiating motion. The breakdown of muscle protein provides significant amounts of energy as muscle glycogen becomes depleted. Fat cells interspersed amoung the muscle bundles are also important as local energy stores, but a horse has relatively small amounts of fat among its muscle bundles.

BLOOD BORNE NUTRIENTS:

Exercise physiologists often regard blood-borne nutrients simply as indicators of metabolism. Yet blood of the horse supplies the muscles with all of their energy that does not originate as intramuscular glycogen, free fatty acids or protein. Consequently, the efficiency with which blood-borne nutrients are replenished in the face of increasing uptake during exercise is an important rate-limiting step in the energetics of motion.

There are several primary sources of replenishment of blood-borne or circulating nutrients. The liver provides a small amount of glucose directly by mobilizing its own glycogen reserves. Much more glucose is made available via hepatic and renal gluconeogenesis from the lactic acid resulting from energy metabolism in myocytes and from the amino acid liberated by muscle protien degradation. The mobilization of triglycerides from adipocytes results in the secretion of free fatty acids. This is a major energy source for myocytes during prolonged exercise-lasting more than 30 seconds. The glycerol from triglycerides is also available for gluconeogenesis.

The ultimate origin of all energy supplies is the diet. Wild or feral horses may be fully capable of maintaining nutrient intake appropriate to their activity levels. However the modern equine athlete undergoing enforced workloads is dependent on its feeding program to efficiently and effectively support its activities.

The most effective means for enhancing the performance of the equine athlete is to couple patient conditioning programs with intelligent feeding programs. At the same tine, it may be possible to nutritionally enhance the performance of certain types of horses under certain conditions. There are a number of nutritional strategies.

ADMINISTERING GLUCOSE:

Studies relating increased speed and endurance to increased rates of muscle glycogen depletion have suggested that muscle energy supply, not lactate or ammonia toxicity, is the limiting factor in determining maximum speed or endurance. All types of physical work decrease the muscle glycogen content of horses. Despite the stimulation of hepatic gluconeogenesis during work, muscle glycogen in the horse is replaced at only 2% of the rate at which it is depleted.

There now are several different approaches to maximizing the glucose supply to the muscles during heavy exertion. The easiest and simplest method is to administer glucose solutions via oral drenching or intravenous infusion immediately prior to exertion. Acute administration of glucose does indeed dramatically increase plasma glucose concentrations in horses. A major function of insulin is to stimulate the transport of glucose into myocytes, apparently increasing intracellular energy supplies.

However, the subsequent fate of the glucose is storage via conversion to glycogen, not catabolism. Insulin triggers storage of glucose for several hours after glucose administration. In the end, this actually decreases the availability of energy to the muscles.

CARBOHYDRATE LOADING:

In a step beyond glucose, many researchers have focused on glycogen."Glycogen depletion," "loading" and supercompensation" have become buzzwords in discussions of the nutrition of the performance horse. The concept of "glycogen loading" is based on the principle that increasing the resting glycogen content of muscle should increase the duration of exercise prior to anaerobic fatigue at a given work load. For example, "glycogen loaded" humans have been reported to exhibit 37% increases in their anaerobic performance.

The glycogen manipulations applied to horses attempt to deplete glycogen stores by combining several days of low carbohydrate, high fat and high protein feeding with strenuous exercise. This depletion phase is then followed by 2-3 days of reduced work and high carbohydrate feeding- "repletion". The intention is to increase the glycogen content above that at the beginning of the program by rebound "overshoot". These programs have successfully increased resting intramuscular glycogen content in Standardbreds, Thoroughbreds and Quaterhoueses.

Unfortunately, subsequent performance was either unchanged by greater muscle glycogen content or was actually impaired. In addition there is evidence that training itself can increase intramyocyte glycogen contents. The magnitude of this effect in not known, but it is quite possible that the reported increases in muscle glycogen content cited above resulted from the exercise regimes employed, rather than from the high carbohydrate feedings.

Drawbacks to the use of glycogen loading include the increased intracellular water retention which accompanies increased intramuscular glycogen concentrations. This increases the likelihood of both dehydration and the over-estimation of an animal's fitness. Also,because the glycogen depletion-repletion cycle is effective only in animals whose muscle fibers have been previously trained to both store and metabolize glucose rapidly and efficiently, there is a risk of triggering exertional myopathy following the high carbohydrate feeding-resting-super-compensation phase. In this reguard, muscle stiffness from lactic acid accumulation has been linked to rapid carbohydrate metabolism. However, there remains a great deal of uncertainty over the role of glycogen reserves in the onset of myopathies.

DIETARY FAT

Feeding of dietary fat holds exceptional promise as a method of increasing dietary energy density without increasing the volume of feed intake. Researchers repeatedly have demonstrated the ability of horses to digest and utilize fats.

Working horses may retain as much as 85% of the metabolizable energy in corn oil. Also, an investigator has shown that Arabian horses ridden for 60 km required 15% less total feed when fed a ration containing 8% fat. Also, horses fed diets containing 18% fat exhibited increased fatty acid production when performing at 75% of their maximum capacity.

Although feeding fat has been shown to result in only minor increases in stamina or delays in the onset of fatigue, rations containing 10% fat have been shown to "spare" muscle glycogen during "cutting" and barrel racing, an American rodeo event.