Metabolic Support: Feeding to Maintain Health

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An important part of the management of equine metabolic syndrome is altering the horse's ration to improve insulin sensitivity and the regulation of blood glucose. In addition to restricting dietary energy and providing a ration with a low concentration of non-structural carbohydrates, supplemental nutrients including omega-3 fatty acids, antioxidants, and certain minerals can be used to optimize the ration.

Understanding Equine Metabolic Syndrome

Equine metabolic syndrome (EMS) describes metabolic and endocrine abnormalities resulting in insulin resistance and the development of laminitis in horses, donkeys and ponies.[1] Horses with EMS are often described as "easy keepers" and most have an increase in adiposity, resulting in an increased body condition score. A lean phenotype of EMS has also been recognized in horses with laminitis and insulin resistance.[1] A genetic predisposition to EMS has been identified, and breeds that are frequently affected include ponies, Paso Finos, Arabians and Morgans.[1-3] Other breeds may also be affected by EMS.[4] Most horses affected with EMS are between 5-18 years of age.[2,5] Horses with EMS become obese when their energy intake is greater than their energy requirement. Excess dietary energy leads to the external deposition of fat in the neck (described as a "cresty neck"), along the back, near the tailhead, near the mammary gland or prepuce and also in the subcutaneous tissues on the horse's body. Even EMS horses with the lean phenotype may have this typical regional deposition of fat. Fat may also be deposited internally and identified on an ultrasound examination.

EMS can be identified in horses that have insulin dysregulation and an elevated fasting insulin concentration. Affected horses may also have an elevated fasting glucose concentration. Diagnostic tests that can be used to identify horses with EMS include an oral sugar test (OST), an insulin tolerance test (ITT) and a combined glucose-insulin test (CGIT).[1] Some horses with EMS will have a mild increase in their serum gamma glutamyl transferase (GGT) activity.[1] Low concentrations of serum thyroid hormones (total triiodothyronine (tT_3), total thyroxine (tT_4)) may also be measured but true hypothyroidism is rarely diagnosed.[1] Use of phenylbutazone in horses with EMS may lower serum tT_4 because of the protein binding properties of phenylbutazone and must be considered when interpreting serum tT_4 concentrations.[6]

Of particular concern to horse owners and vets is the fact that horses with EMS are predisposed to develop laminitis. One proposed reason for the association of EMS and laminitis is that insulin resistance may lower adequate glucose delivery to hoof tissues.[7,8] Subclinical laminitis may occur repeatedly in horses with EMS before clinical signs of laminitis are recognized.[9] Insulin resistance may also be associated with vascular changes in the hoof that impairs appropriate blood flow to the laminar tissues.[9]

Improving Outcomes Using Supplementation

To determine the benefits of an omega-3, vitamin, mineral, antioxidant and amino acid supplement[A] on metabolic parameters associated with insulin resistance or equine metabolic syndrome, researchers at the University of California at Davis measured insulin and glucose responses of horses

[A] Platinum Performance® Equine Wellness and Performance Formula

consuming meals of alfalfa and oat hay before and after 6 weeks of supplementation. Fasting blood glucose concentrations were significantly lower after the supplementation period (Figure 1). Although they did not exceed the normal range, the pre-supplementation fasting values mirrored the average resting plasma glucose values obtained in a study of obese horses with insulin resistance.[4] Figure 1 also shows that blood glucose concentrations were significantly lower in horses receiving the omega-3 supplement during the first 60 minutes after an afternoon meal of oat hay than in horses not receiving the supplement. In addition, peak serum insulin concentrations were 44% lower after the supplemented meal as compared to the non-supplemented meal (data not shown). The effects of the same supplement on fasting blood glucose were determined in a study performed at the University of Georgia with a mouse model of type II diabetes. The results of that study demonstrated that, after 8 weeks, supplemented mice had a 30% lower average fasting glucose than non-supplemented, control mice (Figure 2), as well as an 8% decrease in body weight and significantly improved vascular function (data not shown). Furthermore, results from a study conducted at Colorado State University demonstrate 6-8 months of twice daily supplementation with the omega-3 supplement that had additional magnesium and chromium added[B] resulted in a 19-20% decrease in fasting cortisol ($p < 0.05$) and insulin ($p = 0.052$) among horses defined as "borderline insulin resistant." This change correlated to a significant 15% improvement in the average RISQI score (an index of insulin resistance) reclassifying these horses from borderline insulin resistant to normal.

Figure 1. **Fasting and Post-Prandial Glucose Response in Adult Horses Supplemented with an Omega-3, Micronutrient and Amino Acid Supplement[A] vs. Non-Supplemented Horses**

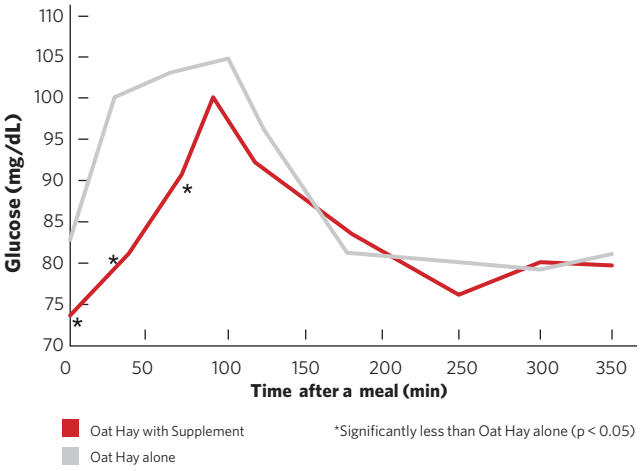
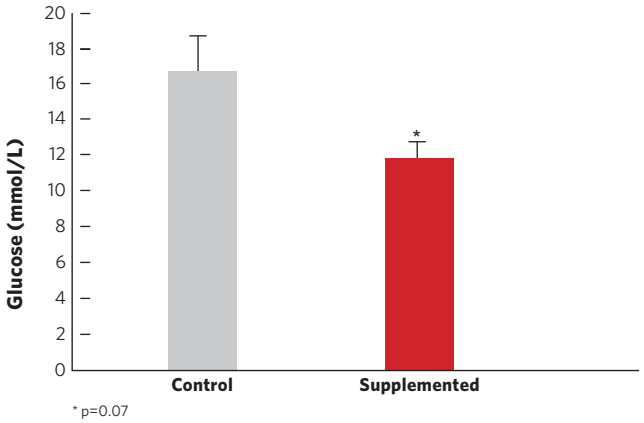


Figure 2. **Fasting Glucose in Mice Supplemented with an Omega-3, Micronutrient and Amino Acid Supplement[A] vs. Controls**



[A] Platinum Performance® Equine Wellness and Performance Formula
[B] Platinum Performance® Equine Wellness and Performance Formula plus Platinum Metabolic Support

Managing Equine Metabolic Syndrome

Diet and Exercise

The primary recommendations for the prevention and treatment of EMS are calorie restriction and increased exercise.[1,3] If exercise is contraindicated because of laminitis then the main strategy for managing EMS is focused on dietary management. Horses with EMS should be fed 1.5–2% of their body weight in forage. Even when an energy restricted ration is fed, the ration should always contain at least 1% of the horse's body weight in forage.[1] Initial restrictions in energy intake can be made by feeding 90% of the horse's original dietary energy. Changes in the ration should be made gradually. It is often helpful to provide the hay in a slow feeder like a NibbleNet® to encourage the horse to eat a small volume of hay throughout the day.

Weight loss results in a decrease in body fat and often improves insulin sensitivity and glucose regulation. A variety of other management strategies should be used to promote weight loss, decrease insulin resistance, and improve glucose regulation. Horses

with EMS should be fed hay or a commercial complete feed with a low concentration (<10%) of non-structural carbohydrate (NSC).[10] A forage analysis is recommended to identify the most appropriate hay based on the water soluble carbohydrate (WSC), ethanol soluble carbohydrate (ESC) and starch concentration in the hay. The concentration of soluble sugars in hay can be reduced by soaking the hay for 30 minutes in warm water or 60 minutes in cold water. Horses with EMS that have pasture-associated laminitis may need to have either restricted access to pasture or they may need to be removed from pasture completely to limit their consumption of fructooligosaccharides or fructans. Grain and other concentrate feeds high in NSC should be eliminated from the ration.

Supplements

Omega-3 fatty acids have been shown to improve insulin sensitivity in rats[11-13] and humans.[14-16] Omega-3 fatty acids may help control glucose metabolism by optimizing cell membrane fluidity, improving insulin receptor signaling, and activating gene transcription. These fatty acids also reduce systemic inflammation, which may be beneficial in horses with laminitis. Antioxidant supplementation is an important component of the treatment of horses with EMS. Oxidative stress is a unifying factor in the occurrence of obesity, insulin resistance, and metabolic syndrome. In laboratory studies, increases in oxidatively-damaged lipids can result in reduced insulin secretion and sensitivity.[17] Supplementation of people with vitamin E, a fat soluble antioxidant, has resulted in improved glucose utilization and insulin sensitivity.[18]

Chromium and magnesium are minerals that influence the action of insulin through facilitation of insulin signaling, which makes them critical nutrients in glucose metabolism. Supplementation with chromium has improved insulin sensitivity in animals[19-21] and humans.[22] A protective effect of magnesium against type II diabetes has been documented in humans as noted by the association between low magnesium intake and increased fasting insulin and insulin resistance[23] and an increased risk of metabolic syndrome.[24] Individuals with type II diabetes or insulin resistance have benefited from magnesium supplementation, as evidenced by improvements in fasting insulin concentrations.[25,26] Although it has not yet been reported in the horse, chromium and magnesium supplementation could benefit horses with insulin resistance and equine metabolic syndrome by enhancing insulin's ability to move glucose into cells.

A final nutrient that improves glucose utilization and insulin sensitivity is carnitine, which transports fatty acids into mitochondria where they are converted to energy. Carnitine has been proven to improve glucose oxidation in laboratory animals[27] and enhance the ability of insulin to lower blood glucose in healthy and diabetic humans.[28,29] Carnitine supplementation has also increased rates of weight loss when combined with reduced caloric intake.[30] Carnitine supplementation in healthy ponies at a dose of 4 grams/day resulted in a decrease in postprandial glucose and insulin demonstrating an improved tolerance to glucose in the supplemented ponies.[31]

Horses with Metabolic Syndrome and Joint Supplementation

Insulin resistance is positively linked to osteoarthritis in humans.[32] Obesity also has a direct association with osteoarthritis in humans due to dysregulation of the adipose-derived hormones leptin, adiponectin, and resistin.[33]

Obese horses with EMS may also suffer from osteoarthritis that may or may not be associated with insulin resistance and obesity. One concern that often is expressed regarding horses with osteoarthritis is the possible adverse effect of glucosamine supplementation on blood glucose concentrations. To evaluate this potential association, the blood glucose concentrations of horses fed a meal supplemented with a joint product[c] containing a daily dose of 8,500mg of glucosamine sulfate were monitored. After 3 weeks of supplementation, there was no significant increase in post-prandial blood glucose concentrations in the supplemented

[c] Ortho-Chon® II HA

group over the glucose concentrations in the non-supplemented group. Therefore, glucosamine and supplements containing a daily dose of up to 8,500mg of glucosamine sulfate can safely be incorporated into equine joint care programs without fear of causing further glucose dysregulation or increasing the risk for metabolic syndrome.

Putting it into Practice

- To establish an ideal body weight in horses with EMS, reduce the total calorie intake and ensure nutrient adequacy by supplementing with vitamins, minerals, antioxidants and omega-3 fatty acids.
- To improve insulin regulation in horses with EMS, reduce or eliminate the intake of grain and other feeds high in non-structural carbohydrates.
- To help control blood glucose levels and insulin action, supplement with omega-3 fatty acids, antioxidants, minerals such as chromium and magnesium, and carnitine.

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