Gastrointestinal Health

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Electrolyte Use & Gastric Emptying

A horse's prolonged sweating during athletic activity or travel means a need for fluid and electrolyte replacement, and horse owners commonly turn to electrolytes for this purpose. A research team examined one electrolyte supplement's (ES) effect on fluid replacement and performance, and Michael Lindinger, PhD, of the University of Guelph, presented the results.

Dehydration significantly impacts the cardiovascular system and exercise performance and recovery, as well as affecting thermoregulation (the horse's ability to cool its body during exercise) and mental acuity. Thus, effectively replacing fluids lost through sweating is of utmost importance in maintaining peak health and performance. Lindinger pointed out that horse sweat contains significant concentrations of ions, such as sodium, potassium, chloride, calcium, and magnesium, and these are lost during exercise.

Keeping this information in mind, he and colleagues tested an oral ES specifically designed with proportions of electrolyte content to replace ion and fluid losses in sweat ("Most supplements have seemingly random proportions of electrolytes; when this one was developed it was the first to have 'appropriate' proportions," Lindinger noted). Electrolytes marked with radioactive labels were administered through a nasogastric tube. In the first phase of the study, Lindinger examined how quickly electrolyte-supplemented resting horses cleared the supplement from the stomach (gastric emptying rate) by measuring disappearance of radioactivity from the abdominal regions using a gamma camera. Radioactivity gradually diminished; by the end of two hours, 82% of ES had emptied.

The second phase of the study involved analyzing intestinal electrolyte absorption in horses at rest, and then exercising the horse to see if they performed better after receiving 3 liters of ES. The team measured how fast sodium and potassium from the supplement appeared in blood plasma in resting horses. Lindinger reported that there was a more rapid uptake of potassium and sodium from the blood in ES-treated horses and that the electrolytes appeared in blood within 10 minutes of being oral administration. Sodium levels were maintained during exercise and into the post-exercise period.

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The researchers demonstrated that an electrolyte supplement helped provide water and electrolytes from the gastrointestinal tract to the rest of the horse's body during the exercise period.

When investigators administered 3 liters of ES 60 minutes prior to exercise, those horses were able to exercise (at a moderate trot, about 6 mph) for 17 minutes longer than the control horses (treated with only 1 liter of plain water or 1 liter of ES), which fatigued sooner. Providing more fluid volume to the ES-treated horses also seemed to enable better thermoregulation; these horses sweated more than the controls. To support this, Lindinger explained that radioactive sodium given with the ES one hour before exercise appeared in sweat within the first 10 minutes of exercise and sodium levels were maintained throughout the exercise period.

He explained that dextrose in the ES enhances the small intestine's uptake of water and sodium, and while it elicits a glycemic response (glucose surges in the bloodstream), it is one of a similar magnitude but shorter duration than what occurs with feeding. Most commercially available electrolytes do not contain dextrose, he noted.

Lindinger explained that an effective electrolyte supplement given prior to exercise serves to replace the loss of ions and water and contributes to the ability to exercise for a longer duration.

"This is the first ES to be tested for effectiveness in horses," Lindinger concluded. "It is the first study to have measured gastric emptying of an ES in horses, and to measure electrolyte absorption in horses. It demonstrates that electrolyte supplementation provides water and electrolytes from the gastrointestinal tract to the rest of the body during the exercise period, and that this is helpful for (increasing exercise duration)."

Supplements in Context of Daily Nutritional Requirements

Nutritional supplement use is widespread in the horse industry, with owners adding scoops of products to feed without necessarily understanding how these nutrients fit into a normal equine diet. David Ramey, DVM, examined how five general equine dietary supplements stacked up in light of a horse's daily nutrient requirements.

Ramey started off his presentation remarking that supplement sales are often driven by direct-to-consumer advertising, with consumers being "educated" that nutritional supplements are necessary. He recognized that horse owners might ask their veterinarians for advice on the best supplements to feed, so he emphasized the importance of knowing what's in supplements and how they might be used. He and Stephen Duren, PhD, an equine nutritionist with Performance Horse Nutrition, in Weiser, Idaho, evaluated the following commonly used products in the context of the diet of a 500 kg (1,100 lbs) horse in light work: Platinum Performance, Dynamite, Grand Meadows Grandvite, Farnam Vita-Plus, and Vita-Flex Accel.

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If a horse's diet is adequate, there might be no need to supplement in the absence of a specific deficiency.

To determine nutritional requirements for such a horse, Ramey and Duren used the National Research Council's (NRC) *Nutrient Requirements of Horses* (6th Revised Edition, 2007). For the purposes of this evaluation, he assumed that the product label amounts were accurate. However, he pointed out that actual levels of a product might vary from label content, in part due to lack of regulatory oversight.

Based on the NRC guidelines, Ramey determined that most equine diets (comprised of approximately 7 kg [roughly 14.4 pounds] of alfalfa plus one pound of oats, or 9 kg [19.8 pounds] of grass hay plus one pound of oats) more than adequately satisfy the nutritional needs of the described horse. Substances that might be lacking are salt (sodium chloride) and possibly selenium in certain geographic areas, he noted.

Ramey found that according to the labels, and depending on the product and the particular nutrient, levels within the analyzed products varied from 0.18% to 875% of daily nutritional requirements. In addition, he opined that formulations of each supplement "lacked balance" and "didn't seem to be prepared with particular dietary goals in mind." In general, Ramey concluded that with a few exceptions, these supplements didn't provide significant-enough amounts of required nutrients to make up for those a horse's diet might be lacking. He stressed, "A diet that is deficient in a particular nutrient is not going to be improved by feeding a supplement that doesn't contain sufficient amounts to correct the deficit."

Ramey noted that indiscriminate human vitamin supplementation is coming under fire, so he feels it is relevant to examine what supplements horses are consuming. He noted that in human medicine it's been shown that nutritional supplementation can sometimes cause harm. One example he cited is the previously accepted use of vitamin E to support the treatment of human prostate cancer; researchers recently found that vitamin E supplementation increased the risk of mortality.

To his clients, Ramey said he suggests "it may be that the best supplement is no supplement at all." He noted that avoiding spending money on supplements is particularly appropriate for horse owners who are struggling to simply maintain their horses in this difficult economy. "Human nutritionists contend that supplements don't make healthy people healthier," he said. Similarly, if a horse is fed an adequate diet, then there may be no need for supplementation in the absence of a specific deficiency. "No benefit is achieved with hypernutrition," he concluded.

Nonstructural Carb Tolerance in Healthy Horses

The words "nonstructural carbohydrates" (NSC) have become almost synonymous with "bad news" in the horse industry, mainly because many owners' goals have been to reduce these sugars and starches (while increasing fat levels) to provide "safer" calories for certain horses. These strategies are desirable for horses with conditions such as recurrent exertional rhabdomyolysis, polysaccharide storage myopathy (PSSM), equine metabolic syndrome, or Cushing's disease, but until recently it was unclear what an NSC diet means for a "normal," nonobese horse.

Joe Pagan, PhD, president of Kentucky Equine Research (KER), described his and colleagues' research on the effects of carbohydrate and fat intake on glucose tolerance in healthy horses. He pointed out that there is a perception among owners that feeding horses any nonstructural carbohydrate will lead to insulin resistance (a reduction in the horse's sensitivity to the hormone insulin that renders his body unable to properly manage blood glucose levels) and metabolic disorders, even when horses aren't obese.

In previous studies conducted at KER, researchers found that healthy horses fed high-fat diets have a marked delay in clearing glucose, whereas when consuming carbohydrates from sweet feed, normal clearance rates resumed.

To test this theory further, Pagan's team evaluated four healthy, nonobese Thoroughbred geldings with body condition scores of 5-6 (out of 9) and around 21 ½ years old. The horses were stalled except for six hours of daily turnout with a grazing muzzle. The investigators fed four treatment diets for a month by adding one of four energy supplements to regular grass hay. The team provided hay rations three times daily and supplements twice daily. The treatment groups were:

- FIBER: 5.6 kg of additional grass hay
- ALF: 3.1 kg alfalfa and Bermudagrass blended pellet
- CHO: 2.3 kg whole oats
- FAT: 1.3 kg alfalfa cubes with 30% digestible energy (the absorbable amount of energy, supplied in most diets with

starch, fat, protein, or fiber) provided with 500 g of soybean oil, which is higher than the normal recommended dietary fat level of less than 10%.

The CHO diet was 20.3% NSC, similar to analysis of 140 diets fed to the sport horses at the Alltech FEI 2010 World Equestrian Games. In the FAT diet 30% of total calories supplied came from fat and 12% from NSC. The FIBER diet contained less than 10% NSC that contributed 17% of total calories supplied.

On Day 14, investigators performed an oral glucose tolerance test (a 12-hour fast followed by feeding half the daily energy):

- The CHO diet produced the greatest glycemic response (glucose circulating in the bloodstream in response to carbohydrate ingestion); as expected, the FIBER or FAT diets triggered no glycemic response.
- Resting blood glucose increased after two weeks on the FAT diet.
- The CHO diet produced a greater insulin response and fewer free fatty acids than the other three treatments.

At Day 28, IV (intravenous) glucose tolerance tests demonstrated that glucose cleared more quickly in CHO-fed horses than the other three diets, returning to baseline 90 minutes more quickly than the FAT diet. Plasma insulin levels in horses fed the FIBER diet were lower than in the other three diets. With the high FAT diet, there was a delayed insulin response to reach peak levels. Pagan pointed out, "The negative effects we found for high fat were from extremely high-fat diets. It is uncertain if these effects would occur at lower fat levels like those commonly used in commercial horse feeds."

Pagan summarized, "A high-fat diet impairs glucose clearance, with a lag phase following the acute insulin response. Glucose intolerance could develop by feeding high fat at levels of 30% (of total calories supplied). In contrast, feeding of moderate amounts (31% of total calories supplied) of nonstructural carbohydrates improved glucose tolerance." Pagan also noted that impaired glucose tolerance could be reversed by feeding two ounces of fish oil, whereas corn oil did not achieve this same effect.

"A moderate intake of NSC is perfectly fine for nonobese normal horses," Pagan concluded.

Farm-Specific Prevalence of *L. intracellularis* Evaluated

Today many breeders are mindful of equine proliferative enteropathy, a still-emerging young horse disease caused by the *Lawsonia intracellularis* bacterium, and researchers have made great strides in comprehending many facets of the disease. Recently, a team from the University of Kentucky, using a newly developed assay, took several steps forward in understanding *L. intracellularis*' environmental prevalence on certain horse farms compared to its seroprevalence (presence of positive serum antibodies) in horses residing on those farms. Allen Page, DVM, a PhD candidate at the Gluck Equine Research Center, presented the findings.

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>
> DR. JOE PAGAN

Equine proliferative enteropathy (EPE) has been reported worldwide and is gaining prevalence in the United States. *L. intracellularis* invades intestinal crypt cells, primarily in the small intestine, and causes thickening of the intestinal lining. This thickening leads to clinical signs such as anorexia, weight loss, reduced daily weight gain, fever, lethargy, depression, peripheral/ventral edema (fluid swelling), and sometimes colic and diarrhea. The current lack of definitive diagnostic tests is a frustration for breeders and veterinarians alike.

Recently, Page and a research team developed a modified enzyme-linked immunosorbent assay (ELISA) test that detects antibodies to *L. intracellularis*—the first serologic assay able to detect the antibodies and, thus, exposure. Using this test, the team evaluated *L. intracellularis* seroprevalence among 337 Thoroughbred foals and weanlings residing on 25 Central Kentucky farms.

"Case information from the three years preceding the study was used to classify farms as having no prior recent history of EPE, a suspected history of EPE, or a confirmed history of EPE," he explained. Then, from August 2010 to January or February 2011, the research team collected monthly serum samples from the aforementioned foals, testing them for *L. intracellularis*-specific antibodies.

Upon reviewing the findings, Page and his colleagues found an overall seroprevalence of 68%, with seroprevalence levels on individual farms ranging from 14-100%. Page pointed out that the overall seroprevalence of 68% isn't likely representative of the Central Kentucky Thoroughbred population, due to the large number of previously affected farms included in the study. Other key findings included:

- All farm populations had evidence of *L. intracellularis* exposure, regardless of whether they had logged previous EPE cases;
- On average, *L. intracellularis* seroprevalence was significantly lower on farms with no history of EPE cases than on those with confirmed or suspected cases; and
- Horses residing on farms with no history of EPE cases tended to have lower *L. intracellularis* antibody levels.

"Using an ELISA to detect serum antibodies to *L. intracellularis* from young horses on numerous farms, seroprevalences corresponded well with past history of EPE cases," Page said. "The data presented here suggests that lower environmental burdens of *L. intracellularis* result in fewer horses being exposed to the bacterium and less antigenic stimulation (promoting an immune response) per exposure."

With the development of a serologic test to identify the presence of *L. intracellularis* antibodies, Page et al. have found a way to measure exposure to the causative bacterium. His study also revealed that while all farms included had evidence of *L. intracellularis* in the environment, the bacterial seroprevalence in horses residing on those farms ranged from 14-100%. Further research is needed to find a possible explanation for the farm-to-farm seroprevalence differences.

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- Watch the Equine Medicine/Gastrointestinal Issues video, TheHorse.com/Video.aspx?vID=556
- Monitoring and Preventing EPE on Endemic Farms, TheHorse.com/19346
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