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Madeline Boast, MSc, PAS

Photo credit Shelley Paulson



Hi, I'm Dr. Randel Raub, Equine Research and Nutrition Specialist at Kent, the makers of Sentinel® Horse Nutrition.

It's been my great fortune to work with horses and horse owners throughout my life and career. It's rewarding to help people from every walk of life learn how nutrition makes a difference for every horse, from those in high-end competitions to senior rescues. Our expert nutritionists formulate Sentinel feeds and supplements with making that difference in mind—to help improve the health and well-being of the horse.

In this issue, we'll explore several ways our formulas and nutrition team can support your veterinary care. These committed experts are passionate about answering questions and helping you craft specialized diet plans that meet each horse's unique needs.

Here's what we'll cover in this issue.

- Nutritional management for recovery from specific equine health conditions.
- The latest research on feeding methods, digestibility, and vitamin supplementation.
- Free fecal water syndrome (FFWS), addressing questions about FFWS, and dietary approaches for combating it.
- Dietary adjustments for horses with dental issues.
- How to determine whether a supplement might benefit a horse's health and performance.
- Managing laminitis with science-based approaches to nutrition.
- Identifying strategies to relieve heat stress, inflammation, and the risk of gastric ulcers in performance horses.

At Sentinel, we're dedicated to providing quality nutrition and education that empowers veterinarians, trainers, and horse owners to make informed decisions. Our ongoing research reflects the latest breakthroughs in nutrition, and we're excited to share them with you. By staying at the forefront of equine nutrition, we aim to give every horse the foundation they need to live a healthy, happy life.

Randel Raub, PhD

KENT Equine Research and Nutrition Specialist | Sentinel Horse Nutrition



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EquiManagement

Editorial Director

Alexandra Beckstett

abeckstett@equinenetwork.com

Associate Publisher/Advertising Sales

Michelle Adaway

madaway@equinenetwork.com

(859) 619-8263

Advertising Sales

Tom Brazil

tbrazil@equinenetwork.com

(805) 538-9986

Yvonne Long

yvlong@equinenetwork.com

(859) 699-8620

Shelley Partridge

spartridge@equinenetwork.com

(859) 327-7057

EDITORIAL/PRODUCTION

Managing Editor

Carly Sisson

Director of Art & Production

Philip Cooper

Art Director

Claudia Summers

Production Manager

Stacey Horne

Prepress Specialist

Brad Burleson

EDITORIAL OFFICES

7500 Alamo Rd NW, Albuquerque, NM 87120

(303) 253-6301

TOM WINSOR

Chief Executive Officer

DINO THEOFANOUS

Chief Operating Officer/Chief Financial Officer

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Equine Nutrition Research Roundup

Researchers offer up their latest findings on topics such as feeding methods, vitamin E supplementation, and feed digestibility.

Stacey Oke, DVM, MSc

ADOBE STOCK

The world of equine nutrition seems to always be evolving, which can be good and bad. Good because horse owners are benefiting from nutrition research actively being conducted but “bad” because it means we, as an industry, need to stay up to date on those advances to be able to make the best feeding decisions for the horses that depend on us.

In this article, we’ll provide a brief overview of recently published studies on equine nutrition, focusing on three topics in particular: feeding methods, vitamin E supplementation, and feed digestibility.

Feeding Methods

Both what and how we feed horses affects their nutritional status and overall health. Several recent studies examined the effects of various feeding practices.

Effect of Meal Frequency on Behavior

Feeding frequency and meal size affect

aggression and dominance behaviors in group settings, says Sara Mastellar, PhD, associate professor and coordinator of the Ohio State Agricultural Technical Institute’s Equine Programs in Wooster, part of The Ohio State University.

“Changing feeding frequency is something that an owner or manager can adjust without the need for a special feed or supplement,” she explains. “We wanted to explore the impacts of common feeding frequencies on physiology but also on behavior, because equine caretakers can readily experience the impact of management choices on horse behavior.”

Mastellar and colleagues conducted a study involving 12 horses assigned to two drylots and fed concentrates via individual nosebags once, twice, or thrice daily for seven days. All horses were also fed 1.55% body weight hay per day on a dry matter basis from multiple slow-feeder hay nets throughout the pen. Hay was provided once, twice, or thrice daily in the hay nets.

This meant the horses receiving the hay three times a day received the smallest volume per feeding. On Day 5 of each arm of the study, the researchers assessed dominance rank and behavior.

Results from that study revealed that horses fed three times daily stood alert more frequently than horses fed once daily during the two hours surrounding the morning feeding. Horses with a higher dominance rank (assigned based on the number of displacements given and received) showed more aggression (ears pinned, biting) more frequently before being fed compared with after.

More horses showed signs of aggression during the hour post-feeding when fed three times a day compared to once a day. Horses fed three times daily walked more frequently and were displaced more frequently than those fed once a day. It is important to remember that the researchers did not analyze group behavior throughout a full 24-hour day, so these findings

are only applicable to feeding time.

“There are many factors that impact group dynamics and behavior around feeding time, including pen size, feeder spacing, and number of feeders or piles of hay,” says Mastellar. “The amount of hay and grain fed or feeding frequency are now additional considerations.”

She adds, “When a horse sees that the hay nets being provided are only one-third of the way full, they may perceive there are limited resources, despite receiving the rest of their forage throughout the day. Behavior is only one piece of the puzzle, and equine caretakers should also consider digestive physiology when making feeding management decisions.”

Effect of Feeding Order on Metabolic, Digestive Responses

Feed order, as in hay before concentrates or concentrates before hay, might affect gastric emptying. In turn, time for gastric emptying might affect metabolic and digestive responses, such as glucose and insulin. Further, feeding order might affect what nutrients reach the hindgut.

In a study conducted by Jensen et al. (2025), four cecum-cannulated horses were fed Timothy haylage three times daily and nonprocessed oats once daily in the morning (0.4 kg starch/kg body weight). The researchers fed either haylage first followed by oats one hour later or oats first followed by haylage 15 minutes later. They measured gastric emptying on Day 12 of

the study by feeding 1 gram of ¹³C-acetate mixed with the oats. They collected blood samples on Day 11 before feeding oats every hour for eight hours.

Gastric emptying was longer when hay was fed before oats, which is in agreement with the researchers’ hypothesis. However, feeding order did not affect baseline or peak insulin or glucose concentrations or AUC (area under the curve). The authors had hypothesized that feeding oats before hay would, in addition to increasing gastric emptying, result in faster peaks of glucose and insulin blood concentrations.

Feeder Style’s Effect on Intake Rate

Horses often consume their concentrate meals rapidly, potentially putting themselves at risk of esophageal obstruction. Some owners therefore soak concentrates to help prevent choke. To determine if feeding horses using different types of feeders affects bite rate and minimizes bolting food, Colorado State researchers (Lawler et al. 2025) calculated the time and bite rates for horses consuming 0.454 kilograms of a commercial concentrate using three different feeders: a small feed pan on the ground, a shallow trough on the ground, or a small hanging feeder mounted on a wall at chest height.

As the researchers anticipated, horses consumed the concentrates slowest when fed from the shallow trough, presumably due to the increased surface area, which allowed the feed to spread out and prevented horses from taking large mouthfuls.

Vitamin E Research

Fat-soluble vitamin E (α-tocopherol) is an essential vitamin that horses primarily obtain from fresh pasture. Levels of this vitamin decline rapidly after harvesting, leaving horses fed a mostly hay diet at risk of deficiency without a supplemental source.

“Grass is an important

Tip for Practitioners: Serum or plasma can be used to measure vitamin E concentrations; however, if you’re performing serial measurements, use the same type of sample each time. Avoid hemolysis, and keep tubes in an upright position to avoid the sample touching the rubber stopper and prevent artificial decreases in vitamin E concentrations (Finno et al. 2025).

source of vitamin E for horses, but even horses with access to grass have variable vitamin E concentrations with some being deficient,” says Megan Palmisano, DVM, DACVIM (LAIM), PhD candidate at North Carolina State University College of Veterinary Medicine. “This is where measuring vitamin E concentration and providing recommendations about supplementation is important for veterinarians, trainers, and owners.”

According to the Nutritional Research Council, horses require 1 IU/kg body weight (about 500 IU for an average 500 kg horse), which is easily met during grazing. Horses grazing about 2% of their body weight on pasture per day will consume approximately 300 to 1,000 IU vitamin E per day (Finno et al. 2025).

“Thus, horses maintained on hay and grain receive far less than the recommended daily requirement of vitamin E,” wrote Finno et al.

Whole body vitamin E is assessed by measuring serum concentrations, which should exceed 2 µg/mL; however, Finno et al. recommend target concentrations fall between 3 and 6 µg/mL.

Vitamin E is a well-known antioxidant that has a protective effect on the central nervous system. Clinically speaking, deficiencies can present as neuromuscular disease, including equine neuroaxonal dystrophy/degenerative myeloencephalopathy, equine motor neuron disease, or vitamin E responsive myopathy.

A decrease in vitamin E reportedly occurs in hospitalized human patients, potentially due to the underlying



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Hospitalization did not affect vitamin E levels despite horses not having access to grass.

pathophysiology of their disease process, ongoing oxidative damage, increased metabolic consumption, and/or decreased intake. The latter, in particular, is believed to contribute to the observed vitamin E decrease during hospitalization.

To determine if this same phenomenon occurs in hospitalized equids provided minimal fresh pasture/grass, Palmisano and colleagues from the New Bolton Center in Pennsylvania measured serum vitamin E levels in client-owned horses and foals. Animals were either patients or companions presenting to the hospital. They measured vitamin E levels at the time of admission and again at the time of discharge, after a minimum five-day hospitalization period. Of the 103 adult horse and 54 foals admitted to the hospital, 16.5% of adult horses and 5.5% of foals were deficient in vitamin E. The total rate of deficiency was 12.7%.

Forty adults and 20 foals stayed for the minimum five-day hospitalization. Of those equids, vitamin E levels in adults at time of admission was 3.6 µg/mL and 3.7 µg/mL at discharge. At the time of discharge, 17.5% were deficient. One hospitalized horse became deficient and, surprisingly, four horses achieved adequate vitamin E levels.

For the hospitalized foals, vitamin E was 4.6 µg/mL at time of admission and 4.8 µg/mL at time of discharge. None of the foals were deficient at discharge.

“Vitamin E was therefore not affected by hospitalization despite the fact that the included animals did not have access to grass,” says Palmisano. “Supplementing hospitalized horses is therefore not necessary if the primary goal is to maintain vitamin E levels while hospitalized.”

Vitamin E concentrations are not routinely measured upon admittance to the hospital, but Palmisano says it's an easy blood test that's good to monitor in horses to ensure concentrations remain normal. In contrast, horses with clinical suspicion of deficiency, such as those with neurologic disease, often have this value

measured when admitted to the hospital.

“For veterinarians, trainers, and owners, routine monitoring of vitamin E is important in all horses, not just those in hospital,” Palmisano adds. “We noted in our study that some horses presented deficient despite being in an area known for adequate pasture access and good-quality hay, which shows that owners could be doing everything right and still face this problem. There is so much variation in concentrations measured in horses with similar diets, likely due to each individual horse's ability to absorb and metabolize vitamin E. Thus, each horse should have their serum concentrations measured.”

The easiest and best way to ensure a horse is getting enough of this essential vitamin is to measure serum concentrations and provide supplementation if needed, she says.

Digestibility Studies

Finally, research on feed digestibility continues to play an important role in advancing equine nutrition. According to Bills et al. (2025), “Digestibility studies provide vital information for formulating the ideal diet based on an animal's ability to digest and absorb the available nutrients from the feed provided.”

Digestibility of the same feedstuffs can differ between horses, such as easy and hard keepers. Bills et al. therefore conducted a study to determine if fiber digestibility differed between these two classes of horses using the ANKOM Daisy II incubator. The study involved three easy keepers and three hard keepers fed the same types of hay and concentrates and maintained on Bermudagrass pasture.

The three hard keepers required 4.53 kg/day (10 lbs) to maintain a body condition score (BCS) near 5, and the three easy keepers consumed an average of 1.81 kg/day (4 lbs) to maintain a BCS of 7.

The researchers collected fecal samples from each horse to create a fecal inoculum for the incubator. Five different feedstuffs (mature fescue hay, alfalfa

cubes, Bermudagrass hay, oats, beet pulp) and two commercial concentrates were digested with the inoculum, then analyzed for neutral detergent fiber (NDF) and acid detergent fiber (ADF).

“No differences were observed in the in vitro DMD (dry matter digestibility), NFD, and ADF values due to horse treatment group,” the researchers relayed. “There was an effect of feedstuff on these values but no horse treatment group by feedstuff interactions.”

They concluded, “Further work is needed to elucidate possible causes for the difference in the amount of feed intake required to maintain BCS of horses subjected to similar feed and a light workload.”

Determining why easy keepers require only a fraction of the food as hard keepers to maintain body condition might help in the management of equine metabolic syndrome, a topic also being heavily studied.

The Future of Nutrition Research

The number of studies published in the past year looking at not just nutrient requirements but also at how nutrients are fed to maximize equine welfare are impressive. While many questions remain, the steps researchers are taking toward understanding the effects of nutrient deficiencies such as vitamin E are driving the health of horses in a continuous direction.

“All horses eat, so learning more about the impacts of nutrition and feeding management on equine physiology and behavior has the potential for meaningful payoffs,” says Mastellar. “Using evidence-based feeding and management practices is the future of equine care in the modern world.” **EM**

Sentinel's equine nutrition team is available to help you and your practice make dietary recommendations, educate clients, and provide your patients with quality nutrition. Submit your nutrition questions and get expert advice at KentFeeds.com/vet-hub.



Dietary Adjustments for Horses With Dental Issues

ADOBESTOCK

Recent research focuses on dietary management strategies for horses with age-related dental disease, feeding to prevent peripheral caries, and natural foraging's effects on oral health.

By Alexandra Beckstett

When horses develop dental issues, nutrition quickly becomes a key part of their management.

Difficulty chewing, changes in feed digestion, and weight loss can compromise overall health. Recent research continues to expand our understanding of how dietary adjustments can support horses with dental pathology. For equine veterinarians, staying current with these findings is essential for developing evidence-based feeding strategies for affected horses.

Natural Diets Benefit Dental Health

Researchers from Iceland and Germany recently confirmed that natural management and feeding conditions over

a horse's lifetime can benefit their oral health. In the study, they evaluated the management, diet, and dental care of 170 Icelandic Horses 15 years of age or older to determine how these factors impacted the health of the rostral oral cavity.

Each study horse's owner completed a questionnaire about the animal and its management. Then, the researchers performed a clinical examination to record body condition and assess the oral cavity, paying particular attention to conditions such as gingivitis, fistula, gingiva retraction, enlargement of the roots and dental calculus, integrity of the incisors, bite angle, and tooth mobility. They found that:

- Most of the horses were in good body condition (average BCS 5.3).
- Only 30.6% of horses received regular dental care.
- The study horses lived and free-grazed on pasture for an average of 11 months per year, as is common in Iceland.
- 47.5% of horses received supplemental hay, 5.3% received concentrate feed, 71.2% had free access to salt blocks, 8.2% received a vitamin/mineral supplement and a salt block, and 2.4% received a vitamin/mineral supplement without a salt block.

Overall, the health of the study horses' teeth and surrounding tissues was "very good," which the study authors theorized was a result of natural grazing behavior. Salivation plays a role in horses' dental health, and free-grazing horses have a steady salivary flow. These findings correlate with previous study results showing that free-grazing Thoroughbreds had fewer dental abnormalities than stabled

ones (Masey O'Neill et al. 2010).

“Natural living conditions, including continuity, intensity of chewing, and nativeness of forage, might support natural attrition and a balanced milieu in the oral cavity, promoting the health of incisors and tissue surrounding the tooth even in elderly horses,” the authors concluded.

Hain AM, et al. *Potential impact of natural conditions on the rostral oral health: a study of horses in Iceland. J Am Vet Med Assoc. 2023 Oct 9;261(S2):S108-S113.*

Dietary Management Strategies for Age-Related Dental Disease

In a 2023 report published in JAVMA, Nicole du Toit, BVSc, PhD, DEVDC, DAVDC, reviewed ways to maintain the welfare of senior horses with age-related dental changes and dental disease. These include diet and management changes in addition to regular dental exams and recognizing early signs of pathology. Here are a few of her recommendations.

Age-Related Wear. “Geriatric equines that have worn down their teeth will have teeth less resistant to wear, will have a greater rate of attrition, and will have smoother teeth, making mastication of coarse fibers less effective,” du Toit wrote. These horses should receive chopped forage, hay cubes, and/or hay pellets in lieu of long-stem forage. Soaking their feed to create a mash also makes chewing easier. Extruded feeds, which tend to draw up moisture faster than pelleted, are ideal because they develop a mushy consistency upon soaking but maintain their form without adhering to each other.

Equine odontoclastic tooth resorption and hypercementosis. This painful progressive disease primarily impacts the incisors and canines and has no treatment other than extracting affected teeth. Even with all incisors extracted, horses can still use their lips, tongue, and gingival pads to grasp food. “Avoiding haynets and very short grass will ensure that extraction of multiple or all incisors does not have any detrimental effect on their dietary intake,” du Toit noted.

Diastema. As horses’ cheek teeth wear down, gaps can develop between them, potentially resulting in food packing and secondary periodontal disease. Affected horses often require frequent dental exams and treatment, including cleaning out impacted food, odontoplasty, widening of the diastema, and dietary changes. Du Toit recommended avoiding hard, short-chopped forage (e.g., alfalfa, chaff); feeding soft, long-stem hay or soaked pellets; and allowing horses to free-graze on pasture without hay, if possible.

In conclusion, du Toit wrote, “careful dietary management to prevent conditions such as generalized peripheral caries or prevent food packing into diastemata aggravating periodontal disease can help to manage or minimize dental conditions. The availability of pelleted forage diets such as hay, alfalfa, or grass pellets can help to supplement or replace roughage in cases where horses are unable to masticate efficiently. Even if horses are unable to masticate any significant amount of long-stem hay or haylage, it is important to still provide this to ensure that there is sufficient saliva production and to occupy horses that might otherwise get bored.”

du Toit N. (2023). *Advances in dental management in the equine geriatric patient: strategies for improved welfare. Journal of the American Veterinary Medical Association, 261(S2), S114-S120.*

Treating and Preventing Equine Peripheral Caries

Peripheral caries is a painful type of dental decay primarily affecting the cementum of the cheek teeth. It puts horses at increased risk of tooth fracture, dental wear, tissue lacerations, and periodontal disease. Study results have indicated the condition is environmental, meaning peripheral caries can resolve if the cause is eliminated.

In a recent review, Jackson et al. provided management and treatment advice for this condition, including the following dietary modifications:

- Feed grass hay instead of cereal

hay, which is high in water-soluble carbohydrates.

- Increase pasture access to reduce the amount of supplemental hay fed.
- Drinking water acidity is a risk factor for peripheral caries, so test the pH and mineral content of the horse’s water source.

The study authors said if you can identify and remove items from the horse’s diet that are acidic or high in sugar, such as sweet feeds and cereal forages, you can begin to see improvements in the condition within a few months.

“More work is needed looking at the role of fluoride varnishes and feed or water additives of buffering agents to assist with cases that are difficult to manage with dietary modification alone,” they wrote.

Jackson K, Kelty E (2023). *Recent advances in the treatment and prevention of equine peripheral caries. Journal of the American Veterinary Medical Association, 261(S2), S79-S86.*

General Guidelines

Basic best practices for horses with poor dentition rely on making it easier for the horse to chew and digest feed and forage. This might include:

- Soaking feeds to make a mash for ease of chewing.
- Substituting long-stem hay with chopped forage, cubes, and/or hay pellets.
- Feeding an extruded feed product.

Extruded feeds are specially formulated for easier breakdown and to optimize nutrient absorption in the equine digestive system. They have a lower breaking strength than pelleted feeds, making extruded feed particularly beneficial for horses with dental issues. **EM**

Scan the QR code to watch a video about how horses can benefit from easy-to-chew extruded feeds.





Guidelines for Combating Excessive Fecal Water

ADOBE STOCK

Researchers are exploring the possible causes of FFWS and dietary solutions.

By Nancy S. Loving, DVM

When it comes to free fecal water syndrome (FFWS), more questions than answers abound. Many theories have been proposed as to why it occurs in some horses, but we haven't yet identified a specific cause. Researchers are attempting to sort through potential causes and management strategies to help mitigate undesirable changes in horses' fecal consistency.

Differences in Microbiota?

One theory about FFWS is that an imbalance in gut microbiota (i.e., dysbiosis) contributes to changes in the liquid and solid phases of defecation. Study results to date have been conflicted on this idea. So researchers in Canada used 16S rRNA sequencing on the fecal microbial composition to examine gut microbiota's influence on FFWS.¹ Wester et al. looked at the fecal microbiome of 14 horses with FFWS and 11 healthy stablemate controls

and concluded that "there is no significant difference between the microbiome of feces from FFWS animals and controls."

All fecal samples had similar community composition and structure, with the exception of differences in microbiota genus between sexes—females had greater abundance of the genus *Roseburia*, which is a butyrate-producing Gram-positive anaerobic bacteria beneficial to gut health. Geographical differences also account for slight variations in microbiota.

The authors concluded that "microbial composition and diversity may not be the central factor that affects FFWS but, rather, simply a contributor toward the metabolomic environment that both the horse and microbiota generate within the hindgut."

Results from a new study² agree with prior ones on the difference in the abundance of two bacterial taxa: Control horses had more *Bacillus spp.*, and FFWS-affected horses had an enrichment of *Alloprevotella sp.* The latter are considered normal to healthy equine

microbiomes, often associated with older age, obesity, or changes in feed. The authors similarly suggest that *Alloprevotella sp.* might be an indicator or biomarker of FFWS rather than a contributing factor.

While identifying the root cause of FFWS is critical to management, researchers have suggested that fecal transplantation can potentially reduce the severity of FFWS symptoms.

Fecal Microbial Transplantation

Researchers in the Netherlands, Britain, and Thailand concluded from their study that there are no differences in hindgut microbiota between horses with FFWS and normal horses. They did determine, however, that fecal microbiota transplantation from a healthy donor horse could reduce the severity of FFWS symptoms temporarily in some individuals.³

The study involved 10 horses with severe symptoms of FFWS for at least a year and 10 healthy controls. The researchers analyzed symptom severity and

microbiota composition for 5 ½ months. The horses received omeprazole to minimize gastric acid that could affect transplanted microbiota viability and psyllium following fecal microbiota transplant.

Two donor horses provided the fecal transplants, which were administered via nasogastric tube for five consecutive days. These fecal transplants contained not only microbes but also metabolites such as volatile fatty acids, including butyric acid, which is beneficial to gut integrity.

Some of the FFWS horses treated with fecal transplants experienced full resolution while others achieved a partial reduction in symptom severity. Clinical signs began improving in most FFWS horses around Day 14 following fecal transplantation; 30% of FFWS horses' symptoms resolved completely after seven days.

Despite finding no differences in hindgut microbiota disruption between FFWS and healthy individuals, the authors concluded that fecal transplantation has "the potential to temporarily alleviate FFWS symptom severity."

Feeding and Management for FFWS

Diet might be a factor in FFWS development. Previous studies have shown that changing from wrapped grass forage to a different grass hay or pasture grass reduced FFWS symptoms by 17-58%. The study authors reported that feed ration composition and forage type might play important roles in the presence of FFWS.

A Swedish report explored case-control studies on horses from 50 farms, looking at specific feed rations, feeding practices, and management of horses with FFWS.⁴ It brought to light some specific dietary considerations for horses with FFWS. While both FFWS and control horses received similar amounts of wrapped forage, other dietary components differed between cases and controls:

- FFWS horses received higher amounts and proportions of concentrates, nearly twice as much per 100 kilograms of

body weight than controls. This results in higher sugar, starch, and water-soluble carbohydrate intake, which could contribute to osmotic movements of water into the bowel.

- FFWS horses received lower amounts of straw and lucerne than controls, resulting in a lower daily intake of digestible crude protein and neutral detergent fiber. Fiber-rich feed intake slows the rate of production and absorption of intestinal water compared to low-fiber feed.
- The addition of commercial probiotics (yeast), prebiotics, psyllium, linseed, or thiamine helped reduce or eliminate signs of FFWS in 26% of horses.
- In summary, the authors reported that while the composition of feed rations differed between horses with and without FFWS, feeding practices and management factors did not.

Investigating Potential Causes of FFWS

At the 2025 ACVIM Forum, Allison Boehm, DVM, described a Colorado State University study to identify risk factors that predispose horses to FFWS. The research team collected fecal samples from 25 FFWS horses and 26 controls for PCR analysis and immunofluorescent antibody testing to evaluate shedding of specific bacterial and viral species: *Salmonella enterica*, *Clostridium difficile*, equine coronavirus, *Neorickettsia risticii*, *Lawsonia intracellularis*, *Cryptosporidium* spp, and *Giardia*.

They concluded that horses with FFWS might have more comorbidities than normal control horses. A noteworthy finding from Boehm's study is that horses with concurrent pituitary pars intermedia dysfunction (PPID) are six times more likely to experience FFWS than controls.

"Administration of at least three oral supplements, recent non-steroidal anti-inflammatory drugs, or prior antibiotic use occurred more often in horses with FFWS," the authors noted. They reported no differences in

prevalence of infectious agent shedding between FFWS horses and controls.

There were also no differences in social interactions, breed, or gender.

The Bottom Line: Dietary Recommendations for FFWS

In closing, here are specific strategies you can recommend to control FFWS:

- Offer digestible forage with minimal stemmy components.
- Substitute long-stem hay rations with beet pulp, hay cubes, chopped forage, pelleted forage, or complete feed.
- Feed small meals 4-6 times per day to reduce colon bulk and particle size.
- If horses are on concentrate feed, choose a high-fiber, low-soluble-carbohydrate product. Use fat supplements to add calories to the diet.
- Provide prebiotics, such as psyllium, to promote butyrate production in the hindgut.
- Make dietary changes slowly, and keep the ration consistent. **EM**

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Managing Laminitis Through Nutrition

Science-based, dietary ways to manage horses with or at risk of developing hyperinsulinemia-associated laminitis.

By Nancy S. Loving, DVM

Horses that consume too many calories, especially relative to their exercise output, are at risk for developing endocrinopathic laminitis, also referred to as hyperinsulinemia-associated laminitis (HAL). Insulin dysregulation (ID) occurs in 30% of horses with pituitary pars intermedia dysfunction (PPID) and nearly all horses with equine metabolic syndrome (EMS). Here are some science-based, dietary ways to manage horses with or at risk of HAL.

Focus on NSC Intake

Nutritional guidelines for managing affected horses and preventing endocrinopathic laminitis in at-risk horses rely

on limiting nonstructural carbohydrate (NSC) intake to less than 10% of dry matter fed. Grass hay NSC ranges from 10-15%; alfalfa hay has an NSC of about 11.3%. Sweet feed, corn, oats, and barley are high in NSC, ranging from 45-75% (Burns, 2017 AAEP). High-NSC feeds can cause horses to experience postprandial hyperglycemia, followed by hyperinsulinemia, which can then contribute to the development of laminitis.

One study¹ reports that “even feeding small amounts of various diets produces 1.7-3.4-fold greater postprandial insulinemic responses in ID horses than those that are not ID.” The authors suggested the threshold for the amount of NSC that can be fed without producing a significant insulin response “may vary

with the severity of ID.”

Study results suggest that an insulin level of > 200 uIU/ml might be a threshold for laminitis risk. However, we don’t know what duration of this threshold might elicit metabolic changes that generate a laminitis attack.

A primary strategy for preventing and managing endocrinopathic laminitis is to reduce a horse’s intake of rapidly fermentable carbohydrates. Specifically:

- Avoid concentrates that contain cereals or grains. Some commercially available low-sugar/low-starch feeds might still have NSC levels of 15%, so it is important to read the labels.
- Reduce meal size by half, and feed small amounts more frequently to lower postprandial insulinemic

responses in ID horses.²

- Restrict pasture access. NSC can reach 40% in autumn due to relatively long daylight hours and low temperatures (65–700 F). Early morning plants that have used up “yesterday’s” energy have lower sugar concentrations. In contrast, pasture grass sugar content is highest in early to mid-afternoon hours.
- Use grazing muzzles to limit pasture intake by up to 30% for horses that are turned out so they can still get exercise and satisfy foraging behavior.³
- Set up strip grazing or track systems that provide food and water at opposite ends of a field’s perimeter, encouraging movement while reducing dry matter intake.
- Feed warm-season grass hays (Bermudagrass, crabgrass, Sudan grass, and teff), which have a lower sugar and starch content than cool-season grasses like orchardgrass, tall fescue, rye, and timothy.

Consider the horse’s total diet NSC levels, both forage (hay and/or pasture) and commercial feeds. Feeds tested at 10–12% NSC can be fed at 1–2% of a horse’s ideal body weight. If weight loss plateaus over 4–6 weeks, decrease the amount fed. Usually, 1.5% of body weight is effective but might need to be reduced to 1.2% body weight. Small amounts of alfalfa pellets—1 pound for a 1,000-pound horse—do not seem to cause postprandial insulin elevations.¹

Additional Feeding Strategies

Another useful technique to reduce sugar content and subsequent glycemic and insulinemic responses is to soak hay and then pour off the supernatant. The European College of Equine Internal Medicine (ECEIM) Consensus Statement on Equine Metabolic Syndrome recommends restricting soaking time to 1–2 hours, especially in warm weather, to limit microbial and mold growth and leaching of protein, minerals, and electrolytes.

Straw has a lower energy density than hay, so you can add a small quantity of straw to hay rations to increase consumption time. Introduce straw very gradually and at no more than 30% of the total forage. Monitor horses carefully because of the risk of colon impaction. Horses that are on a restricted intake diet to achieve weight loss might try to eat straw, wood shaving, and paper bedding. In some cases, it might be best to stable horses on rubber mats to avoid bedding ingestion.

Slow feeders and hay nets facilitate longer feeding times to lower insulin spikes and give horses something to do. The ECEIM Consensus Statement reports that slow feeders or hay nets can extend hay intake from 2 hours to more than 3 hours of eating time. Glunk et al.³ found that a small net size of 1.25 inches (3.2 centimeters) increased consumption time from 3 hours (on the ground) to 5–6 hours. Balls in buckets and buckets with waffle-style bases also slow eating time to help reduce postprandial glucose rises.⁴

Forage testing is advantageous to evaluate NSC content since various hay cuttings and feed lots can vary in NSC content. Because regular testing is expensive, Macon et al. recommend calling your commercial feed manufacturer to request NSC values based on the product’s lot number.⁴

A ration balancer is useful for obese horses on restricted diets to meet their protein, vitamin, and mineral needs. These balancers, fed in combination with low-NSC forage, are not necessarily low in NSC but if fed in limited amounts and split into multiple small feedings can limit postprandial insulin responses compared to feeding the full amount of ration balancer at a single feeding.

One study found that EMS horses fed double the amount of recommended ration balancer had a ninefold increase in postprandial insulin secretion. It is noteworthy that one amino acid, arginine, fed at high levels might induce insulin secretion. Other studies report

that leucine and resveratrol help decrease insulin responses to an oral sugar test in ID horses.⁵

Sulfur-containing amino acids—cysteine and methionine—are important structural components of keratinized tissue, and supplementation in hoof products might improve hoof quality. Biotin is another micronutrient that might help stimulate and improve hoof growth and quality, especially for horses with compromised microbiota integrity that interferes with innate biotin production.

Take-Home Message

Resting and postprandial responses of insulin dysfunction might vary between seasons, with spring eliciting higher insulin concentrations (both basal and post-oral sugar testing) than summer and fall, says Macon. In addition, some horses that experience postprandial hyperinsulinemia might have normal resting insulin responses. This means dynamic oral sugar testing should be performed to achieve an accurate diagnosis that informs the best way to feed each individual endocrinopathic horse at risk for laminitis. **EM**

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A rider wearing a purple shirt, blue pants, and a helmet is on a brown horse, performing a barrel race in a dirt arena. The horse is galloping around a barrel, kicking up a cloud of red dirt. The background shows a green fence and a building.

Nutritional Support for Performance Horses

Areas of study include strategies to relieve heat stress, inflammation, and gastric ulcer risk in this population of horses.

By Nancy S. Loving, DVM

Equine athletes of any discipline need specific nutrients—protein, carbohydrates, fats, vitamins, and minerals—to support muscle strength and metabolism. Most equine veterinarians are familiar with these basic ingredients. Recent research on this population of horses, however, has assessed the use of specific supplements and practical strategies to relieve heat stress and inflammation and to mitigate gastric ulcer disease. We'll discuss those findings briefly here.

Melatonin's Effects on Heat Stress

In certain climatic conditions coupled with exercise intensity and duration, equine athletes are at risk of heat stress that can undermine their performance and metabolic health. Fox et al. recently looked at melatonin, which has antioxidant properties, and its ability to modu-

late exercise-induced heat stress.

The study involved eight horses: Four were supplemented daily with 50 grams of oral melatonin, and the other four served as controls. Each horse was exercised for three days at moderate intensity of walk, trot, and canter for an hour. They then underwent a seven-day washout period, their roles as supplemented or control were reversed, and the researchers performed the experiment again.

Compared to the melatonin-supplemented horses, the control horses had significantly elevated body temperature and heart and respiratory rates by 30 and 60 minutes of exercise and during the 10-minute recovery period. By 20 minutes of recovery, there were no significant differences between supplemented and control horses' parameters.

"Results demonstrate the potential of melatonin supplementation to modulate physiological responses to heat stress during and after exercise in horses,

suggesting its potential value as a dietary intervention for performance horses in challenging environmental conditions," the study authors wrote. Research in the department of Clay A. Cavinder, PhD, Professor and Extension Horse Specialist at Mississippi State University, is ongoing.

Fox AD, Valigura HC, Cavinder C, Smith T. Effects of melatonin on heat stress response in exercising horses. Journal of Equine Veterinary Science 2025, Volume 148; DOI: 10.1016/j.jevs.2025.105476

Antioxidant Supplementation Might Mitigate Oxidative Stress

Oxidative stress in horses is a byproduct of exercise and has the potential to contribute to inflammation. A study at Colorado State University looked at young horses beginning training that received an antioxidant supplement.

In the study, 18 horses were split into two treatment groups: supplement or

placebo controls. For the first 30 days of treatment, the horses were kept at maintenance, followed by 30 days of moderate work. The researchers assessed stride duration and knee and hock range of motion at the walk and trot using motion analysis software.

On Days 30 and 60, the horses performed a standardized exercise test. Blood samples were evaluated for glutathione peroxidase activity (GPX), superoxide dismutase activity (SOD), and thiobarbituric acid reactive substances (TBARS) concentration.

Conditioning led to greater antioxidant capacity, with TBARS concentrations decreasing less in supplemented horses compared to the controls. The standardized exercise test might have triggered an endogenous antioxidant response for both groups but more so for the control than the supplemented horses. In addition, reconditioning led to restricted limb movement as the days of exercise proceeded, with supplementation mitigating the decrease in knee and hock movement.

The authors concluded that, “although the most significant changes to antioxidant status were due to reconditioning, supplementation mitigated aspects of exercise-induced oxygen species and related changes in movement in young horses undergoing training.”

O'Reilly K, Keller K, Bradbery AN, Hess T, Catalano D. *Effect of antioxidant supplementation on oxidative stress in young exercising horses. Journal of Equine Veterinary Science* 2025, Volume 148; DOI: 10.1016/j.jevs.2025.105493

Feed Hay Before Concentrate to Control Inflammation

Equine athletes often receive a concentrate feed for additional calories and to meet their elevated energy needs. General recommendations for equine digestive health limit a single concentrate meal to less than 5 pounds to protect against gastric ulcer disease that's so prevalent in the sport horse population. Ideally, caretakers split grain meals into two to

Feeding Tips to Optimize Performance

Performance horses need balanced energy sources to meet their athletic endeavors. Knowing the roles of forage, fiber, and feed is essential for their health and performance. Here are some basic guidelines:

- **High-quality hay** and pasture should constitute the majority of a performance horse's diet. It provides essential fiber necessary for proper digestive function.
- **Quality fiber** sources help maintain gut function and support a healthy microbial population. When those hindgut microbes ferment fiber, it produces volatile fatty acids that offer a slow, sustained energy release. This steady energy supply helps horses maintain endurance and stamina throughout training and competition, reducing the risk of fatigue and performance dips.
- **Fat-rich feeds** are ideal for horses that participate in stamina-based disciplines. They provide a concentrated, slow-burning energy source that helps sustain endurance and optimize muscle function without the risks associated with excessive starch intake.
- **Incorporating high-quality protein** sources like soybean meal or alfalfa ensures the availability of essential amino acids necessary for muscle maintenance and repair.
- **Consider a gastric support supplement** to maintain proper pH levels and support gut health during the stress of competition and travel.

For expert guidance creating personalized feeding plans for your high-performance patients, contact Sentinel's team of equine nutrition specialists.

three feedings per day.

Concentrate feeds contribute to acidification of the equine intestinal tract, with the potential to cause gastric ulcers, leaky gut syndrome, inflammation, and laminitis. Within an hour of eating, high-starch diets elevate plasma concentrations of inflammatory cytokines, including interleukin-1B (IL-1B), because of changes in intestinal pH.

Researchers compared the effects of feeding 2 pounds of grass hay 30 minutes prior to concentrate to feeding a concentrate diet without offering hay first.

The study involved six mature geldings that were fasted overnight. Blood samples were taken 30 minutes prior to the hay meal and then 1, 2, 4, 6, and 8 hours after hay was offered. A concentrate feed (1.2 g/kg body weight of nonstructural carbohydrates) was fed 30 minutes after the horses received 2 pounds of fairly low-NSC grass hay, which they consumed within 20 minutes. (Postprandial inflammation occurs with consumption of > 1.14 grams NSC per kilogram of body weight.)

Horses receiving hay 30 minutes prior to concentrate had lower amounts of IL-

1B compared to the control horses—an effect that lasted as long as eight hours. Similarly, d-lactate concentrations—produced by microbes in the presence of NSC intake—were lower during the first four hours in horses fed hay first.

“Feeding a small amount of hay before feeding a meal of moderate starch and sugar content reduced the negative effects of rapid starch and sugar fermentation in the equine digestive tract,” the authors concluded. They noted that salivary bicarbonate stimulated by eating hay serves as a stomach buffer that also protects lactic-acid-using bacteria to mitigate declining intestinal pH.

In summary, even a small flake or about 2 pounds of grass hay can blunt the rise in inflammatory IL-1B concentrations if fed 30 minutes prior to offering concentrate. **EM**

Suagge-Bedore JK, Linden DR, Bennett-Wimbush K, Splan RK. *Feeding Grass Hay Before Concentrate Mitigates the Effect of Grain-Based Concentrates on Postprandial Plasma Interleukin-1B. Journal of Equine Veterinary Science* 2019, vol. 86; doi.org/10.1016/j.jevs.2019.102899

The scoop on supplements: Where to begin and what to look for.

As an equine veterinarian, one of the questions you might hear is: Does my horse need supplements?

The answer, of course, depends on a variety of factors, most importantly the horse in question. So, we asked Sentinel® Product Manager Kristyn Sturken how to assess a horse's diet and lifestyle to determine if a supplement could benefit their health and performance.

WHERE SHOULD A VETERINARIAN START?

Before adding anything to a horse's diet, it's important to note their body condition and take inventory of what they're currently getting nutritionally.

Sturken recommends starting with the foundation of their nutrition in forage. What type of hay are they eating, is it good quality and are they eating enough to meet their forage needs?

"You should also look at the makeup of a horse's feed, and whether or not it's being fed according to the label," Sturken says. "If their forage or feed intake falls short, a general protein, vitamin and mineral supplement, or ration balancer, can often fill in the gaps."

WHAT ARE KEY INGREDIENTS TO LOOK FOR?

The right supplement will always depend on the needs of the specific horse and the condition you're trying to manage. For digestive concerns, including ulcers, look for ingredients like:

- Prebiotics and probiotics: Prebiotics nourish beneficial bacteria, while probiotics are live microorganisms that help maintain gut balance.
- Butyrate and zinc: These support intestinal cell integrity, improving digestion and nutrient absorption.
- Marine-sourced calcium: Derived from algae, it helps buffer the stomach, aiding horses prone to ulcers.
- Organic acids: These contribute to overall gut health and immune function.



For supporting hoof condition, look for ingredients like:

- Biotin: This B-complex vitamin promotes healthy cell growth and aids in the metabolism of amino acids that support keratin production.
- Omega-3 fatty acids: These serve as an integral part of cell membranes to regulate inflammation, lubricate hoof tissues and support healthy hoof growth.
- Trace mineral amino acid complexes: Bio-available sources of zinc, copper and manganese are important for healthy growth, structure and maintenance of hoof tissues and joints.
- Methionine: An amino acid used in the building of keratin, the main protein in hoof tissue that provides stability and strength.

HOW CAN YOUR CLIENTS TELL IF A SUPPLEMENT IS WORKING?

Knowing if your supplement regime is benefiting your patient requires patience. It can take a minimum of 30 to 60 days or longer to see improvements in hoof quality, coat condition, weight gain or behavior, so make sure your client documents progress, and gives the supplement time to work.



The Sentinel team can help you make the best nutritional decisions for your horse and the horses in your care. **Sign up** for the latest news, research and expert nutritional guidance for all horses.





Roxy after hospitalization and back to her normal body condition.

Feeding Horses Back to Health

Two examples where nutrition played a key role in a horse's post-hospitalization recovery.

By Madeline Boast, MSc, PAS

Nutritional management is a key aspect of recovery for many equine health conditions. Once you've treated the underlying medical issues, a carefully designed nutritional program can help, quite literally, feed the horse back to health.

Editor's note: The feeding amounts in this article are based on individual horse weight, metabolism, and activity level.

Case Study No. 1: Refeeding After Hospitalization

Roxy, a 4-year-old pony cross, was hospitalized due to a small colon impaction and typhlitis after presenting with clinical signs of colic and diarrhea. Upon admission, Roxy was diagnosed with equine coronavirus, which the treating veterinarians determined was the cause of her gastrointestinal upset.

Although the impaction colic and typhlitis resolved medically, Roxy experienced weight loss while hospitalized and was on a significantly different feed program than normal. At discharge, she was being fed 0.5 kilograms of roughage

mash and half a flake of hay every six hours (totaling 2 kilograms roughage pellets and two flakes of hay/day).

It can be daunting for horse owners to take a horse home after a hospital stay on a very different diet and safely transition them back to a normal program while promoting weight gain. It's important to help clients understand that the recovery process is not complete when the horse is discharged.

After a serious gastrointestinal upset, it is of the utmost importance to make dietary changes slowly to reduce the risk of another health issue presenting. Oftentimes, horse owners will bring their horse home and immediately begin feeding their regular rations. A frequently overlooked aspect of transitioning from a hospital stay back home is that the hay, which generally comprises most of the horse's diet, is different.

The goal for Roxy was to focus on maintaining the base of her diet as highly digestible fiber and encouraging water intake while she transitioned to long-stem fiber at home. Here is the nutrition plan her care team followed:

Minimize changes immediately following discharge. When a horse leaves the hospital, they are changing from the hospital hay back to their home supply, which might differ greatly in nutritional content.

Roxy's owner purchased the fiber-based commercial pelleted feed that was being used for her mashes at the hospital and continued to feed 0.5 kilograms every six hours for the first 48 hours back at home. This minimized changes in the fiber profile of her diet while she transitioned to her regular hay.

Increase hay gradually, and use precise measurements. Using "flakes" as a measurement is unreliable—one flake of hospital hay could weigh 1 kilogram, whereas a flake at home could weigh 2.5 kilograms. When managing a refeeding program, advise your clients to invest in a fish or luggage scale to quantify hay amounts.

After the two-day acclimation period, Roxy's hay was increased by 500 grams per day until she was consuming 2% of her ideal body weight in fiber (both in the form of hay and fiber-based feed).

Ensure the ration is balanced. The 2 kilograms of fiber-based feed was not providing Roxy with adequate vitamin and mineral content. Once Roxy returned to a healthy fiber intake, her owner added a ration balancer to the mare's diet.

Return to a practical program. Feeding four mashes per day is a great way to ensure regular intake of water and digestible fiber after hospitalization. However, it is not practical or often necessary to continue with this diet.

Using a rate of change of 400 grams/day, Roxy's mashes were decreased by 100 grams/meal and her hay was increased by the same amount to transition her back to her regular program. This change took place over 14 days.

Achieve an optimal weight. Roxy had been gaining weight consistently during her transition back home but had not yet achieved her optimal weight. To provide additional support, the owner added a fat supplement to her diet. Within six weeks of hospital discharge, Roxy had returned to a normal, healthy body condition.

Roxy's case illustrates how supporting clients with a structured transition program upon returning to the horse's original diet can reduce the risk of gastrointestinal upset after hospitalization. However, in some cases, the original feeding program might not have been

adequate to begin with and must be permanently adjusted following a medical diagnosis.

Case Study No. 2: Balancing Weight Gain and Palatability Issues

Romeo, an 11-year-old Miniature Horse, had a three-month history of reduced appetite and progressive weight loss. Upon hospitalization, he was diagnosed with lymphocytic plasmacytic infiltrative bowel disease. Abdominal ultrasound and gastroscopy revealed thickening of the small intestinal walls, with anechoic material between the layers, as well as mild hyperkeratosis of the lesser curvature along the margo plicatus.

Feeding Romeo back to health focused on increasing calories gradually using highly digestible fiber and supplemental fat. Romeo's owners were able to feed him four meals per day. The initial plan included:

- A fiber-based complete feed fortified with fat (25% fiber).
- A senior feed to improve palatability and nutrient intake.
- A vitamin/mineral premix to increase his intake of key nutrients.

Palatability, however, proved to be a major challenge. At first, Romeo enjoyed his feed and was eating it well.

However, after the first week, he stopped enthusiastically consuming his meals. Romeo's owners noted that he had historically done well with meal variety, and they were open to trying different things with his diet.

So they were given two meal options: One that must be fed soaked and one that could be fed dry. The basic combination of a senior feed with a complete feed and added fat remained the same. This allowed the owners to provide Romeo with daily variety while ensuring his ration remained balanced and provided adequate caloric supplementation.

At four weeks post-hospital stay, Romeo had gained 17.5 kilograms (38.5 pounds) and continued to consume his feed well while his condition was managed medically.

Take-Home Message

Medical management of equine health issues is critical. However, upon discharge from the hospital, nutritional support becomes important. Owners often struggle to confidently implement a balanced and effective feeding program on their own. Visit the Sentinel Equine Nutrition Veterinarian Hub for expert advice and resources to help support your clients and their horses in recovery. **EM**



Romeo weighing 100 kilograms (220 pounds) post-hospital stay.



Romeo eight weeks later, after achieving an optimal body condition through a balanced diet program and meal variety.



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