

Forage Buffering Capacity Relevant in Gastric Ulcer Prevention



The capacity of feeds and forages to counteract changes in gastric pH plays an important role in the prevention of gastric ulcers in horses. This ability to resist changes in pH is called buffering capacity. Alfalfa hay has been shown to be effective in reducing the severity of ulcers in horses by providing superior buffering capacity compared to grass hay.

Gastric ulcers are very common in performance horses, affecting more than 90% of racehorses and 60% of show horses. Most ulcers occur in the upper portion of the horse's stomach, which is comprised of nonglandular squamous epithelium. These ulcers are primarily the result of prolonged exposure of this tissue to gastric acid. Unlike the glandular portion of the stomach, the upper half of the equine stomach does not have a mucous layer and does not secrete bicarbonate onto its surface. The only protection this portion of the stomach has from gastric acid and pepsin comes from saliva production and the buffering capacity of feed.

The high incidence of ulcers seen in performance horses is a man-made problem resulting from the way we feed and manage these horses, since ulcers are much less prevalent in unexercised horses maintained solely on pasture.

Horses evolved as wandering grazers with digestive tracts designed for continual consumption of forages. Meals of grain or extended periods of fasting lead to excessive gastric acid output without adequate saliva production. Additionally, production of volatile fatty acids

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(VFA), particularly butyric acid, from the fermentation of grain in the stomach makes the nonglandular epithelium more susceptible to acid damage.

Horses secrete acid continuously whether or not they are fed. The pH of gastric fluid in horses withheld from feed for several hours has consistently been measured to be 2.0 or lower. Horses that received free-choice timothy hay for 24 hours had mean gastric pH readings that were significantly higher than fasted horses. High pH readings in hay-fed horses should be expected since forage consumption stimulates saliva production.

German researchers measured the amount of saliva produced when horses ate either hay, pasture, or a grain feed. When fed hay and fresh grass, horses produced twice as much saliva compared to when a grain-based meal was offered.

There is growing evidence that the type of hay fed to horses has a significant impact on acid neutralization and the incidence of gastric ulcers.

Researchers at the University of Tennessee reported a study in which six horses with gastric cannulae were fed either alfalfa hay and concentrate or bromegrass hay without grain supplementation. The alfalfa hay and concentrate diet was predicted to produce more ulcers due to the greater gastric production of VFA and less saliva production compared to when the horses were fed only grass hay.

Surprisingly, these researchers found that feeding alfalfa hay and concentrate increased the pH of gastric fluid and reduced the number and severity of squamous mucosal ulcerations compared to feeding the diet of bromegrass hay. Saliva production was not measured in this study, but it was suggested that the buffering capacity of the alfalfa and/or concentrate was greater than for grass hay.

A more recent study at Texas A&M University suggests that the differences seen in the Tennessee study were related to the type of hay fed. In the study conducted by Texas researchers, the incidence of ulceration was compared in horses fed a pelleted concentrate along with either Bermuda grass hay or alfalfa hay. Twenty-four Quarter Horse yearlings (12-16 months of age) were used in a trial with two 28-day treatment periods separated by a 21-day washout period in which neither of the treatment diets was fed.

Gastric endoscopy was performed at the beginning of the study, and each horse was assigned an ulcer severity score using a grading system ranging from zero (intact gastric epithelium with no sign of ulceration) to four (submucosal penetration).

The horses were assigned to one of two treatment groups to ensure equivalent ulcer severity scores in the two treatment groups. Group 1 horses were fed a diet consisting of coastal Bermuda grass hay and a pelleted concentrate in a weight:weight ratio of 1:1, and group 2



horses were fed a diet consisting of alfalfa hay and the same concentrate in a weight:weight ratio of 1:1. The horses were housed in small drylots and subjected to an exercise regimen three days per week using a mechanical exerciser.

At the end of the first 28-day period, gastroscopy was repeated, and horses were turned out to pasture with no forced exercise and fed a diet comprised of grazing and 4 pounds (1.8 kg) per horse of the same pellet. After 21 days on pasture, gastric endoscopy was repeated, and diet regimens were switched (i.e., group 1 and group 2 horses were switched to the opposite diets).

The ulcer severity scores were significantly lower for horses in the alfalfa hay group than horses fed coastal Bermuda grass hay. Among horses fed alfalfa, 12 had no ulcers at baseline and 11 had ulcer scores of two or three. Of the 11 horses with ulcer scores greater than zero, all improved by at least two ulcer grades while on the alfalfa diet. One of the 12 horses without ulceration developed gastric ulceration during the time it was fed alfalfa.

In contrast, of the 12 horses fed coastal Bermuda grass hay that had ulcer scores greater than zero, scores of five horses improved, and only two were improved by at least two grades. Of the 12 horses with initial ulcer scores of zero fed coastal Bermuda grass, only three remained free of ulcers, and seven developed ulcers with scores of two or greater.

Among the horses fed coastal Bermuda grass during period 1, ulcer scores did not change

significantly between the end of period 1 and the end of the washout period; however, the ulcer severity scores of horses fed alfalfa hay during period 1 were significantly higher after the washout period ended than at the end of period 1.

Relative to feeding coastal Bermuda grass hay, feeding alfalfa hay reduced ulcer severity scores in horses with gastric ulceration and prevented ulcer development in 11 of 12 (92%) horses fed alfalfa hay that did not have ulcers, whereas only 25% (3 of 12) of the horses without evidence of ulceration fed coastal Bermuda grass hay did not appear to develop ulcerations. Moreover, horses that were initially fed alfalfa hay had a significant worsening of ulcer severity scores during the washout period.

Alfalfa hay provides greater buffering capacity compared to coastal Bermuda grass hay for several reasons. First, alfalfa contains higher levels of protein and calcium, both of which buffer gastric acid. Also, alfalfa cell wall contains certain indigestible compounds such as lignin that gives it a greater buffering capacity than grasses.

In the early 1980s, researchers showed that the cell walls of alfalfa plants have a much higher buffering capacity than the cell walls of either timothy plants or oats when titrated with hydrochloric acid.

A few years later, other researchers measured the in vitro buffering capacity of 52 feeds to determine the buffering capacity range among feed types. Buffering capacity was



Alfalfa comes in many forms. Cubes are frequently given to horses to increase their forage intake.

Superior buffering capacity of alfalfa hay compared with grass hays helps reduce and prevent gastric ulcers.

EXPERIMENTAL AIM	MAJOR RESULT	SUMMARY
<ul style="list-style-type: none"> Incidence and severity of gastric ulcers in horses fed a diet of alfalfa hay and concentrate compared with horses fed brome grass hay only 	<ul style="list-style-type: none"> Feeding alfalfa hay and concentrate increased gastric fluid pH and reduced the number and severity of ulcers compared with horses fed brome grass hay only 	<ul style="list-style-type: none"> Buffering capacity of alfalfa was greater than in brome grass hay
<ul style="list-style-type: none"> Incidence and severity of gastric ulceration in horses fed pelleted concentrate compared with either alfalfa hay or Bermuda grass hay 	<ul style="list-style-type: none"> Ulcer severity scores lower in alfalfa-fed horses compared with grass hay Alfalfa prevented ulcer development in 92% of horses fed alfalfa compared with only 25% in grass-hay group 	<ul style="list-style-type: none"> Buffering capacity of alfalfa greater than Bermuda grass hay

Nadeau, J.A., F.M. Andrews, and A.G. Matthew. 2000. Evaluation of diet as a cause of gastric ulcers in horses. *American Journal of Veterinary Research* 61:784-790.

Lybbert, T., P. Gibbs, N. Cohen, B. Scott, and D. Sigler. 2007. Feeding alfalfa hay to exercising horses reduces the severity of gastric squamous mucosal ulceration. In: *Proceedings of the American Association of Equine Practitioners* 53:525-526.

lowest for energy feeds, intermediate for low-protein feeds and grass forages, and highest for high-protein feeds and legume forages.

The buffering capacity of feed and forage is an essential component in the prevention of gastric ulcers in horses. Alfalfa hay has been shown to be effective in reducing the severity of ulcers in horses by providing superior buffer-

ing capacity compared to grass hay. Unfortunately, high levels of alfalfa hay may not be desirable for performance horses because of the detrimental effects of excess protein intake.

More research is needed to identify other feeds and forages that also possess high buffering capacities while containing more desirable nutrient compositions. 

