The Bacterial Community of the Horse Gastrointestinal Tract and Its Relation to Fermentative Acidosis, Laminitis, Colic, and Stomach Ulcers

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KEYWORDS

• Bacterial community • Fermentative acidosis • Laminitis
• Colic • Stomach ulcer

Fermentation in the hindgut of the horse is similar to that in the rumen, resulting in the production of short-chain volatile fatty acids (VFAs), mainly acetic, propionic, and butyric acids. The proportion of these acids is influenced by the availability and type of substrate, the composition of the microbial community, and the hindgut physiologic conditions. The microbial community of the hindgut of the horse, particularly the fiber-degrading bacteria, is far less understood than that of the ruminant's compartmental stomach. VFAs are absorbed across the hindgut wall, transported by blood into different tissues, and used as an energy source. Horses are less efficient than ruminants in the digestion of fiber and therefore have a lower survival rate than ruminants under severe drought conditions. In addition to VFAs, a large volume of gases is produced and removed dorsally. Under normal feeding conditions, horses spend approximately 10 to 12 hours a day eating. Such feeding patterns allow them to maintain a full stomach and a continuous supply of nutrients both to the host animal and the microbial community residing the hindgut. This feeding behavior also helps the horse to overcome the problem of having a relatively small stomach compared with other herbivore species of a similar body size, such as the cow. This feeding behavior is

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important for health and for meeting horses' nutritional needs, especially energy. In contrast, racehorses are fed grain-rich diets twice daily and are withheld from feed for extended periods before exercise. The increase in gastric acid production during exercise, the reduction in saliva production caused by the low fiber content of the diet, and the periods of feed deprivation between meals lead to prolonged periods in which the unprotected non-glandular region of the stomach is exposed to acid. This exposure combined with typical indoor confinement and the stress of intense exercise is the probable cause of stomach ulcers in race and performance horses. The ingestion of a diet high in starch or rich in nonstructural carbohydrate also is associated with diseases such as fermentative acidosis, equine metabolic syndrome, equine Cushing's disease, laminitis, and colic. Maintaining health in horses under conditions of concentrate feeding is a real challenge facing nutritionists, veterinarians. and owners. Such challenge requires better understanding of the anatomic, physiologic, and functional features of the horse gastrointestinal (GI) tract. An understanding of the complexity of the microbial ecosystem, the interactions among the large and diverse microbial community and between microbes and the host animal, and the influences of diet on the microbes is equally important. This article focuses on the feeding conditions that maintain good health and on the dietary changes associated with diseases such as fermentative acidosis, laminitis, and colic that occur mainly in intensively managed horses.

The present horse belongs to the genus *Equus*, which evolved 1 million years ago from its ancestor *Eohippus*, an early type of mammal that began evolution 60 million years ago.[1] The evolution of the horse coincided with the development of grasslands that displaced forests. The environmental and geographic changes during that period led to anatomic and physiologic changes that enabled the horse's survival. It is not known exactly when the horse was domesticated, nor is it known whether its GI tract was modified to suit the available high-fiber grasses present at that time or whether the horse selected the type of feed most suited for its GI tract. Domestication that adapted horses to human use and captive life secured the survival of the species and assisted humankind in creating civilization.

Horses are best described as hindgut fermenters with an enlarged cecum and colon that harbors a complex microbial community. These microbes contribute to the digestion processes that enable the horse to extract energy from dietary components that otherwise would be wasted. In addition to hindgut fermentation, extensive fermentation occurs in the stomach when horses consume diets rich in nonstructural carbohydrates. The fermentation in the stomach, however, produces mainly lactic acid and small amounts of VFAs because of the acidic conditions of the stomach that support acid-tolerant bacteria (eg, lactic acid–producing bacteria). Horses are subject to nutritional disorders and diseases common to intensively managed animals such as acidosis, colic, gastric ulcers, and laminitis. The special anatomic and physiologic features of the horse's digestive system need to be considered when deciding what to feed horses. Improved pastures that have been developed to maximize microbial protein synthesis in the rumen of cattle and sheep[2] and to increase milk yield[3] may be deleterious to horses because of their high content of nonstructural carbohydrates and crude protein. Improved pastures may have an effect similar to that of grain or concentrate feeding for performance or racehorses.[4]

This article describes the GI tract of the horse, its bacterial community, the diets best suited for it, and the effects on health of feeding concentrate- or grain-based diets.