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Review article

The equine gastro-intestinal tract: An overview of the microbiota, disease and treatment

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ABSTRACT

Horse is a hindgut fermenter, *i.e.* most microbial activities take place in the large intestine which constitutes approximately 60 per cent of the gastro-intestinal tract (GIT). The feed reaches the large intestine after approximately 3 h and is fermented for 36–48 h in the caecum. This rate of transition is only possible if the roughage component of the feed is kept optimal. A diet rich in starch leads to an imbalance in gastro-intestinal microbiota, which may lead to colic and often death. Lactic acid bacteria form a major constituent of the microbiota in the GIT, especially in the large intestine, and produce most of the volatile fatty acids (VFA) needed for energy. Production of antimicrobial compounds, including antimicrobial peptides (bacteriocins) may prevent the growth of pathogens and keep a healthy microbial balance in the GIT. Lactic acid bacteria may also play a role in stimulation of the immune system.

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1. Introduction

Horse (*Equus caballus*) is a monogastric, hindgut fermenting animal, *i.e.* most of the feed is degraded in the caecum and colon (Fig. 1). Production of large quantities of saliva (10–12 L/day) helps to transport the feed through a 1.2–1.5 m long oesophagus and buffers the digesta (Cunha, 1991). The oesophagus enters the stomach at the oesophageal section

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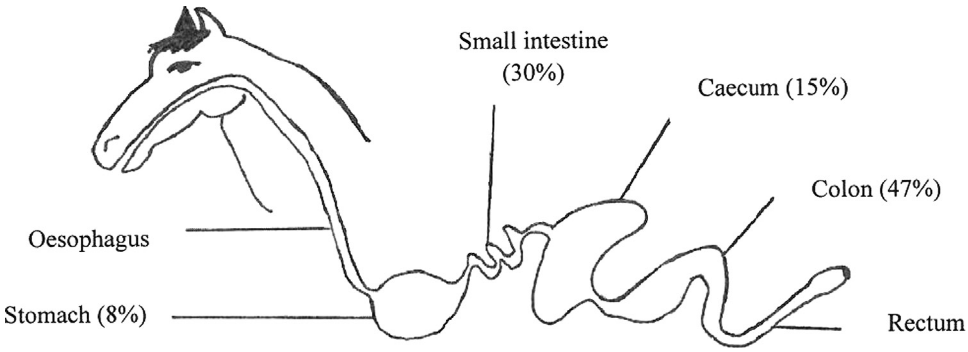

Fig. 1. Schematic presentation of the equine gastro-intestinal tract (adapted from Cunha, 1991).

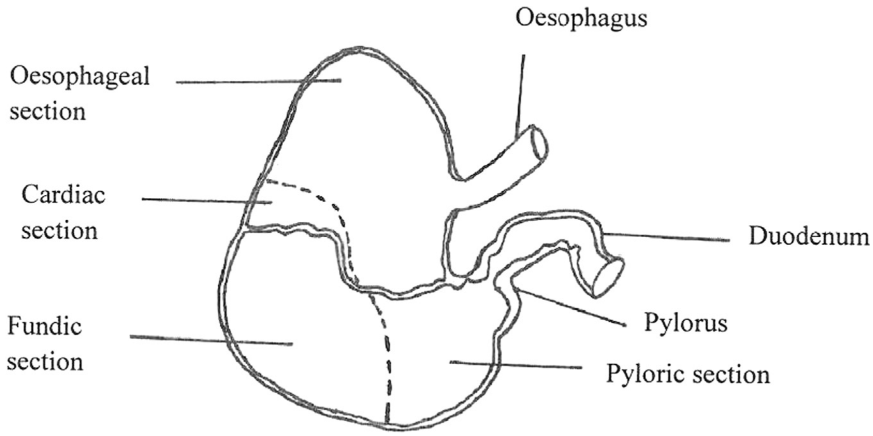

Fig. 2. Anatomy of the stomach (adapted from Pilliner, 1993).

(Fig. 2). This part of the stomach is non-glandular, but pepsin and other proteolytic enzymes are secreted by glands in the pyloric section (Pilliner, 1993). Transition of digesta through the stomach is relatively rapid, although a large portion remains for 2–6 h in the anaerobic fundic (lower) section of the stomach.

Carbohydrates are fermented to lactic acid and the pH of the digesta decreases to approximately 2.6 (Frape, 2010). Most of the enzymatic breakdown and absorption of digesta takes place in the small intestine (Pilliner, 1993). As soon as the acidic digesta reaches the duodenum, the pH is neutralised to 7.0 or 7.4 by bile secreted from the liver (the horse does not have a gall bladder) and fats are emulsified (Colville and Bassert, 2008). Proteins are digested to produce amino acids and fat is converted to fatty acids and glycerol (Pagan, 1998). Soluble carbohydrates are hydrolysed by α-amylase and α-glucosidase to lactic acid which are absorbed, together with fatty acids, vitamins and minerals (Pagan, 1998).

Digesta reaches the caecum and colon approximately 3 h after feeding (Frape, 2010). The caecum of 25–35 L has two valves situated relatively close to each other (Pilliner, 1993). The ileum enters at the position of the first valve and further passage to the colon is through the second valve (Pilliner, 1993). The motility and capacity of the caecum increase during feeding to optimise interaction between the bacteria and digesta (Frape, 2010).

The pH of the caecum and colon is approximately 6.0 and forms the ideal condition for anaerobic bacteria, fungi and protozoa to degrade hemicelluloses and pectins (Bonhomme-Florentin, 1988). Complex carbohydrates such as cellulose are fermented (Pagan, 1998; Pilliner, 1993), and vitamins B and K and essential amino acids are synthesised (Pagan, 1998). If the feed is high in starch content, residual starch may end up in the caecum and colon where it is slowly fermented, and when present in excess quantities, may favour the growth of amylolytic bacteria. This results in an increase in volatile fatty acid (VFA) and lactic acid production, leading to a significant decrease in pH (Biddle et al., 2013). The accumulation of lactic acid may irritate or damage the intestinal mucosa and may alter the permeability of the large intestinal mucosa to toxins and larger molecules that have been implicated in the development of laminitis (Biddle et al., 2013). When the pH drops below 6.0, the growth of many fibre-fermenting microorganisms, such as *Ruminococcus albus* and *Fibrobacter succinogenes*, is suppressed, whilst the number of acidophiles, such as *Streptococcus bovis* (renamed *Streptococcus lutetiensis*; Poyart, 2002), *Lactobacillus* spp and *Mitzuokella* spp. increases (Biddle et al., 2013; Milinovich et al., 2008). This leads to more lactic acid production in the hindgut and a further drop in pH. A decrease in pH may lead to hindgut acidosis and the developing of colic and anorexia. If the pH remains below