EQUINE DIGESTION

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Introduction

In most cases, domestic mammals are subdivided in ruminants and monogastric animals. Horses are herbivorous animals like ruminants, but they are typical hindgut fermenters. Their digestive system is well equipped for utilising fibrous feed. The stomach consists of regions with enzymatic and with fermentative digestion. The small intestine preferentially performs enzymatic digestion, whereas the caecum and colon will only perform microbial fermentation. Evidently, feed on itself influences the way in which it will be digested by the horse, e.g. by its physical form, the concentrate/roughage ratio, nutrient composition, the feeding rate and the level of antinutritional factors.

Mouth and stomach

Feed intake is modulated by pregastric stimuli like taste, feed texture and odour, whereas the duration of satiety is mainly determined by gastrointestinal, metabolic and environmental aspects (Ralston, 1984).

Horses graze with their teeth instead of the tongue like cattle. This implies that pastures can be grazed more intensively and that also more fibrous parts of grass are ingested by the horse. The provision of sufficient fibrous feed components is necessary to induce chewing activity, leading to adequate saliva production and a proper mingling of saliva and digesta.

Saliva is secreted in the mouth, depending on the quantity of feed material that is ingested. It does not contain digestive enzymes like alpha-amylase: carbohydrates are not attacked in the stomach, but instead saliva serves several other important aims: the considerable amount of bicarbonate and saline will buffer the acidity in the stomach, whereas the high mucus content in saliva prevents choke by lubricating the feed bolus (Frape, 1986). The continuous buffering of the proximal stomach is necessary to allow microbial fermentation with lactate production from fermentable carbohydrates (Frape, 1986). This lactate will be resorbed in the small intestine or converted to volatile fatty acids in the large intestine.

The distal part of the stomach is more analogue to other monogastrics, as a considerable HCl secretion lowers pH to a level that bacterial fermentation is inhibited. Together with HCl, pepsin is secreted to break down proteins. The stomach only represents a relatively small portion of the equine digestive system, meaning that digesta flow should be rather high (Jackson, 1998). Nevertheless, when stomach fill is exaggerated – e.g. by rapid concentrates intake – risk for colics is real because of excessive fermentation. The cardiac sphincter that controls the entrance of the stomach, only permits ‘one-way traffic’. Hence, the sphincter disables the relief of abundant pressure (Pilliner, 1992). Therefore, meals should be spread over the day.
Small intestine

Like in carnivore species, amylase activity is low and is ration-dependent. Amylase is triggered by bio-available starch: starch-rich feedstuffs evoke a higher amylase response than fibrous materials. Meyer et al. (1993) applied exogenous amylase with success to increase starch digestibility in horses, but also cereal processing like grinding or popping increased prececal starch digestibility: preileal starch digestibility of whole corn was only 28.9%, whereas popped corn reached up to 90.1%. Cell wall components are not digested in the small intestine. High fibre content can deteriorate the digestion of other nutrients. Pagan (1998) describes the inverse relationship between the level of protein that is incorporated in feedstuff cell walls and the crude protein digestibility. A proper digestion of valuable plant cell content therefore requires the thorough crushing of cells by a good set of teeth. In the small intestine, degradable protein is subjected to hydrolysis by pancreatic and epithelial enzyme activity and subsequent amino acid resorption.

The required protein content of an equine ration thus depends on several factors. At first, some proteins are less digestible due to a typical incorporation in for instance cell wall components, but also by the structure of the protein itself, e.g. keratin. Secondly, the amino acid composition of feed proteins will determine how much protein will be needed to fulfil amino acid needs in the horse, as the utilisation of high-quality microbial proteins from the hindgut is supposed to be negligible compared to the uptake of microbially synthesised amino acids in ruminants (see below). Martin-Rosset (1990) takes this into account for the calculation of the horse’s crude protein requirement.

Finally, the energy/protein ratio is of importance because energy is needed to incorporate feed derived protein into tissues. If this ratio is low, protein will be combusted as an inefficient energy source. Moreover, excessive protein intake increases water requirements and increases the risk of enterotoxaemia through elevated urea blood levels (Pagan, 1998). When energy level largely exceeds protein level, a clear effect is seen on feed intake (Schryver et al., 1987).

The mainly vegetal ration of horses has a rather unsaturated fat content. Unlike ruminants, this fraction is not altered by bacterial fermentation before entering the small intestine. The resorption of unsaturated fats causes the soft depository fat in horses.

Calcium is also mainly resorbed in the small intestine, whereas electrolytes are secreted. The latter are important in the ration of exercising horses as they may be lost through sweat (Hintz and Squires, 1983), but also other minerals will depend on exercise level. Moreover, the European ban on the use of animal and fish meal products might lead to situations where the bioavailability of minerals might be limited through the use of vegetal protein sources. As a example: phytate makes phosphorus scarcely digestible preileally, together with some macrominerals (e.g. Ca, Mg) and trace elements (e.g. Zn, Mn) due to complex formation. Little is yet known about the requirement of trace elements in horses.
Large intestine

The whole of cecum and colon takes about 120 litres and thus represents the largest part of the equine digestive system. Bicarbonate from the pancreas elevates intestinal pH to a level that allows microbial fermentation. Just like in the bovine rumen, nitrogen sources are partly converted in high-quality microbial protein. Very high true digestibility of hay nitrogen was demonstrated in ponies (Gibbs et al., 1988), although it is suggested that little or none of this protein is taken up by the large intestine. The same probably goes for de novo synthesised vitamins. In contrast, volatile fatty acids from fibre fermentation are still able to contribute consistently to the energy provision in the horse. The role of protozoa in the hindgut is limited (Moore and Dehority, 1993). When a large fraction of starch is not digested in the small intestine, amylolytic microflora will develop on the expense of cellulolytic microflora. Excess fat that cannot be resorbed in the small intestine but will appear in cecum and colon, will also inhibit proper bacterial fermentation of fibre components (Frape, 1986).

The impact of exercise on digestion still needs further investigation, but Miller-Graber et al. (1991) found that the intraconversion between lactate and pyruvate was influenced by an interaction between dietary protein and exercise. Pagan et al. (1998) reported that a decrease in dry matter digestibility and an increase in passage rate was caused by exercise, as a consequence of muscular blood flow taking over priority from the gastro-intestinal blood flow. The interaction between exercise and digestion can be of critical importance in equine nutrition and should therefore a major topic in equine research.

References


