A Journey through the Equine Digestive System

The digestive system, also known as the gastro-intestinal tract, is vital in providing nutrients and fuel for metabolism through its mechanical, chemical and bacterial actions. It starts at the mouth with the ingestion of food and water, then digestion of this food and water in the intestines for chemical and bacterial conversion to allow absorption by the blood stream for use by the body's cells and tissues, ending with the excrement of wastes and indigestible materials at the anus (Rogers 2008).

This paper provides an overview of the digestive system, following food throughout its journey from the mouth through to the anus, describing the actions and functions along the way, referencing quantities and measurements that are typical of a mature 500kg horse.

The equine digestive system, or gastro-intestinal tract, is typically 23-31 metres long, holding a total volume of 143-177 litres, with a total transit time of 72-84 hours (ie: around 3 days for food to pass from one end to the other).

The digestive system begins at the horse's mouth with the ingestion of food. This is the first site of mechanical and chemical digestion, where the food is masticated by the teeth and tongue and mixed with saliva. The saliva contains enzymes that breakdown starches. When sufficiently chewed and mixed with saliva, the food is swallowed. The chewing action and production of up to 12 litres of saliva daily also provides lubrication for the oesophagus and a buffer solution (similar to bicarbonate) for the stomach to aid pH balance. There are more than 25 muscles involved with swallowing and this action forms the food into a bolus, or ball shape.

The bolus passes through the pharynx, along beside the larynx and into the oesophagus. As the pharynx and larynx are also shared with the respiratory system, there are cartilaginous flaps that close off the nasopharynx and trachea to prevent food from entering the airways.
Once in the oesophagus, the bolus is lubricated with mucous and the action of peristalsis, or wave-like contractions of the smooth muscle, encourages movement of the bolus through its tube and into the stomach. The stomach of the horse is relatively small, around the size of a football, with a capacity of 4-5 litres, or half-a-bucket.

The upper portion of the stomach has a pH of around 6-7, which becomes more acidic towards the lower portion, with a pH of around 1-2. This is why it is important for a horse to be able to continually graze and chew – if the stomach becomes too empty of food matter and saliva-buffer (from chewing), then the increased acidity will adversely impact the upper stomach lining and small intestine lining – a common cause of ulceration. To minimise these health issues, a horse should not be without access to feed for more than 4-6 hours at any one time. A feed that requires chewing, such as grass or hay, is also much

more beneficial than food that can be quickly and easily swallowed, such as processed/pellet feeds. (Barnett 2017, Layton 2017)

Once in the stomach, the bolus is further mechanically and chemically digested. The bolus is churned and mixed with digestive juices to form chyme. These juices contain pepsin and hydrochloric acid to help with digesting protein, and a sugar compound called intrinsic factor for the absorption of vitamin B12 (to aid red blood cell development), but very little other absorption occurs in the stomach (Rogers 2008). The retention time for water in the stomach is typically 30-60 minutes, and for dry matter, it can range from 30 minutes to 12 hours with its total volume comprising about 8% of the digestive system (Williamson 2014).

Controlled by the pyloric sphincter, the acidic chyme passes from the stomach in small spurts into the small intestine, where it is received by the duodenum. The duodenum and its hormone, called cholecystokinin, stimulate the liver to secrete bile and the pancreas to secrete juice, which is rich in sodium bicarbonate. These juices, along with the mucosa of the duodenum, neutralise the stomach acids and provide a variety of digestive enzymes. This is where most of the chemical digestion occurs. Horses do not have a gall bladder.

As food is sufficiently broken down, it passes into the small intestine. Finger-like projections, called villi, line this area to increase its surface area and segmentation of the food occurs to enable it to come into the utmost contact with the lining of the small intestine, so as to maximise absorption of nutrients. Retention times for the small intestine are typically 2-8 hours for water and 1-8 hours for dry matter. It has a length of 15-22 metres with its total volume comprising 28% of the digestive system. Digestion of grains and seeds and uptake of most of the vitamins and minerals occur in the small intestine, along with 50-70% of starch, protein and fats. Fermentation of soluble fibres also occurs towards the end of this area (Layton 2017, Williamson 2014).

When most of the nutrients have been absorbed from the small intestine, the ileocaecal valve controls transfer of the chyme into the hindgut, firstly through the caecum, where cellulose is digested and vitamins B and K are manufactured. Its main role is microbial fermentation of fibre (grass/hay/beet pulp) into volatile fatty acids (sometimes called short chain fatty acids) and fermentation of residual protein and starches. The main volatile fatty acid created is acetate, which is a source of fuel for muscle cells to produce energy (Layton 2017). Retention times for the caecum are typically 5 hours for water and 6-12 hours for dry matter. It has a length of 0.9-1.2 metres with a volume of 25-30 litres.

Chyme then moves from the caecum into the large intestine, also known as the colon or large bowel. The large intestine contains a large quantity of bacteria, which continue to digest and absorb remaining nutrients in the chyme; however its main function is to absorb sodium, electrolytes and water and convert to volatile fatty acids. The retention time for the chyme that remains is 24-50 hours. The large colon has a length of 3-3.7 metres, with a volume of 50-60 litres, comprising about 34% of the digestive system.

For the next 8-10 hours, the small colon finishes off the role of the large colon through its 3-3.2 metres of tube. It has a capacity of 18-20 litres, comprising about 11% of the digestive system.
The leftover product, called faeces, is passed through the rectum where it is stored until sufficient pressure has built up to prompt the anal sphincters to relax and excrete the contents. Typically, a horse produces 13-18kg of faeces per day during 8-12 excrements (Rogers 2000, vol.1).

The rectum is about 0.3 metre in length with a capacity of 2-3 litres, comprising about 2% of the digestive system. Some water is also absorbed during storage, with the excreted faecal matter being about half water and half dry matter, which is the undigested parts of plant material, mostly cellulose and lignin (Rogers 2008).

It is interesting to note that lignin cannot be digested by any animal and its content in grass increases as the plant ages. Otherwise, the digestive process results in the metabolism of digestible carbohydrate, fat and protein from food.

Carbohydrate, in the form of glucose, and acetate from fibre fermentation provide the main sources of energy and, to some extent, are always circulating in the blood for ready use. Some is stored in the liver for maintaining blood sugar, some is stored in the muscles for muscular activity and the excess is converted to fat and stored by the body. Adequate carbohydrate and fibre are essential components of the equine diet.

Digested fats are transported by the lymphatic system to the liver where they are reformed into fats for storage. When needed for energy, the fats are desaturated by the liver and a hormone from the kidneys, called ketones.

Digestion breaks protein into its basic form of amino acids to allow absorption through the villi of the small intestine. Many of the amino acids are essential for the body, helping to rebuild and repair; however, because the body cannot store amino acids, there needs to be a regular supply in the diet (Rogers 2000, vol.1).

In summary:
As the direct link from raw food to providing the horse's source of energy, the digestive system is vital for bodily nutrition and fuel through its ability to break down, absorb and utilise the carbohydrate, fats and protein contained in food for cell and tissue function. The best nutritional results come about when the horse has access to an adequate and balanced diet with fresh water, and the ability to move about and maintain fitness in a stress-free environment to aid digestive peristalsis and the lymphatic system.

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