# HOW HORSES DIGEST FEED

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We want to discuss important nutrition fundamentals of how does the horse digest feed and therefore make use of the nutrients contained within the feedstuffs it consumes? A basic understanding of how the horse digests feed is necessary for the selection of appropriate diets and feeding practices.

It is important to remind ourselves that horses evolved as forage eaters, grazing for upwards of 16-17 hours of each day and traveling considerable distances as they grazed. The horse's digestive system is well suited to this feeding behavior the stomach and small intestine are designed to cope with the almost continual entry of small amounts of food while the large intestine is geared toward the extraction of maximum nutritional value from fibrous feeds.

With domestication have become changes in diet and feeding behavior. Continual re is but a dream many spend a considerable part of the day in her than continual grazing,

energy-dense ingredient

be avoided by returning

the horse to

access to pastu for most horses, and a stall. As well, our own work schedules dictate feeding programs rat horses are often fed large meals morning and night. The high-energy requirements of the performance horse has necessitated inclusion of more s such as cereal grains and fats in horse diets. All of these factors can contribute to digestive upsets, some of which can a more "natural" feeding circumstance.

**Twists and Turns**

The basic components of the digestive tract are similar in all mammals the mouth (including salivary glands), esophagus, stomach, small intestine, cecum and large colon. We can divide the horse's digestive system into tow section. The pre-cecal section (esophagus, stomach and small intestine) function much as in man, dog and pig. On the other hand, the cecum and large intestine work like the forestomachs of a ruminant (e.g. cow or sheep) there is continual microbial fermentation of dietary fiver. For this reason, horses are classified as hindgut fermenters. In fact, normal function of the hindgut is heavily reliant on an adequate supply of dietary fiber. This is a key point without adequate dietary fiber, the horse is predisposed to nutritional imbalances and colic problems.

The digestive process begins with the prehension of food, that is, food is grasped using a combination of the lips, tongue and teeth. When eating tightly packed hay, larger muscles of the head and neck are also used to grab and pull feed into the mouth. After prehension, the food is chewed (mastication) this is an extremely important part of the digestive process digestion is most efficient when hay and other fibrous feeds are ground into small pieces. Proper mastication of whole grains such as oats is also important to ensure optimal digestion in the small intestine. This is why it is so important that the teeth are in good working order. Poor teeth, a common problem in older horses, will result in deceased feed intake and weight loss, particularly in horses on an all-forage diet. Quidding, the dropping of partially chewed feed from the mouth, is a sure sign of dental woes. Choke (the lodging of a food bolus in the esophagus) and impaction colic can also occur when horse has poor dentition.

The type of feed has a dramatic effect on the speed of ingestion. An average size horse (500kg) will chew between 3500 and 4500 times per kg of dry hay consumed, taking about 40 minutes to eat each kg of hay. Therefore, if 12 kg of hay is provided each day, the horse will spend at least 8 hours feeding. When grains and other concentrate feeds are substituted for fiber in the diet, the total time spent feeding will be markedly reduced 1 kg of eats can be consumed in 10 minutes or less, requiring only 850 chews. So, a diet of 7 kg hay and 5 kg oats will decrease feeding time by 2-3 hours. Such reductions in feeding time are thought to cause boredom and other behavioral problems (e.g. stable vices). This is another reason why fiber is such an important part of the horse's diet.

The horse produces saliva during chewing. Saliva moistens the ingesta thereby easing the passage of feed from the mouth to the stomach. Saliva is rich in bicarbonate which helps to buffer the acid secretions produced in the stomach. Here, the nature of the feed is also important on a dry matter basis, twice as much saliva is produced when horses eat hay or grass compared to grains and other concentrates. Diets high in grain and low in forage will therefore decrease saliva flow and result in low gastric pH values, a risk factor for the development of gastric ulcers.

Only a limited amount of digestion occurs in the stomach. The stomach's main job is to further liquefy the incoming food and "feed" the ingesta into the small intestine, where digestion really cranks into gear. However, gastric acid helps to break down some of the feed particles and the enzyme pepsin initiates protein digestion. In fact, the stomach produces gastric acid on a continous basis this works well when horses are grazing or nibbling on hay for much of the day because the incoming feed soaks up these gastric juices. However, if the horse is meal fed (morning and evening) the stomach will be empty for long periods. In this situation, the acid can cause injury to the nonglandular portion of the stomach lining, gastric ulcers being the end result.

The actual extraction and absorption of nutrients contained within food begins in earnest once ingesta enters the small intestine, a tube-like organ about 60 to 70 feet in length. Despite this considerable length, the ingesta traverses the small intestine quickly. Some food enters the cecum within 1 hour and much of the ingest will reach the fermentation

vat by 3 hours after eating. This rapid transit reflects the coordinated activity of the nerves and muscles contained within the walls of the small intestine.

Factors such as meal size, feed type and exercise will influence transit time. Big grain meals result in rapid gastric emptying and intestinal transit and a reducion in the digestion of the available starch. More on this later. Pelleted and ground feeds also tend to move faster through the small intestine than fibrous feeds such as hay and grass. Exercise also results in a moderate speeding of intestinal transit.

**Sugar, Fat and Protein**

The small intestine is the primary site for the digestion and absorption of sugar and starch, protein and fat. The fat-soluable vitamins (A, D, E and K), calcium and some phosphorus are also absorbed from the small intestine. Let's first deal with sugar and starch. Molasses is perhaps the best recognized source of dietary sugar for the horse some "sweet feeds" are up to 10% molasses although the current trend is for lower amounts. However, pasture grasses are by far the most important source of sugar; a horse grazing fill time could consume up to 2 kg of sugar (nutritionists use the term water-soluble carbohydrate or WSC). Sun-cured hay has a lower WSC content as there is loss following harvest.

Starch is the plant world's version of glycogen, the body's storage carbohydrate  a huge number of glucose molecules are linked by chemical bonds, forming a single structure. Starch is a major component of cereal grains  oats are about 50% starch while corn is between 65 and 70% starch.

The simple sugars in molasses and grasses are easily digested; glucose is absorbed directly into the bloodstream while enzymes located on the small intestinal lining make other sugars available to the body. Starch is a slightly different story; the first step involves its breakdown to smaller sugars. Then the enzymes on the intestinal lining act on the small sugars until they are in an absorbable form. Amylase, an anzyme released by the pancreas when ingesta enters the duodenum, is the catalyst for the first step.

Unfortunately, compared to other mammals, amylase is in short supply in the horse. As a result, the horse has a limited capacity to digest starch  the upper limit probably varies between horses but as a general rule, a single grain or concentrate meal for an 1100-1200 lb. Horse should not exceed 6 lbs.

The starch story is further complicated by the fact that the digestibility of starch varies between grains. For example, the starch in whole corn is very poorly digestible. Fortunately, most manufactured feeds contain grains that have been processed to greatly improve starch digestibility in the small intestine. Even so, with grain feeding (particularly large meals) there is always a risk that undigested starch will reach the large intestine.

The digestion of protein and fat is more straightforward. Enzymes from the pancreas and those present on the intestinal linin digest proteins to their constituent amino acids,

which are absorbed into the bloodstream. Even though the "natural" equine diet is very low in fat, horses can digest fairly large quantities. Studies have shown that horse can tolerate a 10% fat diet (total diet), although there should be a gradual increase to this level to allow the digestive system to adjust.

**The Boiler Room**

The large intestine begins with the cecum, a structure that lies in the right flank area. This organ is 3 to 4 feet long and holds up to 15 gallons of fluid and ingesta. Adjoining the cecum is the large colon, the largest single structure in the digestive tract (about 40% of total capacity). Like the rumen of a cow, the cecum and large colon work like a fermentation vat. Literally billions of microorganisms (bacteria and protozoa) do the digestive work, producing enzymes that are able to break down the fibrous portion of the diet. This process is much more time-consuming compared to digestion in the small intestine and the ingesta dwells in the large intestine for upwards of 36-48 hours.

Dietary fiber is the portion of the ingesta not affected by the horse's own digestive enzymes. There are many (confusing) chemical and physical definitions of dietary fiber, but basically we are talking about the structural components for plant material. Some of this fiber can be digested by microbial enzymes, particularly cellulose and hemicellulose. On the other hand, lignin  another fiber form  is not digestible and will be passed in the feces. The type of dietary fiber greatly influences its nutritional value  for example, over-mature grass hay will be relatively high in lignin which depresses digestibility of the fiber. Other fiber sources such as young grass, beet pulp and soy hulls are highly digestible.

The products of the fermentation process are the volatile fatty acids (VFAs) acetate, butyrate and proprionate, heat, water and gas. The VFAs are absorbed into the bloodstream, providing an extremely important source of energy for the horse. Microbial enzymes also break down undigested proteins which enter the large intestine, although this protein is not used by the horse. Instead, the main end-product of this process ammonia  is used by the bacteria to produce proteins that are needed for their own growth and survival. On the other hand, vitamin K, another product of microbial activity, is absorbed into the horse's bloodstream. As a result, in most circumstances the horse does not require vitamin K in its diet.

Another very important function of the large intestine is the absorption of water. Each day, a hugh quantity of water is secreted into small intestine as part of the digestive process  about 30 gallons for an 1100 lb. Horse. As the ingesta moves down the various sections of the large colon, much of this fluid is reabsorbed allowing the formation of semi-solid fecal material. The final step in the digestive process occurs in the small colon, where the waste material is formed into fecal balls that are evacuated through the rectum an anus.

**The Starch Problem**

Proper function of the horse's "fermentation vat" is highly dependent on the health of the microbial population. Things work well when the horse is in its natural environment

pasture or is fed an all-forage diet. However, heavy grain feeding can upset this delicate environment, sometime with disastrous consequences. When undigested starch enters the large intestine, it too undergoes fermentation, the end product being lactic acid. The buildup of lactic acid causes a decrease in the pH of the cecum and colon.

A large drop in pH can result in a radical change in the makeup of the microbial population, with the death of organisms that cannot survive at low pH and the release of endotoxins by the dead bacteria. There can also be damage to the large intestinal lining, allowing absorption of the endotoxins and, in the worst-case scenario, the horse can develop colic, laminitis and diarrhea.

Here's the bottom line  the horse's digestive system functions best when it is fed a predominantly forage diet on an almost continuous basis. Problems are much more likely when they are fed a relatively high concentrate, low forage diet, particularly when given two (or even one) large meals per day. Yes, the performance horse needs more energy than can be supplied by an all-forage diet, but try to reduce the amount of dietary starch by using highly digestive fibers sources such as beet pulp and by adding fat to the diet. If possible, spread the daily grain allotment over more meals e.g. three rather than one or two. Finally, allow the horse to nibble on hay (or better, pasture) as much as possible.