The equine gastrointestinal tract, which includes the small intestine, large intestine, and caecum is designed to process ingredients that are incorporated in equine diets. In this part of the series on "Anatomy of the digestive system of horses", we will focus on how the equine digestive system works.

Feed processing techniques
In part 1 of the series we discussed the common feed ingredients that are incorporated in equine diets. In this part we continue explaining the main processing techniques used in equine feeds.

To have a better understanding about feed processing techniques and their importance, we need to recapitulate on how the equine digestive system works.

The three part series on "Anatomy of the digestive system of the horse" functioning of the various parts of the gastrointestinal tract were explained extensively. It highlighted that horses in their natural environment will eat on a continuous basis, spending generally 16-20 hrs per day grazing and browsing foliage.

The equine gastrointestinal tract, which includes small intestine, large intestine, and caecum is designed to process a near-continuous stream of high-fibre forage and is not adept at handling low-fibre, high-carbohydrate meals such as cereal grain based concentrates which contain abundant starch.

Starch plays a minor role in the natural diet of the horse; as they are grazing herbage and receive most carbohydrates in the form of fructans and non-starch polysaccharides (NSP). Grain supplements may cause starch overload and can affect the physiology of the horse due to the lack of amylase to hydrolyse all the ingested starch. If large amounts of undigested starch enter the hindgut, digestive upset can occur, leading to colic, acidosis, and dysentery. Mechanical processing is primarily used on hard-kernel grains such as corn, barley, and wheat. Oats have a softer seed-coat and asexplained in part 1 of this series, oat starch is more readily digestible in the small intestine than the other grains. Oats are sometimes crimped or rolled, but this appears to have little benefit on the total tract digestibility. For corn, which has a higher and less digestible starch content than oats, cracking or grinding increases digestibility significantly.

Mechanically processed feeds
The most basic form of grain processing is mechanical, which include actions such as grinding, crimping, cracking, rolling, flaking, and dehulling. Mechanical processing is primarily used on hard-kernel grains such as corn, barley, and wheat. Oats have a softer seed-coat and as explain in part 1 of this series, oat starch is more readily digestible in the small intestine than the other grains. There are a few disadvantages with mechanical processing. When you break the grain's outer shell (the seed coat or hull). This makes the starch inside more accessible and more digestible, so the horses can digest and use the starch more easily. Mechanical processing breaks the grain's outer shell (the seed coat or hull). The seed is more vulnerable to moulds, mycotoxins (toxins from moulds), micro-organisms and insects. It also decreases the shelf-life due to quicker nutrient breakdown and oxidation.

Extruded feeds
Cooking is a general term used to describe the effect of heat, pressure and time on the food material being processed. Cooking is necessary for its effect on the protein portion of the ration where it acts to denature or denature enzymes. Expansion occurs by rupturing the cell structure and exploding the product. The same conditions of abrasion, pressure, and time needed for developing heat are also used for expanding the starch portion of the ration.

Extrusion is the most popular processing technique used in equine feeds. Extrusion cooking process can be classified as wet or dry, depending on the use of water and steam to prepare the product before being extruded.

Wet extrusion cooking often implies the use of a conditioner and always implies the use of a dryer. The extrusion process begins by grinding and mixing the grains and/or legumes and other feed ingredients. The resulting product is then conditioned using pressure (and water/steam in the case of 'wet' extrusion), with temperatures reaching about 80-200°C (160-370 °F). The ground starch mix is forced through an extruder—which basically is a steel tube with an auger that rotates the mix under increasing pressure. The cooking process during extrusion takes place as the product moves through the barrel while the heat is progressively increased. The mixture is then shaped into so-called nuggets using a die. By vaporizing moisture, the starch cells are ruptured. When the nuggets are exposed to cooler air as they come out of the die, they "pop" or expand.

Raw materials go in here

Feed processing is not only used for cereal grains but also to inactivate anti-nutritional factors in legumes and oil seeds. In general, processing can affect the physical, chemical, and microbiological properties of feed ingredients and may improve animal performance, feed manufacturing, storage, ease of feed handling and consumer acceptance.

Extruded feeds are more expensive and to some extent don’t allow you to examine the quality of individual ingredients.

Extrusion is the most popular processing technique used in equine feeds and can improve the utilization and digestibility of starches. The ingredients are combined and put through a cooking, conditioning and drying process. As the nuggets come out of the die and are exposed to cooler air, they expand giving the product the characteristic “popped” shape pictured on right.

The amount of expansion depends on several factors, such as the starch content of the product, temperature, pressure, and the amount of moisture. After drying, the final product contains less than 10% moisture.

Advantages
Extruded feeds have many of the same suggested benefits as pelleted feeds; ingredients can easily be combined, the product has low dust levels, and the low moisture content improves shelf-life.

The extruded nuggets are bulky and have been reported to slow the rate of eating, which may reduce the risk of colic and choke. The main suggested advantage is the improved utilization of starches in extruded feeds which has a greater overall digestibility and may avoid high-starch concentrations in the large intestine when fed in small amounts. Just be aware that the digestion will decline as starch intake increases. So even if you feed products that are processes by cooking they still can cause digestive dysfunction when you overfeed!

Disadvantages
The extrusion process can destroy some of the feed ingredients and premix content, so manufacturers must add excess amounts before extrusion in order to end with satisfactory levels. Extruded feeds are bulky and take up more space than other bagged feeds. Extruded feeds are more expensive and to some extent don’t allow you to examine the quality of individual ingredients.

About the author
Mariette van den Berg, B. (Hons), MSc (Equine Nutrition) MB Equine Services- Equine Nutrition Consultancy www.mberg.com

Mariette is a nutrition consultant, dressage rider and coach who graduated at the Wageningen University in The Netherlands specialising in animal/equine nutrition. In 2009 she founded an independent equine nutrition consultancy which she combines with two other passions: coaching and training work. MB Equine Services offers specialised and effective consultancy services for horse owners seeking integrated horse nutrition and regenerative property design and pasture management. Visit the website for more information or contact nutrition@mberg.com.au or 0494 849 396.
**MICRONISED FEEDS**
Other cooking procedures that involve thermal processing include steaming, toasting and micronisation.

Heat is used to pre-digest grains which “gelatinizes” the grain, breaking the starch bonds, which makes the energy more available for absorption in the small intestine. In legumes and oil seeds it can be detoxify or denature enzymes.

Steam cooking uses wet heat to soften the starch hords. Grains can either be steam-crimped (oats), steam-frieded (barley) or steam-rolled (corn).

During micronisation, cereals or vegetable protein seeds are spread on a revolving belt in an even thin layer, which passes a series of ceramic burners that emit infra-red irradiation. This results in a rapid internal heating of the grain or seed and a rise in water-vapour pressure, during which the starch granules swell, fracture and gelatinize.

The product will pass cut rollers and is cooled afterwards. The raw product will reach temperatures ranging from 150-185ºC for 30-70 sec. For each feed product there are optimal values within these ranges. The end products are generally used in texture mixtures for horses.

Micronisation has shown in different studies that it may result in higher protein content, compared to other processes (including crimmed and extruded)\(^2\),\(^3\).

**‘PELLETS’**
Pelleting is another form of heat processing which involves grinding the grain and/or other feed products into particles. Reducing the particle size of grains increases the surface area of the grain, which increases the gelatinization and digestibility of the feed.

The particles are then mixed and compacted which is followed by “conditioning” them with forced steam and heat at 60-80ºC. The mix is then forced through a die to create pellets. After cooling and drying, the end product has less than 15% moisture which is low enough to help the pellets remain hard and to discourage mould.

Pellets need a binding agent to hold the ground grain particles together. In horse feed, molasses is probably the most common binder.

Many equine feed companies combine all ingredients (grains, vegetable protein seeds etc) in pellets, but separate feed product pellets can also be added to the so-called textured feeds (i.e. sweet feeds) that mix processed grains, pellets, and molasses.

The advantage of the pelleting process is that it lends more uniformity to the feed, letting manufacturers easily add and evenly distribute ingredients. Pelleting can also let a manufacturer use products such as dried beet pulp, soy hulls, or wheat bran to enhance a feed’s nutritional value. Hulls and beet pulp-based feeds are high in fibre and safer energy sources than grain because the majority of ingredients are digested in the hindgut, so you’re not going to have to spike in glucose or insulin levels that causes hyperactivity.

Pellets tend to be less dusty than loose grain or hay and, because they’re denser, they take up less storage space. Pelleting also helps prevent the horse from sorting or separating out individual ingredients. Pellets soften in water, so they’re easier for young equines and horses with digestive problems.

Disadvantages is the pellets are more expensive than unprocessed products and you can’t assess the quality of the individual ingredients.

**‘SWEET FEED’**
Sweet feeds are one of the first mixes fed to horses; which included oats, barley, corn and molasses. Nowadays, sweet feeds—also known as textured feeds or mash—often contains additional ingredients such as extruded or micronised grains and legumes, vegetable oil seeds, pellets and other additives. Because of the added molasses they are likely to be the most palatable, especially for horses that are picky eaters or are under stress (performance horses).

**REFERENCES**
\(^1\) Van den Berg, M. 2010. Anatomy of the digestive system of the horse; (part 1) From the mouth to the stomach. Horses and People magazine, March edition; page 20-23 (can be sourced on the H&P website).
\(^3\) Van den Berg, M. 2011. Anatomy of the digestive system of the horse; (part 3) From large intestine. Horses and People magazine; March edition; page 36,39 (can be sourced on the H&P website).

**LET YOUR HORSE PLAY**
Encourage exercise, promote mental challenge and alleviate boredom. Build trust, confidence, camaraderie and partnership with your horse. Encourage free-play for your horse and your own co-ordination, focus and teamwork skills whilst having fun playing Equine Soccer.

www.ozhorseteams.com.au

[でしょうねにこの人のために作られたページを提供しています。](www.ozhorseteams.com.au)