

Take-Home Message

- A good diet should meet your horse's nutrient requirements, as well as satisfy his need for variety and his motivation to eat almost continuously.
- Avoid feeding practices that allow horses to eat quickly and subsequently spend large blocks of time waiting on their next meal.
- Selecting concentrates that use added fat and fiber (instead of starch and sugar) as principle calorie sources can help temper excitable behavior in some horses.
- Maximizing forage in the diet, feeding smaller meals more frequently, and clever use of hay nets and feeders can help prolong intake and promote good digestive and mental health.

You Are What (and How) You Eat

A balanced diet is essential for the health of your horse; however, the benefits of a good feeding strategy go beyond simply meeting your horse's nutrient requirements. What you feed your horse, as well as how you feed it each day can impact their behavior – both positively and negatively. The end result is either a happy and content horse in good physical and mental health, or a frustrated and stressed horse who is at greater risk for gastrointestinal disorders, infectious disease or the development of unwanted behaviors. This article and the accompanying presentation will discuss how modern feeding practices differ from normal eating patterns in feral horses, how specific nutrients can affect behavior and trainability, and how horse owners can modify their management to more closely mimic the natural eating patterns of the ancestral horse.

The Desire for “Chew Time”

Eating is the predominant activity for most horses in a natural environment. Observational studies on feral horses indicate that up to 70% of their time (10-17 hours/day) is spent feeding (Salter & Hudson 1979; Duncan 1985; Mayes & Duncan 1986; Crane et al 1997; Boyd & Bandi 2002). Free-ranging domestic horses and those housed fulltime on pasture spend a similar amount of time feeding as their feral counterparts (Martin-Rosset et al 1978; Crowell-Davis et al 1985). And grazing is not just limited to daylight hours; nocturnal intakes may account for up to half of the total time spent foraging over a 24-hour period in both feral and domestic horses (Doreau et al 1980; Crane et al 1997). Thus, horses are naturally inclined to spend lots of time eating. The normal pattern of grazing is made up of many small meals (lasting either a few minutes or several hours each), thus earning horses the descriptor of “trickle feeder.”

Modern horse management is associated with significant changes in the nature, quantity, and frequency of food consumption. Many of today's horses do not have continuous access to pasture forage. Instead, horses may be housed in stalls for most or part of the day, with limited turnout. Others may be housed outside, but in smaller exercise paddocks and corrals that are devoid of grass. Under these management schemes, horses are reliant on their human caretaker to provide all of their food. These horses are also at the mercy of their human's feeding schedule, where food is provided as larger, more distinct meals, as opposed to smaller, more continuous meals consumed while grazing. Modern diets can also be very different from our horses' free-ranging relatives, often consisting of better quality forage (leafy hay with more consistent composition than seasonal pasture) and calorie-dense concentrates (nicely fortified, well-balanced bag of grain from the feed store).

So how does modern management of horses influence their feeding patterns? As mentioned above, horses housed fulltime on pasture will spend up to 70% of their time feeding, depending on forage availability and quality (Doreau et al 1980; Kondo et al 1993). Even when supplied with unlimited hay, total time spent eating is reduced to 45-65% of the day when horses are housed outside (Kondo et al 1993) or in a stall (Elia et al 2010; King et al 2013). A recent study compared time budgets in horses housed on pasture fulltime to horses housed in stalls fulltime or half the day with unlimited access to hay (King et al 2013). Horses housed fulltime on pasture spent more time eating and moving around and less time inactive compared to horses housed full- or part-time in stalls. Interestingly, partial confinement to a stall also affected the diurnal pattern of ingestion. Horses housed fulltime on pasture ate throughout the day with no significant pattern based on time of day. Horses housed fulltime in stalls exhibited the greatest frequency of ingestion behavior from 6:00am–9:00pm and the lowest frequency between 3:00am–6:00am. Horses confined to stalls part-time spent less time eating during confinement, and a greater proportion of their time eating when they were turned out to pasture. Further, horses confined to a stall at night and turned out during the day exhibited a distinct period of uninterrupted feeding in the first few hours of turnout (likely to compensate for lower intake while in the stall), compared to horses that were stalled during the day and turned out at night.

Feeding patterns are more significantly affected when feed supply (particularly roughage) is restricted and when the daily allotment of feed is provided as one or two large meals. For example, stabled horses fed a meal of hay and concentrate in the morning and evening, with additional hay given at midday spent only 30% of their day eating (Cooper et al 2007). Ponies with unrestricted access to a chopped forage diet ate an average of 16 meals a day and had a slower rate of intake than when fed the same diet in two quantity-restricted meals (Dugdale et al 2010). The composition of the meal also has a significant impact on rate of intake. In general, horses can eat cereal grains and other concentrate feeds a lot more quickly than hay (10 minutes/kg grain vs. 33 minutes/kg hay). Additionally, crushed or pelleted grains take horses less time to consume than whole grains (Bergero & Nardi 1996). Similarly, pelleted and cubed forages, as well as moistened hay can be consumed a lot faster by horses than long-stem hay.

There can be health consequences to a reduction in time spent eating. Incidence of colic and gastric ulcers can be higher in meal-fed horses, particularly if those meals contain large quantities of grain. Horses have a digestive system designed to accommodate almost continuous intake of high fiber feeds (eg, forage). Part of this design includes a stomach that is

small for the horse's size allowing food to pass out quickly, and where acid is constantly being secreted to aid in digestion. If meals are infrequent, the stomach spends a lot of time empty with nothing to absorb the acid, leaving it to erode the stomach lining creating ulcers. Additionally, while saliva is a great buffer to stomach acid, it is only produced when the horse is chewing. More saliva is produced when the horse eats forage (hay or pasture) compared to grain. Since it takes the horse longer to eat forage than grain, more total saliva and buffering action will be provided with high forage diets. The horse also has an enlarged hindgut (cecum and colon) that houses millions of bacteria, fungi and protozoa which aid in fiber digestion. Irregular feeding patterns can disrupt food supply to these microorganisms, affecting the efficiency that food can be digested. If food supply to the microorganisms is severely altered, they can die off and release of harmful endotoxins that affect gut motility and can possibly result in colic or laminitis.

There can also be mental health consequences when feeding patterns are altered. With modern feeding practices, the provision of horses with more nutrient-rich, consistent quality feeds may remove the physiological need to eat 10-17 hours per day (ie, their nutrient requirements have been met with less time spent eating), yet the horse's motivation to "forage" for food may still remain. For example, diet composition (especially high grain, low forage diets) and feeding management have been linked to the development of oral stereotypies, such as cribbing and wood-chewing in some horses (Hothersall & Nicol 2013). The reader is referred to Dr. Camie Heleski's paper and presentation in this proceedings for more on this topic.

The Desire for Variety in the Diet

Another feature of normal feeding behavior exhibited by both feral and domestic horses is their desire to seek out and eat a variety of foodstuffs (Salter & Hudson 1979; Goodwin et al 2002). Grazing horses are selective, choosing the grasses they eat based on stage of growth, preferring to munch on vegetative, immature grasses and avoid taller, more stemmy mature grasses. Preference for specific botanical species varies widely, but in general horses prefer pastures containing a mixture of forage species over monocultures. In studies where horses were given the opportunity to graze strips of different forages that had been planted, horses were observed to sample each forage for a short time and then return to their favorite forage for a period of time. When pasture forage availability is not limited, horses tend to be more selective. In contrast, horses are more likely to "take what they can get" when on poor quality or overgrazed pastures, including sampling some species that may be poisonous.

This desire for variety is not usually met with modern diets fed to horses that are not on pasture. For example, it is more common for a horse owner to feed one type of hay (eg, timothy, alfalfa, orchardgrass), rather than giving their horse several different ones to choose from. Similarly, feeding the same grain mix or concentrate day after day is also routinely practiced. Although constant feeding of the same diet can help reduce risk of digestive disorders, it may also lead to monotony, which could reduce feed intake and lead to abnormal behaviors.

Research in the United Kingdom has explored the concept of "foraging enrichment" for stabled horses. Because horses housed in stalls miss out on opportunities to be selective in their feed intake, the idea behind foraging enrichment is to offer a variety of food choices to lessen boredom and reduce incidence of unwanted behaviors. In one study, horses were offered a

single forage or multiple forages, including different types (grass, legume, haylage, soaked hay, molassed hay), different lengths (chopped or long-stem), and in different feeders (buckets, hay nets) (Thorne et al 2005). Horses provided with multiple forages to choose from spent more time eating and less time searching their stall than when provided with a single forage. Another study evaluated behavior in horses fed a single concentrate or a variety of concentrates that differed in sensory characteristics, such as nutrient content (fat, fiber, starch/sugar) or flavor (mint, molasses, garlic, herbs) (Goodwin et al 2005). Horses foraged more frequently, but each bout of foraging (meal) was shorter when offered multiple compared to a single concentrate. As a result, the total time spent eating was greater and the time spent standing idle was less in horses offered multiple concentrates. More recently, these investigators evaluated the horse's desire to physically move between foraging locations (Goodwin et al 2007). A single forage was offered in one stall, while at the same time multiple forages were offered in a second stall. Horses were released in the barn alleyway and allowed to move about freely between the stalls for 5 minutes. Overall, horses spent more time in the stall with multiple forages. When the horse's "favorite" forage was offered as the single forage, as well as included as an option in the multi-forage stall, the horses moved back and forth between the stalls more often. These results suggest that horses may be motivated to move between foraging locations, regardless of the palatability of the forages or their preference for a forage. Collectively, these studies also highlight that the horse's desire for variety may meet a motivational need independent from nutritional content – that is, a horse's selection for variety persists even when a nutritionally complete diet is presented. This type of behavior permits a "patch foraging" strategy, where the horse can select a better than average diet from a heterogenous resource. Although they may become satiated with one food type, they remain motivated to forage on others.

Specific Nutrients that Influence Behavior

There is a lot of interest in specific nutrients or types of diets that will generate desirable behavior. Of note, lower excitability has been reported when horses are maintained on diets higher in fat. For example, spontaneous activity and reactivity to pressure, loud noise and visual stimuli were reduced in horses fed diets containing 10% soy lecithin and corn oil (Holland et al 1996). Weanlings fed diets high in fat and fiber cantered less frequently and for a shorter duration, spent more time investigating, and took less time to complete a handling test compared to foals fed an isocaloric diet high in starch and sugar (Nicol et al 2005). Horses in dressage training had lower resting cortisol concentrations and a reduction in the intensity of their responses to a startle reaction test when fed a fat-added diet (11%) compared to an isocaloric diet higher in starch (Redondo et al 2009). Much of the improvement in behavior observed in these studies is likely attributable to the lower level of starch and sugar intake when fat intake was elevated (ie, fat was added to the diet for calories, at the expense of starch/sugar). Additionally, many of the fat-added diets in these studies also contained a higher level of fiber, which may have prolonged eating time.

There are several "calming supplements" on the market, usually containing tryptophan and magnesium, as well as various vitamins, minerals and herbs among the active ingredients. The basis for including many of these ingredients appears to be that deficiencies can cause clinical problems. For example, depletion of the amino acid tryptophan has been shown to cause anxious and depressive behavior in rats. However, there is currently no scientific evidence for

tryptophan's efficacy in horses; indeed, some studies indicate that at low doses it may cause excitability (Grimmett & Silence 2005; Malmkvist & Christensen 2007; Nobel et al 2008). The capacity for herbal ingredients to modify behavior in horses has been subject to even less validation. Common ingredients include valerian, vervain, Indian ginseng, passion flower, hops, chamomile, lemon balm, and peppermint. Some of these may have potent effects and should be considered as medications rather than food sources. Many are also banned for use during competition.

Research in human babies and children has highlighted the need for good nutrition to foster growth, development, and learning. One nutrient of particular interest is docosahexaenoic acid (DHA), which is found in rich supply in the brain, nervous tissue and the retina of the eye. Sources of this very long-chain omega-3 fatty acid include marine fish, as well as the algae these fish eat. Additionally, DHA can be synthesized in the body from the precursor fatty acid alpha-linolenic acid. Supplementation of DHA to pregnant women, as well as directly to infants and children has been shown to augment learning ability during the early years of cognitive development. We recently evaluated whether DHA could influence behavior and learning ability in young horses (Adkin et al 2013; Hansen et al 2013). In this double-blinded study, we supplemented broodmares with DHA in late gestation and early lactation and evaluated foals while they were still nursing the mare, then again as weanlings, yearlings and two-year olds. Foals born to mares supplemented with DHA stood and nursed earlier than foals born to placebo-fed mares, suggesting improved viability at birth. At 2 months of age, foals exposed to maternal DHA exhibited more independent and play behaviors during group-housing on pasture. As weanlings, foals from mares supplemented with DHA performed better on operant conditioning tasks associated with training them to load in a horse trailer. As yearlings, there was a trend for them to continue to perform better while undergoing training to accept a bridle. Overall, this avenue of investigation is intriguing and we are looking forward to conducting more studies to evaluate the impact of DHA on cognition and trainability in young horses.

Practical Feeding Guidelines

Although there is much left to learn about how diet and feeding management affect behavior, there are some practices that horse owners can implement that could improve the overall well-being of their horses in addition to meeting their nutrient requirements:

- 1) Maximize forage, minimize grain – More time spent eating and a greater amount of saliva are some of the many benefits of high forage diets. While some horses do need grains and concentrates in their diet to help meet nutritional requirements, feed only the amount you need to accomplish this. Further, make sure each meal of concentrate is less than 0.5% of your horse's body weight to minimize starch overload in the hindgut.
- 2) Match the hay you feed to your horse's needs – You can extend feeding time by providing a hay that best aligns with your horse's nutrient requirements. Not all horses need a high nutrient quality hay. Save the alfalfa and grass/alfalfa mix hays for growing horses and broodmares, which have the highest nutrient requirements. Feeding nutrient-dense hays to horses that have high nutrient requirements will also help to minimize the amount of grain or concentrate usually

needed by the same types of horses. For all other horses, a grass hay (eg, timothy, orchard, brome) will be a better choice. A grass hay won't be as calorie-dense, allowing you to feed a greater overall quantity before calorie needs are met, thereby increasing the time they spend eating. For mature horses that are overweight, selecting a grass hay that is more mature (stemmy, large fully developed seedheads) will be even less-calorie dense, helping you to satisfy chew time while not having to sacrifice quantity offered as severely as would be necessary with a more nutrient-dense hay.

3) Whenever possible, try to keep horses on pasture – Pasture access allows horses move around and forage for small meals of their own choosing. For some horses (eg, overweight horses, seniors with poor dentition) 24/7 pasture access is either not sound or feasible. Additionally, in Alberta horses will have to be supplemented with hay during the winter months.

4) Feed smaller meals more frequently – Whether you are feeding hay or concentrate, you can increase your horse's time spent eating by providing small meals spread out over time, rather than a large breakfast and a large dinner. This prevents your horse from spending large blocks of time without eating, and supports good digestive and mental health.

5) Implement strategies to slow rate of intake – Can't be home to feed during the day? Don't want to get up in the middle of the night to throw another flake? There are still some options for slowing down your horse's intake so that they spend more time eating. One low-cost option is to physically deposit your horse's hay at several locations in his pasture/corral, rather than one single pile. Double-netting hay (two hay nets) or using hay nets with smaller mesh holes can slow intake further. Though more expensive, there are also special feeders that can be purchased that distribute hay (or concentrate) at timed intervals, as well as feeders that make it more difficult for the horse to grab and eat large quantities. Grazing muzzles can also be used to slow intake of pasture, as well as hay.

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