

Influence of Feeding Practices on Behavior and Activity Levels of Quarter Horse Mares

Amelia Nyhart

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Research Advisor: Dr. Kimberly Cole
Department of Animal Sciences
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Abstract

The horse is a grazing animal by nature and will forage 16-18 h per day if given the opportunity. However, today's management practices often include restricted access to forage and feeding high amounts of concentrates in a limited number of meals throughout the day. Infrequent meals may lead to increases in stereotypic behaviors such as weaving and crib-biting. Therefore, to mimic the natural grazing patterns of the horse and decrease the incidence of stereotypic behavior, it may be beneficial to divide larger portions of the daily ration into smaller, more frequent meals. The purpose of this study was to investigate the effects of feeding an identical diet, with different meal frequencies and order of delivery, on behavior and activity level in horses during periods of confinement and turnout. Six Quarter Horse mares (7 ± 5 yr; 524 ± 87 kg) were used in a 6 x 6 Latin square design. Each horse received a similar quantity of feed per day (2.0% of BW of a mixed-grass hay and 0.5% of BW of a 12% CP pelleted concentrate) and was randomly assigned to one of six feeding protocols during the 7 d period: 1 meal/d (08:00) with grain fed first followed by hay 15 min later (1GH) or hay fed first followed by grain 15 min later (1HG), 2 meals/d (08:00 and 18:00) with grain fed first followed by hay 15 min later (2GH) or hay fed first followed by grain 15 min later (2HG), 3 meals/d (08:00, 13:00, and 18:00) with grain fed first followed by hay 15 min later (3GH) or hay fed first followed by grain 15 min later (3HG). Behaviors were observed each day before and after meal times (07:30-9:00, 12:30-14:00, and 17:30-19:00) using a scan sampling technique (6 scans/horse/5 min for 1.5 hr). Instantaneous scans (1 scan/horse/min for 2 h) were used to observe and record behaviors during daily turnout (9:30-11:30). Pedometers attached to the horse's left front leg were used to determine activity by recording the number of footsteps taken. Horses fed more

frequently (HG) were observed eating food more often with the exception of horses fed 1GH. Horses fed 1 meal/d were observed drinking water more often compared to horses fed smaller, more frequent meals throughout the day. Nibbling on stall structures was observed more often in horses fed 1 meal/d than those fed 2 or 3 meals/d. No differences were observed in crib-biting or pawing; however, horses fed 1 meal/d (GH) were observed weaving more often than horses fed 2-3 meals/d (GH and HG). The activity level of horses as indicated by the number of footsteps recorded while housed in stalls and during turnout, was higher in horses fed grain prior to hay, regardless of the number of meals/d. Overall, this study suggests that meal frequency and order of grain vs. hay delivery influence the behavior and activity of horses, and that smaller, more frequent meals may be beneficial for the horse by reducing stereotypic behaviors and health risks associated with infrequent meals.

Introduction

Horses evolved as grazing herbivores and will forage 16-18 h per day if given the opportunity (Harris et al., 1999). As monogastrics with a relatively small stomach volume in comparison to body size, horses will exhibit short, frequent periods of grazing throughout the day if allowed, and are often referred to as trickle feeders (Harris et al., 1999). Prior to domestication, horses were able to freely consume high fiber diets and grasses with little access to cereal grains or starch-containing substances; however, the horse's natural environment has progressively changed along with its use and increased physical demands (Harris et al., 1999). Today's management practices are very different from how the horse evolved and often include increased confinement with restricted access to forage while feeding large amounts of

concentrates in a limited number of meals throughout the day. It is common to feed horses one or two meals per day with concentrates given prior to forage. While horses are used more often as high performance animals requiring high energy intake to endure repetitive and intense workouts, these management practices are used as a result of inadequate amounts of energy supplied by forage (Harris et al., 1999). This dietary change has created many problems both physiologically and behaviorally in the horse.

In relation to the horse's digestive tract, feeding large amounts of concentrate increases the rate of digestion in the stomach, therefore decreasing digestibility in the small intestine and hindgut (Thorne et al., 2005; van Weyenburg, 2007). This rapid digestion can be accompanied by a decrease in hindgut pH which can result in a variety of problems including colic, laminitis, and diarrhea (Harris et al., 1999). Studies have also shown that feeding large, infrequent meals can decrease plasma volume in horses, resulting in variable levels of dehydration during exercise (Harris et al., 1999). The level of plasma volume loss is dependent on the size of the meal received and is considerably improved with smaller, more frequent meals (Haupt et al., 1988).

Another concern with feeding large and infrequent meals is an increase in stereotypic behaviors (Cooper et al., 2005). Stereotypic behaviors can be defined as repetitive patterns in behavior that are constant and without purpose (Waters et al., 2002). Examples of such behaviors include box-walking, crib-biting and weaving and often result from confinement (Waters et al., 2002). It is believed that in older horses, these stereotypic behaviors may become habit during both pre and post-feeding, particularly with a consistent feeding regime (Waters et al., 2002; Cooper et al., 2005). Previous studies have found that behaviors such as pawing may begin as an

anticipatory response to meal time; however, over time they may become a conditioned response, especially when followed by food (Cooper et al., 2005). These stereotypic behaviors may also develop as a coping mechanism for boredom or frustration from anticipation when receiving grain or when little fiber is provided (Cooper et al., 2005). This is a management issue of concern because such stereotypic behaviors can be harmful to the horse's physical and mental welfare, as well as the financial wellbeing of equine owners and facilities as a result of damages incurred by such behavior. Therefore, in order to mimic the natural grazing patterns of the horse and decrease the incidence of stereotypic behavior, it may be beneficial to divide the horse's daily ration into smaller, more frequent meals throughout the day (Houpt et al., 1988).

The activity level of the horse may also be an important indicator of how horses are affected by various feeding protocols and was measured in this study. Currently no published literature has been found documenting activity level in terms of movement during both confinement and turnout; however, it may be possible that activity level can indicate boredom in the stall and the desire to find additional forage during confinement and restricted turnout periods. In addition, while several studies have evaluated the effects of meal frequency on behavior, no published literature has been found regarding the effects of order of delivery on behavior. Providing forage before concentrates may decrease the incidence of stereotypic behavior associated with anticipation of concentrates. Altering the order of meal delivery as well as frequency may together decrease stereotypic behaviors and be beneficial to the horse in regard to activity in confinement and the natural behaviors of the horse. Therefore, the purpose of this study is to measure the effects of feeding an identical diet, with differing meal frequencies and

order of delivery, on behavior and activity levels in horses during periods of confinement and turnout.

Hypothesis

Stereotypic behavior and activity level in horses will decrease with increased meal frequency and the delivery of forage before concentrate during meals.

Materials and Methods

Animals

Six Quarter Horse mares, aged 7 ± 5 years with an average BW of 524 ± 87 kg were used in this study. Throughout the study, the horses were housed and fed individually in 3.0 x 3.4 m stalls with access to water and a loose trace mineral salt at all times. The horses were given free access to exercise while turned out for 2 h per d in a 30.5 x 60.9 m sand arena. The study was approved and performed in accordance with the Institutional Laboratory Animal Care and Use Committee of the Ohio State University.

Dietary Treatments and Experimental Design

A 6 x 6 Latin square design was used to determine the effect of feeding frequency and order of meal delivery on behavior and activity levels of Quarter Horse mares. Each horse received a similar quantity of feed per day (2.0% of BW of a mixed-grass hay and 0.5% of BW of a 12% CP pelleted concentrate) and was randomly assigned to one of six feeding protocols during a 7 d period (Table 1). Feeding protocols included 1 meal/d (08:00) with grain fed first

followed by hay 15 min later (1GH) or hay fed first followed by grain 15 min later (1HG), 2 meals/d (08:00 and 18:00) with grain fed first followed by hay 15 min later (2GH) or hay fed first followed by grain 15 min later (2HG), 3 meals/d (08:00, 13:00, and 18:00) with grain fed first followed by hay 15 min later (3GH) or hay fed first followed by grain 15 min later (3HG).

Behaviors were observed each day before and after meal times (07:30-9:00, 12:30-14:00, and 17:30-19:00) using a scan sampling technique (6 scans/horse/5 min for 1.5 hr). Instantaneous scans (1 scan/horse/min for 2 h) were used to observe and record behaviors during daily turnout (9:30-11:30). A list of the behaviors that were recorded during the observation periods and their definitions are shown in Table 2 (Strand et al., 2002; Waters et al., 2002; Cooper et al., 2005). The behavioral observations were divided by time period (7:30-9:00, 12:30-14:00, and 17:30-19:00) for indoor observations and outdoor observations (9:30-11:30). The incidence of each behavior was averaged across the total number of time periods for each diet. Pedometers attached to the horse's left front leg were used to determine activity by recording the number of footsteps taken. The pedometers were secured to the horse's leg using a modified splint boot and placed in a plastic bag to avoid water damage during daily turnout. Pedometers were reset before daily turnout and before the horses returned inside for indoor observation. Activity level based on the number of footsteps was calculated separately to determine the number of footsteps during turnout and stall confinement for each feeding protocol given.

Week	1	2	3	4	5	6
Horse 1	2HG	1HG	3HG	3GH	1GH	2GH
Horse 2	1HG	3GH	2HG	2GH	3HG	1GH
Horse 3	3HG	2HG	1GH	1HG	2GH	3GH
Horse 4	2GH	1GH	3GH	3HG	1HG	2HG
Horse 5	1GH	3HG	2GH	2HG	3GH	1HG
Horse 6	3GH	2GH	1HG	1GH	2HG	3HG

Table 1: Feeding Protocols

Behavior	Definition
Standing alert/vigilant	Standing with eyes open and ears pricked
Eat hay/food	Eating concentrate or hay
Lie	Lying recumbent or sternally
Locomotion	Moving from one location to another
Paw	Kicking stable door, stamping, or scraping foot
Investigate	Sniff or touch muzzle to
Vocalization	Vocalize with loud, high-pitched sound
Defecate	Eliminate waste
Drink	Drinking from water bucket or puddles in arena
Weave	Repetitive lateral movement of head
Nibble	Oral activities without nutritional function
Groom	Rub body against stationary body or other horse
Crib-biting	Grasps object with teeth, contracts neck muscles and draws in air
Negative Behavior	Initiate a kick, threaten to kick, bite or threaten to bite
Positive Behavior	Allogroom, touch nose-to-nose, or nuzzle
Eat bedding	Sniffing, nosing, or eating bedding

Table 2: Behaviors Recorded During Daily Indoor and Outdoor Observation Periods

Statistical Analysis

Data was analyzed using a Proc Mixed Procedure in SAS version 9.2. Least square means were reported along with standard error of the mean taking into account the variance due to horse, period and experimental error in the Latin square design.

Results

Throughout the study, each horse received a similar quantity of feed regardless of meal frequency or delivery. Horses fed 3 meals/d (HG and GH) were observed eating food more often than horses fed 1 or 2 meals/d (Figure 1). While there was no statistical significance due to order of delivery, there was a tendency for horses that were fed hay first followed by grain 15 minutes later to eat more often.

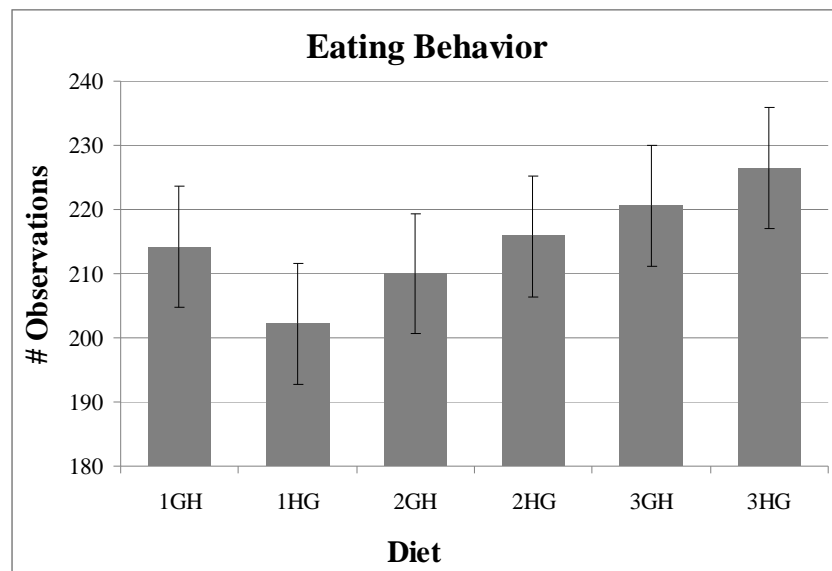


Figure 1. Eating Behavior of Mares Fed Identical Diets with Different Meal Frequencies and Order of Delivery

Nibbling on stall structures was observed less often in horses fed more frequently throughout the day (Figure 2). Horses receiving 1 meal/d (HG) exhibited the greatest number of occurrences nibbling versus those fed 2 meals/d (GH or HG) and 3 meals/d (HG). Nibbling behavior was not influenced by order of delivery.

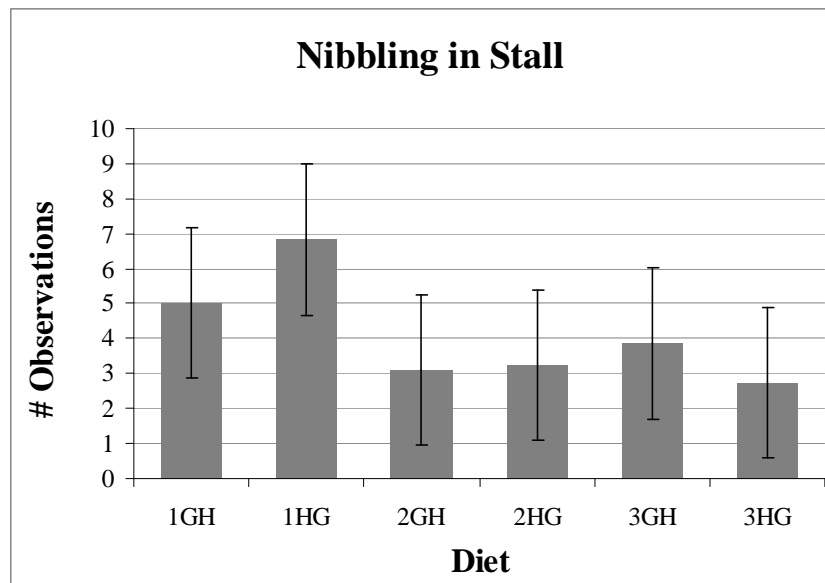


Figure 2. Nibbling Behavior of Mares Fed Identical Diets with Different Meal Frequencies and Order of Delivery

In this study, drinking water was observed as a behavior rather than measuring the amount of water consumed (Figure 3). Although not statistically significant, horses fed 1 meal/d (HG and GH) were observed drinking water more often compared to horses fed smaller, more frequent meals throughout the day, regardless of the order of delivery.

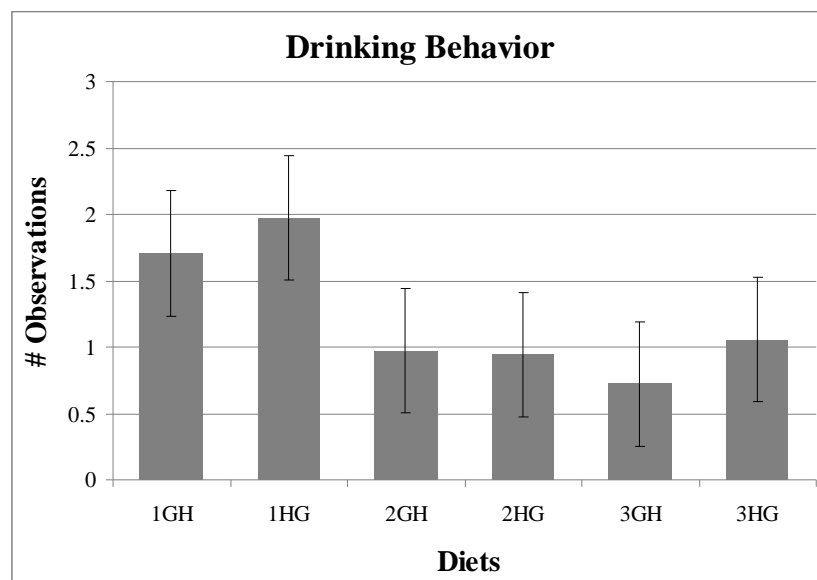


Figure 3. Drinking Behavior of Mares Fed Identical Diets with Different Meal Frequencies and Order of Delivery

No differences were observed in crib-biting or pawing (data not shown); however, horses fed 1 meal/d (GH) were observed weaving more often than horses fed 2 or 3 meals/d (GH or HG) (Figure 4). There were no statistical differences in the incidence of weaving behavior among the different feeding protocols; however, there was a tendency of horses fed grain before hay (GH) to exhibit weaving behavior more often than horses fed hay prior to grain (HG).

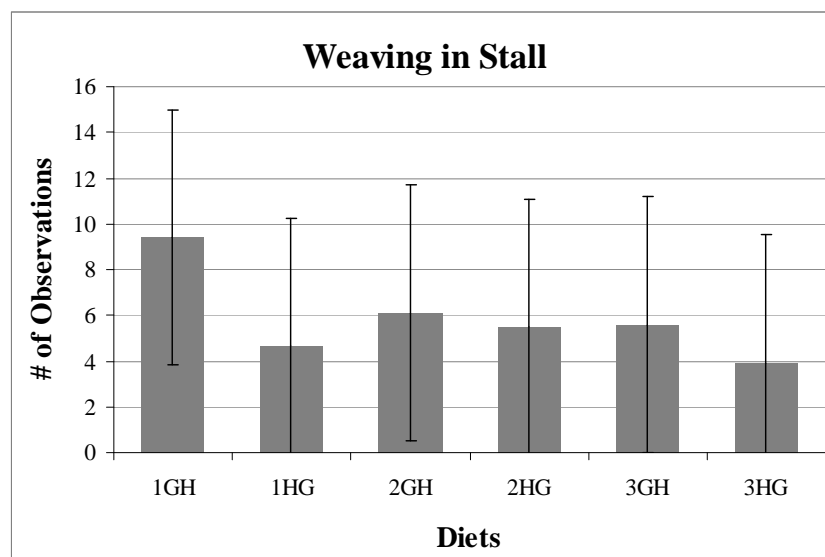


Figure 4. Weaving Behavior of Horses Fed Identical Diets with Different Meal Frequencies and Order of Delivery

Activity Levels

The activity level of horses as indicated by the number of footsteps recorded while housed in stalls and during turnout, was higher in horses fed grain prior to hay, regardless of the number of meals/d. This indicates that when the horse is given smaller, more frequent meals, they spend more time eating and less time moving around in the stall and during turnout.

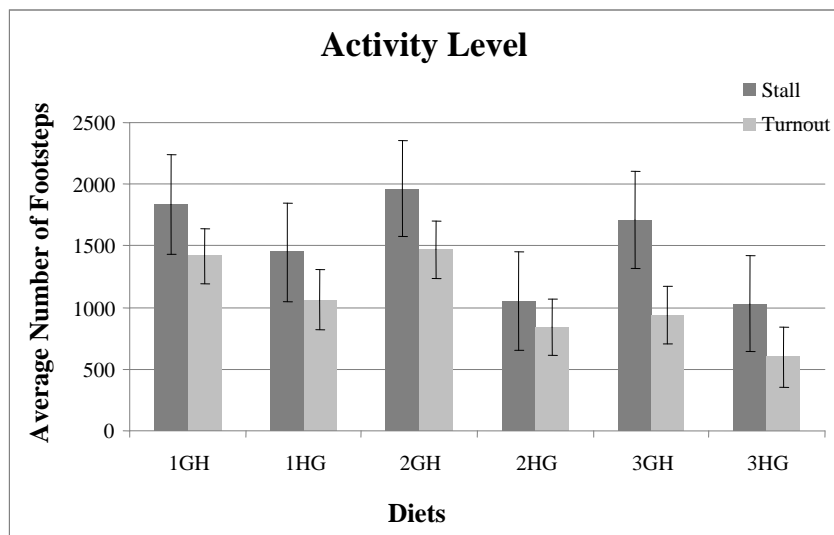


Figure 5. Average Number of Footsteps Taken by Mares in Confinement and Turnout

Discussion

Current management practices often include feeding horses 2 meals/d with concentrates being fed prior to hay. This can result in a limited amount of time spent eating and an increase in stereotypic behaviors. As expected and consistent with the present study, horses that were fed smaller, more frequent meals throughout the day spent more time eating than horses fed the same 1 meal/d. As a result, horses that spent more time eating were observed nibbling on stall structures less frequently, exhibited less activity, and exhibited less drinking behavior. Previous research indicates that large, infrequent meal feeding may affect water balance, reducing plasma volume and increasing plasma protein concentration (Houpt et al., 1988). In the present study, horses fed more often were observed drinking water less frequently which may indicate that dehydration in relation to plasma volume was less severe as a result of smaller, more frequent meals. Weaving decreased with smaller, more frequent meals and is consistent with previous studies examining the relationship between stereotypic behaviors and feeding frequency (Cooper et al., 2005). Nibbling on stall structures was observed less often, indicating that horses may have become bored while in the stall receiving only 1 meal/d, and nibbled on stall structures to satisfy their desire to forage. The stereotypic behaviors observed in this study may have developed as an anticipatory response to feeding or as a coping mechanism for boredom or frustration.

A study by Goodwin et al. (2002) found that limited forage could result in searching behavior for other food sources. Slight increases in the activity level of horses in the present study, during periods of confinement and turnout, when fed fewer meals throughout the day may

also suggest attempts to continually forage. A previous study by Harris et al. (1999) found that larger meals result in a greater rate of gastric emptying. An increase in the rate of gastric emptying from larger meals may result in greater hunger and more stereotypic behaviors to cope with such hunger. When analyzing order of delivery in the current study, it was found that giving horses hay prior to grain encouraged eating behavior as well as decreased stall and turnout activity. In contrast, horses that were given hay prior to grain exhibited more nibbling behavior, which may be due to their ability to see other horses eating grain. This trend may not have been seen if horses receiving hay prior to grain were housed separately from horses receiving grain prior to hay. In addition, trends in this study with order of delivery show that horses fed grain prior to hay exhibited more weaving behavior which may indicate that horses became bored with their forage after consuming their grain first, therefore exhibiting weaving as a coping mechanism.

Conclusion

Overall, this study suggests that meal frequency and order of grain and hay during a meal can influence the behavior and activity of horses, and that smaller, more frequent meals may be beneficial for the horse by reducing stereotypic behaviors and health risks associated with infrequent meals.

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