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CASE STUDY: Interstitial glucose concentrations over time in horses fed sweet feed or a low-moisture, molasses-based block supplement[1]

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ABSTRACT

This preliminary study compares the effects of a twice-daily meal of sweet feed (SF) to a free-choice molasses-based block (BL) on interstitial glucose patterns in horses. Six geldings were equipped with continuous glucose monitoring systems and used in a crossover design over two 6-d periods. Diets consisted of free-choice prairie hay with either SF fed twice daily or free-choice access to a BL. Total intake was not different, with 10.6 kg of DM for horses on both dietary treatments ($P > 0.05$). A novelty effect was observed where horses consumed more BL in the first 12 h of exposure than during any remaining time period. Mean interstitial glucose concentration was 3.55 ± 0.15 and 4.18 ± 0.13 mM for horses consuming SF and BL, respectively ($P = 0.44$). Horses consuming SF had an initial glucose response that ranged from immediate to 2 h, and there was a second significant glucose response in 1 to 2 horses per time period that ranged from 2 to 4 h after feeding. The amount of BL consumed was significantly positively correlated with glucose response in 3 of 4 horses over multiple time periods ($P \leq 0.05$). The maximum correlation between BL consumed and glucose response was $r = 0.25$ for 2 horses and $r = 0.42$ for the third horse. Patterns of postprandial glucose response varied from an immediate effect, to a delay of 15 min, to a delay of 4.5 h ($P \leq 0.05$). Glucose responses were similar between treatments, although variability among horses was noted in quantity of BL consumed as well as timing and magnitude of glucose responses.

Key words: continuous glucose monitor, glycemic response, horse, molasses-based block, sweet feed

INTRODUCTION

Various supplements, such as minerals, omega-3 fatty acids, prebiotics, and NPN (for ruminants), can be incorporated into molasses-based blocks to provide free-access supplementation. Molasses is palatable to horses, creating an incentive to consume the lick (Randall et al., 1978; Goodwin et al., 2005), and it provides 17.0 MJ/kg digestible energy (NRC, 2007). Because molasses is a sugar by-product, usually made from sugarcane or sugarbeets (NRC, 2007), its dietary inclusion generally increases the glycemic indices of horse feeds (Kronfeld et al., 2004; Rodiek and Stull, 2007). Excessive consumption of high-glycemic feeds has been associated with metabolic diseases in horses (Kronfeld and Harris, 2003; Kronfeld, 2005; Treiber et al., 2005).

Because a block-type supplement (**BL**) is assumed to be consumed more slowly and over a longer period of time than a meal of sweet feed (**SF**), we hypothesized that the glycemic effects of BL may be less than those of SF, despite the fact they both contain ingredients, such as molasses, that have appreciable quantities of nonstructural carbohydrates (**NSC**). This study was designed to collect preliminary data regarding effects of consuming a twice-daily meal of SF or a free-choice, molasses-based BL supplement on glucose parameters and patterns in horses.

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Table 1. Composition of prairie hay fed free choice to horses throughout both 6-d treatment periods and a 4-d washout period in a crossover experiment[1]

Item (%)	Prairie hay
DM	92.62
CP[2]	5.49
NDF	69.69
ADF	41.15

[1]Results are reported on a 100% DM basis.

[2]CP was calculated using a 6.25 conversion factor.

MATERIALS AND METHODS

Horses

All procedures were approved by the Institutional Animal Care and Use Committee at Kansas State University. Six 4-yr-old American Quarter Horse geldings with a mean BW of 468 ± 26 kg were used. Throughout the experiment in the late winter and early spring, horses were housed in heated individual stalls (3.05 × 3.66 m). Horses received daily turnout into a dry lot (15.24 × 36.58 m) during the 4-d washout period between treatments. Long-stemmed prairie hay (Table 1), salt blocks, and water were offered to all horses free choice.

Treatments

A crossover design was employed over two 6-d periods where 3 horses were assigned to each dietary treatment for 6 d, and then the groups were switched for the subsequent 6-d feeding period. Treatments consisted of SF concentrate (9% molasses, 22% NSC, Sweet Stuff 12, Cargill Animal Nutrition, Minneapolis, MN) provided twice daily or free-choice access to a 5-kg molasses-based BL supplement (67.8% molasses, 43% NSC, HorsLic, New Generation Feeds, Belle Fourche, SD) presented in fence-mounted feeders (Table 2). Based on information from the BL manufacturer, horses were expected to consume approximately 0.5 to 1.0 g of BL per kilogram of BW per day. Sweet feed was fed at 0700 and 1900 h daily, gradually increasing meal size over the first 3 feedings (as the horses were not accustomed to receiving a concentrate feed), which brought final meal size to 0.82 kg, a consumption level that would provide similar quantities of dietary NSC to those expected for horses consuming the BL. Consumption of the BL and hay were measured every 12 h for the first 3 d, and then each were weighed on a staggered schedule every 6 h for the final 3 d of the treatment period.

Equipment

Each horse was equipped with a SEVEN continuous glucose monitor (**CGM**) system (Dexcom, San Diego, CA) as described by Slough et al. (2011). Briefly, a sensor was inserted subcutaneously into the adipose tissue on the posterior dorsum lateral to the dock of each horse. Every 5 min, sensors obtained an interstitial glucose reading that was transmitted to a wireless receiver attached to the tail of the horse. Sensors were calibrated according to the manufacturer's specifications every 12 h and each time new sensors were installed. To calibrate, about 0.50 mL of blood was obtained via jugular venipuncture, and approximately 10 μL was placed into the channel on a test strip inserted into the One Touch Ultra hand-held glucometer (Life Scan, Milpitas, CA). The blood glucose concentration obtained with the One Touch Ultra was manually entered into the CGM receiver. The One Touch Ultra was stored and maintained according to the manufacturer's specifications.

A motion-sensing camera with infrared technology, either a Digital Game Camera DV-5 (Vibrashine Inc., Taylorsville, MS) or a STC-1540IR (Stealth Cam LLC, Grand Prairie, TX), was placed above each BL feeder to generate time-stamped photographs when a horse approached the BL. The cameras took a maximum of one photograph per minute each time movement of a horse's head broke the vertical infrared beam. This enabled monitoring of both when the BL was consumed and the duration of each consumption episode.

Table 2. Composition of the sweet feed (SF) and molasses-based block supplement (BL) provided to horses in a crossover design over two 6-d treatment periods[1]

	Diet	
Item (%)	SF	BL
CP, minimum	12.0	12.0
Crude fat, minimum	3.0	6.0
Crude fiber, maximum	15.0	2.0
Ca, minimum	1.25	1.5
Ca, maximum	1.75	2.0
P, minimum	0.45	1.0
Molasses[2]	9.0	67.8
Nonstructural carbohydrates	22.0	43.0

[1]Analysis of treatments as reported by Cargill Animal Nutrition (Minneapolis, MN) for Sweet Stuff 12 (SF) and by New Generation Feeds (Belle Fourche, SD) for HorsLic (BL) on an as-fed basis.

[2]Sweet feed contained cane molassess, and BL contained beet molasses.

Technical Challenges

There were considerable challenges due to technical difficulties with the CGM and infrared cameras. Although the CGM sensors were reported to last longer than 5 d in humans, they functioned properly an average of 3.7 d in these horses. Sensors that failed were either reinitialized or replaced. Because of the 2-h initialization period, some data were lost during each reinitialization. Most horses in this study required 1 to 3 sensors to complete the 6-d treatment period. The CGM monitors also had problems. Because of humidity inside the barn,