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ORIGINAL RESEARCH

Glycemic Index of Ten Common Horse Feeds

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ABSTRACT

Two 6 × 6 Latin-square designed experiments examined the glycemic responses to 10 common equine feeds in six Quarter Horse mares. At 8:00 AM of the sampling days, horses were offered a meal of 1 of 10 common feeds. The amount of feed offered was calculated on an isocaloric basis at 4 Mcal digestible energy per meal. Jugular blood samples were collected for 300 minutes after feeding, and plasma was analyzed for glucose concentration. The results showed that plasma glucose values peaked approximately 90 to 120 minutes after eating, whereas glycemic index (GI) values ranged from 7 to 129 based on a standard of oats set at a GI of 100. The four feeds with the highest GI values (sweet feed, corn, jockey oats, and oats) were greater ($P < .05$) than the four feeds with the lowest GI values (beet pulp, alfalfa, rice bran, and soy hulls). Barley and wheat bran had intermediate GI (55–69) values, but were not significantly different from either the high or low group. Whereas large variations in the data were found, conservative utilization of the ranking or categories of GI values of the 10 common horse feeds examined may be useful for formulating rations with different glycemic objectives.

Keywords: Horses; Glucose; Glycemic response; Energy; Oats; Alfalfa

INTRODUCTION

Population studies in humans have shown a relationship between high glycemic diets and obesity, insulin resistance, coronary heart disease, and possibly cancer, particularly in older people who are overweight and maintain a sedentary lifestyle.[1] The glycemic index (GI) for human foods was developed in the 1980s to provide information on the blood glucose concentrations produced by different foods after ingestion, because this could not be predicted by chemical composition of foods.[2] A glycemic value for a food is determined by comparing the area under the plasma glucose response curve of the test food with that of a standard food (originally glucose, but later white bread). The glycemic index of any given food is calculated and expressed as a percentage of the glucose response to the standard food.[3] Large variations can occur in the glycemic index of a food because of the starch and sugar content, food form, cooking or processing,[4] rate of eating,[5] and other factors. Variations of 10–15% are considered to be within the error associated with the measurement of GI.[6]

Some human nutritionists recommend that foods be divided into three categories based on GI: a high GI group (GI > 70), medium GI group (GI 55–69), and low GI group (GI < 55), and small differences in GI between foods within a category not be considered when formulating diets with different glycemic objectives (www.glycemicindex.com).

A GI of horse feeds is of interest because starch and sugar digestion and glucose metabolism in the horse is similar to that of humans, creating comparable fluctuations in blood glucose and insulin concentrations; and also because horses have been shown to suffer at least some of the same health maladies associated with high glucose concentrations or fluctuations in glucose concentration as humans. Less research has been done to show similar relationships between high glycemic diets and comparable equine conditions as in humans, but limited research and anecdotal evidence indicate that horses do experience obesity, insulin resistance, and other maladies associated with high starch intake.

Formulating equine diets that produce attenuated glycemic and insulinemic responses may have health benefits to the horse in avoiding or ameliorating insulin resistance and its undesirable effects related to laminitis and other metabolic conditions.[7] Conversely, formulating diets that produce elevations in glucose concentration may provide a powerful energy source for some types of athletic performance, particularly for work in which carbohydrate oxidation supplies a large percentage of the energy requirement.[8] Creating a GI of common horse feeds, under controlled conditions, is the first step toward understanding carbohydrate digestion and glucose metabolism in horses, and to having the knowledge to formulate diets with low or high GIs or loads.

The objectives of this study were to quantify the plasma glucose responses of 10 common horse feeds fed on an isocaloric (digestible energy) basis, calculate a glycemic index for these feeds, rank the feeds by GI, and categorize feeds into groups based on their glycemic index for utilization in appropriate dietary recommendations.

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Table 1. Weight of feeds offered in high and low glycemic Latin squares calculated to contain approximately 4 Mcal DE

Feed	Weight (kg)
High Glycemic Square	
Oats	1.38
Alfalfa hay	2.04
Barley	1.23
Corn	1.18
Sweet feed	1.26
Jockey oats	1.38
Low Glycemic Square	
Oats	1.38
Alfalfa hay	2.04
Wheat bran	1.37
Rice bran	1.53
Beet pulp	1.71
Soy hulls	2.36

MATERIALS AND METHODS

Design

Six mature, healthy mares, ranging in initial body weight between 506 and 631 kg (1,114 and 1,388 lb), were used in two 6 × 6 Latin-square designed experiments to examine the glycemic response to 10 common equine feeds. The mares were of Quarter Horse breeding, and the mean age was 17.8 ± 4.3 years. Feeds in one square (high glycemic square) were chosen, anticipating that these would produce a high glycemic response, and feeds for a second square (low glycemic square) were selected based on an assumption that these would produce a lower glycemic response. Steamed, crimped oats and long-stem (baled) alfalfa hay were common to both squares. The feeds in a high glycemic square included, besides oats and alfalfa, steamed, rolled barley; steamed, rolled corn; sweet feed (a commercial feed composed of steamed, rolled corn; steamed, crimped oats; steamed, rolled barley; and molasses), and steamed, crimped "jockey" (heavy) oats. The additional feeds in a low glycemic square were rice bran, shredded beet pulp, pelleted soy hulls, and wheat bran. Nutrient composition of the feeds was determined by a commercial laboratory (Equi-analytical, Ithaca, NY).

Horses were individually housed in outdoor pens with no bedding provided on sampling days. On non-sampling days, horses were fed medium-quality alfalfa hay twice daily. Horses had *ad libitum* access to water at all times. After an overnight fast on each blood sampling day (twice weekly), horses were offered an amount of feed calculated from 1989 NRC[9] values to contain 4 Mcal digestible energy (DE) (Table 1). No other feed was offered during this time. Time to complete eating of the experimental feeds was recorded, and any feed not eaten by the end of the 300-minute sampling period was weighed.

Blood Collection and Analysis

Jugular blood (30 ml) was sampled via venipuncture 15 minutes before, and 30, 60, 90, 120, 180, 240, and 300 minutes after feeding at approximately 8:00 AM. Blood was collected into evacuated tubes containing anti-glycolytic agents, potassium oxalate and sodium fluoride, and maintained on ice until centrifuged. Plasma was obtained and frozen at −56°C. Glucose concentration was determined in duplicate by use of an auto-analyzer (YSI 2300 STAT Plus, Yellow Springs, OH).

Statistical Analysis

Glycemic indices were calculated as a summary of the temporal glucose pattern, defined in terms of the area under the plasma glucose curve (above the pre-feeding glucose concentration) for each feed for each horse. Areas under the plasma glucose response curves were calculated by the trapezoidal method of numerical integration.[3] The oat treatment was assigned a GI of 100, and the GIs for the other dietary treatments were calculated as the area under the curve for that treatment, expressed as a percentage of the mean area under the curve for oats. The response to oats for each horse (and within each square) was used to calculate the GIs for other feeds fed to that horse.

Glycemic index values were analyzed using a general linear model in SPSS (SPSS for Windows, Rel. 14.0.0. 2005. Chicago: SPSS, Inc.) with day and horse and square as random factors and feed treatment as a fixed factor. Because no significant differences were found between squares ($P = .956$), both Latin squares were combined by dropping square from the model. Multiple comparisons were made using Tukey's HSD ($\alpha = 0.05$). The relationship of glycemic index to feed composition as well as feed intake was examined using a linear regression.

RESULTS

Changes in plasma glucose concentrations over the 300-minute sampling periods in the low and high glycemic squares are shown in Figs. 1 and 2. Plasma glucose concentrations peaked at approximately 90 to 120 minutes after the start of eating for feeds in both the high and low glycemic squares. The glucose concentration in all feeds, with the exception of oats, returned to prefeeding concentration ($P > .05$) by the end of the 300-minute sampling period (Fig. 3). The plasma glucose responses of the feeds within a square, other than oats and alfalfa, were relatively greater in the high glycemic square compared with the low glycemic square. Horse significantly affected GI ($P = .042$) across all data, indicating variation in response from one animal to the next. However, no attempt was made to remove horse-induced variation from the area under the curve (AUC) or GI values.

Mean values for areas under the plasma glucose response curves for all feeds and GI values are shown in Table 2. Glycemic indices for all 10 feeds were determined based on areas under the plasma glucose response curves for each feed and for each horse. With the AUC for oats set at 100, percentage differences from the AUC for oats