RELATIONSHIP OF BLOOD GLUCOSE CONCENTRATION AT ARRIVAL TO PERFORMANCE AND CARCASS CHARACTERISTICS OF BEEF HEIFERS

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Summary

Crossbred yearling heifers (n = 394) were used to compare the effect of high or low blood glucose measured at arrival on feedlot performance and carcass characteristics. A blood sample was collected when heifers arrived at the Beef Cattle Research Center, and heifers were sorted into two groups: high or low blood glucose. The mean blood glucose concentration of the heifers was 57 ± 2 mg/dL in the low group and 78 ± 2 mg/dL in the high group. Heifers that had low blood glucose at arrival consumed more feed (P=0.02), tended to have increased final bodyweight and rate of gain (P<0.10), had increased backfat thickness (P<0.05), and tended to have heavier hot carcass weights and fewer standard carcasses (P<0.10) compared with heifers that had high blood glucose at arrival.

Introduction

During the period of time from weaning to placement in a feedyard, cattle are exposed to many stressors. Being moved in and out of sale barns; shipped long distances; and hauled into a new environment are some factors that cause stress. One of the stress responses is for an animal to mobilize glucose from body tissue, which increases the concentrations of glucose and lactate in the blood. Previous research at K-State has shown that plasma glucose is related to feedlot performance, carcass weight, longissimus muscle area, and fat thickness. However, documentation of the effect of sorting incoming cattle on the basis of blood glucose concentration measured from a single blood sample taken after arrival is lacking. Our objective was to determine the effect of sorting cattle into low or high blood glucose groups, based on incoming blood glucose concentrations, on feedlot performance and carcass characteristics.

Experimental Procedures

A total of 394 crossbred yearling heifers (658 ± 4 lb initial body weight) were sorted based on their blood glucose concentration and fed for 174 days (148 days on the finishing diet). Information relative to previous nutrition and management of these heifers was not known. The heifers were allocated to 24 feedlot pens, 12 pens of high blood glucose heifers and 12 pens of low blood glucose heifers. Diet composition and actual nutrient levels are listed in Table 1. The diet was formulated to provide a minimum 14% crude protein, 0.7% calcium, 0.3% phosphorus, 0.7% potassium, 300 mg/heifer monensin daily, 90 mg/heifer tylosin daily, and 0.5 mg/heifer melengestrol acetate daily. Heifers were fed between 9:00 and 11:00 a.m. daily, except on weigh days when cattle were fed after being weighed.

Heifers were shipped 655 miles from Cameron, TX to Manhattan, KS arriving in Manhattan at approximately 4:00 a.m. and unloaded between 6:15 and 7:30 a.m. Initial processing commenced at approximately 10:00 a.m. During initial processing a blood sample was taken via jugular venipuncture, and heifers were vaccinated against viral (Bovishield-IV®) and clostridial (Fortress-7®) diseases, implanted with Component EH®, treated for internal and external parasites with

Eprinex® pour-on, and administered a metaphylactic dose of Micotil®.

The concentration of glucose in the blood sample at initial processing was used for characterizing heifers as having either low or high blood glucose. A mean blood glucose concentration was calculated within each receiving group. Cattle that had blood glucose concentrations above the mean blood glucose concentration (66 mg/dL) were sorted into the high blood glucose group and cattle that had blood glucose concentrations below 66 mg/dL were sorted into the low blood glucose group. Nine days prior to slaughter, heifers were weighed and a blood sample was collected; this sample is referred to as the "final" blood sample. On the day of the final blood sampling, blood samples were collected between 7:05 a.m. and 3:17 p.m.; heifers were not fed until body weight was measured and a blood sample was obtained.

Blood and plasma glucose and lactate concentrations were measured using a YSI 2300 STAT plus (YSI Inc., Yellow Springs, OH). After measuring blood glucose and lactate, the blood was centrifuged for 15 minutes at 2000 × *g* using a Centra-GP8R centrifuge (Thermo-IEC, Needham Heights, MA). Plasma was stored frozen for later analysis. Concentration of glucose and lactate in the blood and plasma were measured from the initial sample; only the plasma glucose and lactate concentrations were measured in the final sample.

In this study, treatments were arranged as a 2 × 2 factorial; factors were dietary concentrated separator byproduct or cane molasses and high or low blood glucose. There were no interactions between diet and glucose, and only blood glucose data is presented in this paper. The diet listed in Table 1 represents the average composition of the two diets that were fed.

Feedlot pen constituted the statistical unit. Each pen of heifers was weighed at the beginning of the experiment and immediately before shipping to a commercial slaughterhouse in Emporia, KS. Treatment differences were evaluated by analysis of variance using the General Linear Models procedure of SAS.

Table 1. Diet Composition[a], % of Dry Matter

Ingredient	Inclusion Level
Steam-flaked corn	77.0
Ground alfalfa hay	8.0
Cane molasses/concentrated separator byproduct	5.2
Soybean meal	3.5
Tallow	3.2
Limestone	1.4
Urea	1.3
Salt	0.3
Premix [b]	0.1
Nutrient [c]	
Crude protein	15.6
Calcium	0.76
Phosphorus	0.24
Potassium	0.78

[a]Diet represents the average of two diets that were fed.
[b]Formulated to provide 1200 IU/lb vitamin A, 51 ppm Zn, 50 ppm Mn, 8.7 ppm Cu, 2.4 ppm Fe, 0.5 ppm I, 0.25 ppm Se, 0.1 ppm Co, 33.3 grams/ton Rumensin, 10 grams/ton Tylan, and 0.5 mg/heifer melengesterol acetate.
[c]From analysis of ingredients.

Results and Discussion

Initial and final blood glucose concentrations are listed in Table 2. The initial blood sample was taken the day the cattle arrived at the Beef Cattle Research Center and the final blood sample was taken 9 days prior to slaughter. The heifers that were categorized as having high blood glucose at arrival maintained a higher level of blood glucose throughout the feeding period ($P<0.01$). The lactate concentration was greater in heifers

with high initial blood glucose concentrations than in those with low initial blood glucose concentrations (P<0.01).

Feedlot performance and carcass characteristics of heifers with either low or high blood glucose concentrations are shown in Table 3. Heifers that were categorized as having low blood glucose ate 4% more feed (P=0.02) and tended to gain at a faster rate (P=0.09). Feed efficiency was similar between these two groups (P=0.82). Heifers with low arrival blood glucose had more 12th rib back fat (P<0.05) and tended to have heavier carcass weights and less standard carcasses (P<0.10).

Cattle with lower blood glucose concentrations at arrival maintained a lower circulating glucose concentration throughout the feeding period. Furthermore, better feedlot performance was observed for heifers that had low initial blood glucose concentrations. The reason for the high or low concentrations of circulating glucose at arrival is not known because we did not have any background information on the heifers. If the high levels of glucose measured in the blood and plasma in the initial sample are due to higher stress on those individuals during shipping and receiving, the high level of circulating glucose maintained after 165 days on feed could stem from reduced insulin sensitivity, which would reduce tissue uptake of glucose.

These data demonstrate that cattle with low levels of circulating glucose have greater feedlot performance and carcass fat accretion compared to cattle with high levels of circulating glucose.

Table 2. Blood and Plasma Glucose and Lactate Levels of Yearling Heifers with Low or High Blood Glucose at Arrival Sampled at Arrival (Initial) and 9 Days Prior to Slaughter (Final)

	Low Glucose	High Glucose	SEM	P [a]
Initial glucose				
Blood, mg/dL	57.1	78.0	2.4	<0.001
Plasma, mg/dL	95.6	117.5	3.2	<0.001
Final glucose				
Plasma, mg/dL	113.9	139.0	6.2	0.01
Initial lactate				
Blood, mmol/L	3.79	5.70	0.31	<0.001
Plasma, mmol/L	6.80	9.02	0.47	0.003
Final lactate				
Plasma, mmol/L	4.91	6.22	0.35	0.01

[a]Probability that the observed response is not due to random chance.

Table 3. Finishing Performance and Carcass Characteristics of Yearling Heifers with Low Blood Glucose or High Blood Glucose at Arrival

Item	Low Glucose	High Glucose	SEM	P [a]
Dry matter intake, lb	18.1	17.4	0.2	0.02
Initial body weight, lb	660	655	3.8	0.41
Final body weight, lb[b]	1136	1111	9.3	0.07
Average daily gain, lb[c]	3.22	3.08	0.06	0.09
Gain:Feed	0.178	0.177	0.002	0.82
Hot carcass weight, lb	721	705	5.9	0.07
Dress, %	63.8	64.2	0.1	0.07
Longissimus muscle area, inch^2	13.4	13.3	0.1	0.42
12th rib fat thickness, inches	0.52	0.47	0.02	0.05
Kidney, pelvic, & heart fat, %	2.44	2.38	0.06	0.47
Yield grade 1, %	13.7	17.9	2.5	0.25
Yield grade 2, %	35.0	35.1	3.6	0.98
Yield grade 3, %	39.2	39.5	2.8	0.95
Yield grades 4 & 5, %	12.1	7.6	2.4	0.19
Marbling score	Slight 79	Slight 68	7.1	0.30
USDA Choice, %	43.8	41.8	4.3	0.75
USDA Select, %	48.5	47.9	4.2	0.92
USDA Standard, %	5.6	9.2	1.4	0.08
Liver abscesses, %	1.5	2.1	0.8	0.61
Dark cutters, %	1.0	1.0	0.7	0.95

[a]Probability that the observed response is not due to random chance.
[b]Calculated as hot carcass weight ÷ 63.5% dress.
[c]Calculated using carcass adjusted final weight.