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Abstract

Three Holstein steers (930 lb) were surgically fitted with abomasal and ileal cannulae, portal and mesenteric venous catheters, and an elevated carotid artery and used to study small intestinal starch digestion. Water, corn starch (66 g/hr), corn dextrin (66 g/hr), or glucose (66 g/hr) were continuously infused into the abomasum. Small intestinal disappearance of corn dextrin (57 g/hr) and glucose (57 g/hr) were higher (P<.05) than that of starch (48 g/hr). The percentage of carbohydrate disappearance accounted for as net portal glucose flux was 52, 54, and 72% for corn starch, corn dextrin, and glucose, respectively. Small intestinal starch utilization in the bovine may be limited by starch granular characteristics, enzyme activity, and glucose transport across the small intestine.; Dairy Day, 1988, Kansas State University, Manhattan, KS, 1988;

Keywords

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SMALL INTESTINAL STARCH, DEXTRIN, AND GLUCOSE DIGESTION IN STEERS

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Summary

Three Holstein steers (930 lb) were surgically fitted with abomasal and ileal cannulae, portal and mesenteric venous catheters, and an elevated carotid artery and used to study small intestinal starch digestion. Water, corn starch (66 g/hr), corn dextrin (66 g/hr), or glucose (66 g/hr) were continously infused into the abomasum. Small intestinal disappearance of corn dextrin (57 g/hr) and glucose (57 g/hr) were higher ($P<.05$) than that of starch (48 g/hr). The percentage of carbohydrate disappearance accounted for as net portal glucose flux was 52, 54, and 72% for corn starch, corn dextrin, and glucose, respectively. Small intestinal starch utilization in the bovine may be limited by starch granular characteristics, enzyme activity, and glucose transport across the small intestine.

Introduction

Previous experiments have been conducted at Kansas State University (Dairy Day, 1987) to evaluate small intestinal starch digestion in steers. In those experiments, 1) increasing the level of abomasal glucose infusion increased net portal glucose flux and 2) increasing levels of corn starch and corn dextrin infusion increased small intestinal disappearance. However, net portal glucose flux became maximal when they were infused at 20 g/hr. The present experiment includes the abomasal infusion of glucose, corn starch, and corn dextrin at a level known to exceed the digestive capacity of the small intestine (66 g/hr). Thus, the objective of this experiment was to evaluate the effect of carbohydrate complexity on small intestinal disappearance and net portal glucose flux.

Procedures

Three Holstein steers (930 lb) were fitted with an elevated carotid artery, hepatic portal and mesenteric venous catheters, and abomasal and ileal cannulae. Steers were fed daily alfalfa hay at 1.5% of body weight. Treatments included the continuous infusion of water, corn starch (66 g/hr), corn dextrin (66 g/hr), or glucose (66 g/hr) into the abomasum. Treatments were randomized in an incomplete Latin square design, using three steers and eight infusion periods. Steers were infused with 250 ml of solution per hr, and each infusion period lasted 10 hr. The infusate contained tap water, carbohydrate, and Cr:EDTA as a fluid flow marker. Between hours 4 and 10 of infusion, ileal digesta samples were collected, and disappearance of carbohydrate within the small intestine was determined. Simultaneous blood samples were collected from the hepatic portal vein and carotid artery, and glucose flux across the small intestine was calculated. Portal plasma flow was determined by a primed continuous infusion of para-aminohippuric acid into the mesenteric vein catheter.

Results and Discussion

Results are summarized in Table 1. Steers consumed daily 14 lb of alfalfa hay (dry matter basis) during the carbohydrate infusions. Fluid flowing past the ileum was similar

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among treatments and ranged from 1.6 to 2.0 l/hr. Small intestinal disappearance of corn dextrin and glucose was larger (P<.05) than that of corn starch. A portion of the infused corn starch and corn dextrin flowing past the ileum occurred as glucose (10-15%). This indicates limited active transport of glucose at distal sites of the small intestine.

Volatile fatty acids (VFA) flowing past the ileum were highest when starch was infused (P<.10). The increased VFA presumably resulted from microbial fermentation. Since starch infusion resulted in the highest amount of infused carbohydrate passing the ileum, perhaps the increased substrate availability increased microbial fermentation at distal sites within the small intestine.

No significant changes in portal plasma flow occurred across treatments. Net portal glucose flux was large and negative (-15.2 g/hr) when steers were infused with water. This indicates that glucose was metabolized by the gut for maintenance of normal functions. Net portal glucose flux became positive when each of the carbohydrates was infused (P<.05), was largest during glucose infusion (P<.05), and was similar for starch and dextrin infusions. An increased net portal glucose flux also was associated with an increased arterial glucose concentration.

Small intestinal carbohydrate disappearance accounted for by net portal glucose flux was 52, 54, and 72% for corn starch, corn dextrin, and glucose, respectively. The carbohydrate disappearance unaccounted for by glucose flux might be attributed to microbial fermentation or changes in gut metabolism. The relative importance of these processes may be critical in our overall understanding of small intestinal starch utilization in ruminants.

Table 1. Effect of Abomasal Carbohydrate Infusion on Small Intestinal Disappearance and Net Portal Glucose Flux

	Abomasal infusion				
Item	Water	Corn starch	Corn dextrin	Glucose	SE
Daily feed intake, lbs	14.0	13.9	14.5	13.9	0.5
Ileal fluid flow, l/h	1.8	2.0	1.7	1.6	0.2
Ileal glucose flow, g/h[ab]	0	1.7	1.3	9.1	0.6
Ileal starch flow, g/h[abc]	0	15.0	6.9	0	1.4
Ileal VFA flow, mmol/h[d]	44	56	44	35	5.0
Portal plasma flow, l/h	898	730	731	823	54.0
Arterial glucose, mM[ab]	3.9	4.2	4.3	4.5	0.1
Net portal glucose flux, g/h[ab]	-15.2	9.9	16.1	26.0	4.5

[a]Water vs others, P < .05
[b]Starch + Dextrin vs Glucose, P < .05
[c]Starch vs Dextrin, P < .05
[d]Starch vs Dextrin, P < .10.