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FAT SOURCE EFFECTS ON FINISHING STEER DIGESTION AND METABOLISM

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Summary

A replicated 3 × 3 Latin square design was used to explore the effects of fat source (none vs 3.5% soybean oil soapstock or animal tallow) when fed with high (1.0%) calcium on digestion and metabolism of a finishing diet by steers. Adding fat did not affect site or extent of starch or dry matter digestion. A net synthesis of long chain fatty acids occurred in the rumen. Feeding fat tended (P=.11) to depress bacterial N flowing at the duodenum but did not affect nonbacterial N or total N.

(Key Words: Digestibility, Fat, Calcium, Finishing.)

Introduction

Feeding fat to ruminants can cause palatability problems as well as depressed fiber digestibility, probably because of a toxic effect of long chain fatty acids on ruminal bacteria. Past research has indicated that a high dietary calcium (Ca) level helps alleviate negative effects on fiber digestion in high forage diets (>40% forage), presumably by increasing insoluble soap formation in the rumen. The type of fat used may affect these interactions. The low ruminal pH found in feedlot animals as compared with forage-fed animals would be more likely to ionize long chain fatty acids and Ca, thereby enhancing insoluble Ca soap formation. The objective of the present study was to evaluate the effect of feeding two types of fat with 1.0% dietary Ca in a cattle finishing diet.

Experimental Procedures

Six Holstein steers, averaging 768 lb, were prepared with permanent cannulae in the rumen, duodenum (15 cm posterior to the pylorus), and ileum (30 cm anterior to the ileal-cecal junction) and used in a replicated 3 × 3 Latin square experimental design. Dietary treatments consisted of a control (0% fat), 3.5% dietary soybean oil soapstock, or 3.5% tallow, all fed with 1.0% dietary Ca. The diets were based on dry, coarsely rolled wheat with 10% alfalfa. Chromic oxide was included in the supplement (crumbled pellet form) as the flow marker.

Steers were housed in an enclosed barn in individual tie-stalls and fed 2% (dry matter basis) of their body weight in 12 equal portions daily (2-hr intervals) using automated feeders. Animals gained an average of 3.12 lb/d over the 94-d trial. Each period of the Latin square

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consisted of 20 d. Dietary fat was analyzed as total long chain fatty acids (LCFA) using gas chromatography and represents fatty acids from C14:0 to C20:4 present in the diet or digesta sample. Insoluble fatty acid salts (IFAS) were isolated using three extractions of a 1:1 acetone and ether mixture.

Results and Discussion

Dry matter intakes were similar between treatments (Table 1.1). Starch and nitrogen (N) intakes were lower, and fatty acid intake, ruminal LCFA, and ruminal IFAS (% of ruminal LCFA) were higher ($P<.10$) in the diets containing fat. Intake of starch, fatty acids, dry matter (DM), or ruminal IFAS (% of ruminal LCFA) were similar between fat sources; however, animals fed tallow tended to have lower amounts of ruminal LCFA ($P=.11$) and ruminal IFAS ($P=.09$). Fat presence or type did not affect DM or starch digestibilities or ruminal IFAS content expressed as percent of ruminal fatty acids.

As shown by the negative numbers, a net ruminal synthesis of fatty acids occurred for all treatments. Fatty acid digestibility was lower ($P<.05$, measured as percent of fatty acid intake) in the rumen, small intestine, and total tract in animals fed fat compared to those not fed fat. Ruminal and small intestinal digestibilities of fatty acids were also lower ($P\leq .10$) in the tallow-fed animals compared to the animals fed soybean oil soapstock. The animals fed soybean oil soapstock had the lowest digestibilities of insoluble fatty acid salts, followed by the tallow diet, but digestibility nearly doubled comparatively in the diet not containing fat.

Feeding fat tended ($P=.11$) to depress bacterial N flowing to the duodenum but did not affect nonbacterial N or total N measured at the duodenum. Values were similar between the two fat sources.

Fat additions to high-Ca finishing diets did not affect DM or starch digestion in any segment of the gastrointestinal tract. Data indicate that large quantities of fatty acids are synthesized ruminally, and fat source causes small differences in fat digestibility and utilization by the animal.

Table 1.1. Fat Source Effects on DM, N, Starch, Fatty Acid, and Insoluble Fatty Acid Salt Digestion[1]

Item	No fat	Soybean oil soapstock (SS)	Tallow	SE	Prob. = No fat vs fat	Prob. = SS vs tallow
DMI, kg/d	7.98	7.88	7.89	.81	.3659	.9452
Starch intake, g/d	4342	4118	4090	38	.0023	.6302
N intake, g/d	177.6	174.8	172.1	1.7	.0968	.3220
Fatty acid intake, g/d	98.68	191.79	192.89	4.34	.0001	.2002
Ruminal LCFA, mg/g DM	44.3	87.2	74.5	4.7	.0008	.1083
Ruminal IFAS, mg/g DM	35.0	62.0	54.2	2.7	.0004	.0853
Ruminal IFAS, % of ruminal LCFA	79.2	71.8	73.3	3.0	.1237	.7359
DM digestibility, %						
ruminal	58.24	57.72	61.31	2.94	.7362	.4217
small intestinal	23.49	25.15	22.49	1.31	.8480	.2268
total tract	82.59	82.23	82.77	1.39	.9623	.7918
Starch digestibility, %						
ruminal	86.76	84.77	86.50	2.91	.7619	.6883
small intestinal						
% of intake	7.97	11.82	8.97	1.75	.3252	.3182
% of duodenal flow	78.40	72.20	66.62	3.85	.1331	.3659
total tract	95.90	96.11	96.04	.69	.8475	.9499
Fatty acid digestibility, %						
ruminal	−66.04	−55.28	−37.95	5.81	.0342	.0795
small intestinal						
% of intake	141.13	122.07	113.10	2.99	.0031	.1034
% of duodenal flow	86.00	78.62	77.14	2.54	.0614	.7041
total tract	72.46	59.79	65.48	2.80	.0285	.2003
Insoluble fatty acid salt (IFAS) digestibility, %						
total tract	82.45	24.77	46.52	4.26	.0002	.0178
Duodenum, g/d						
Bacterial N	90.2	75.7	71.5	7.2	.1102	.6942
Nonbacterial N	43.3	45.1	42.5	4.3	.9330	.6825
Total N	133.5	120.8	114.0	9.0	.1912	.6093

[1]Least squares means, n=6. Digestibilities reported as a percent of intake.