EFFECTS OF GRAIN PROCESSING AND LIPID ADDITION TO FINISHING DIETS ON CATTLE PERFORMANCE AND BLOOD CONSTITUENTS[1]

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Summary

Experiments were conducted to evaluate effects of grain processing and lipid source on finishing cattle performance, carcass characteristics, and plasma concentrations of glucose, urea, and α-amino nitrogen (amino acids). Eighty yearling Hereford x Angus steers (847 lb) were fed diets containing either steam-flaked corn or dry-rolled corn, both fed with and without 4% added tallow. In a fifth diet, ground flaxseed (equivalent to 4% lipids) replaced a portion of steam-flaked corn. Diets were fed once daily for 85 days. As expected, cattle fed steam-flaked corn were more efficient than steers fed dry-rolled corn. Adding tallow had little effect on performance. Including flaxseed resulted in performance similar to that with tallow addition. Plasma glucose concentrations measured 2 hours after feeding were higher for steers fed steam-flaked corn than for steers fed dry-rolled corn, and were higher for cattle fed tallow than for those fed no supplemental fat. Steers fed the flax/steam-flaked corn combination had lower plasma glucose concentrations 2 hours after feeding than those fed steam flaked corn with added tallow ($P<0.05$). Steam flaking corn increased performance and elevated glucose concentrations compared to dry rolling, suggesting that increasing the ruminal degradable starch allowed for a greater supply of substrates for gluconeogenesis. Adding flaxseed resulted in lower levels of plasma glucose after feeding, compared to tallow.

(Key Words: Steam-Flaked Corn, Dry-Rolled Corn, Flax, Tallow.)

Introduction

Compared with dry rolling, steam flaking of corn in cattle finishing rations increases ruminal digestibility of starch. In monogastric animals such as pigs, the degree of starch gelatinization can result in changes in circulating glucose concentrations after ingestion of a meal. Furthermore, these levels can be altered by both dietary fat concentration and fat type. Tallow is frequently an economical source of energy for cattle rations and is high in saturated fatty acids. Alternatively, flaxseed contains approximately 40% lipid, which is highly unsaturated, containing approximately 60% alpha linolenic acid. Our objectives were to evaluate effects of grain processing and dietary fat sources on animal performance, carcass attributes, and circulating glucose concentrations in finishing cattle.

Experimental Procedures

Eighty Hereford × Angus steers (847 lb BW) were adapted to a common dry-rolled corn diet for 7 days prior to initiating the experiment to minimize differences in gastrointestinal fill. Animals were stratified by initial weight and allotted, within strata, to five experimental treatments with 16 steers per treatment. The experiment was a randomized complete-block design with individual animal as the experimental unit.

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Dietary treatments (Table 1) were: steam-flaked corn, steam-flaked corn plus 4% tallow, dry-rolled corn, dry-rolled corn plus 4% tallow, or steam-flaked corn plus 10% ground flaxseed. Steers were placed into individual pens and fed their respective diets once daily for 85 days. Cattle were implanted with Component-TES. Cattle were weighed and blood was collected via jugular vein puncture approximately 15 hours after feeding on days 0, 43, 71, and at 2 hours after feeding on day 78.

On day 85, steers were individually weighed and shipped to a commercial slaughter facility where carcass data were collected. Hot carcass weights and liver abscess scores were obtained at slaughter. Percentage of kidney, pelvic, and heart fat; 12th-rib fat thickness; marbling score; longissimus muscle area; USDA yield grade; and USDA quality grade were obtained after a 24-chill. Dressing percentages were calculated on an individual basis as hot carcass weight divided by final live weight. Data were analyzed by analysis of variance as a $2 \times 2 + 1$ randomized complete block design using the MIXED procedure of SAS with individual animal as the experimental unit.

Results and Discussion

Diets are shown in Table 1. The crude protein concentration of the diet containing flaxseed was greater than that of other treatments. Long chain fatty acid concentrations of dietary lipid sources are presented in Table 2. As expected, Flaxseed contained much higher levels of polyunsaturated fatty acids than tallow. Tallow, on the other hand, contained greater amounts of saturated and monounsaturated fatty acids.

Steers fed diets containing steam-flaked corn had higher gains (Table 3), resulting in heavier carcasses compared to steers fed dry-rolled corn ($P<0.10$). Different dietary lipid sources (flax vs. tallow) resulted in similar ($P=0.60$) gains and feed efficiencies. Feed efficiency was better for steers fed diets containing steam-flaked corn than for those fed dry-rolled corn ($P<0.10$). Adding tallow to diets of finishing steers resulted in less subcutaneous fat deposition over the 12th rib when compared to diets with no added tallow ($P<0.10$; Table 3). There were no significant differences among diets in the percentages of carcasses grading USDA Choice, or in kidney, pelvic, and heart fat ($P>0.5$). Yield grade was lower ($P<0.10$) for steers fed dry-rolled corn than for those fed steam-flaked corn. Liver abscesses were significantly higher for steers fed flaked corn and steam-flaked corn with tallow compared to dry-rolled corn and dry-rolled corn with tallow ($P<0.10$).

Concentrations of plasma glucose, plasma urea nitrogen, and total α-amino nitrogen are presented in Table 4. Steers fed dry-rolled corn diets had lower glucose concentrations on days 43 and 78 than steers fed steam-flaked corn or steam-flaked corn with added tallow. On day 78, feeding flaxseed lowered post-feeding plasma glucose compared to adding tallow. Hydrothermal processes such as steam-flaking can drastically alter the protein characteristics.

Measurements of plasma urea nitrogen taken on days 43, 71 and 78 were lower for diets containing steam-flaked corn or steam-flaked corn with tallow compared to dry-rolled corn or dryrolled corn with tallow ($P<0.10$). This suggests greater absorption of ammonia from the rumen with dry-rolled corn. Tallow supplementation decreased plasma urea nitrogen concentrations on day 43 ($P<0.10$), but no effect was observed on days 71 or 78.

Steam flaking corn created elevated concentrations of plasma glucose two hours after feeding compared to dry-rolled corn, suggesting a greater availability of glucogenic precursors. Steam flaking corn also allowed some protein to bypass ruminal degradation resulting in lower plasma urea nitrogen and higher plasma α-amino nitrogen compared to dry-rolled corn. Flax addition to steam-flaked corn diets resulted in lower plasma glucose concentrations compared to steers fed flaked corn diets containing tallow, which may reduce the incidence of certain metabolic disorders.

Table 1. Composition of Experimental Diets (100% Dry Basis)

	Diet				
Item	SFC[a]	SFC/ Tallow	DRC[b]	DRC/ Tallow	SFC/ Flax
Steam-flaked corn	79.6	75.6	-	-	69.6
Dry-rolled corn	-	-	79.6	75.6	-
Ground flaxseed	-	-	-	-	10.0
Alfalfa hay	8.0	8.0	8.0	8.0	8.0
Soybean meal	3.06	3.06	3.06	3.06	3.06
Urea	1.19	1.19	1.19	1.19	1.19
Molasses	4.0	4.0	4.0	4.0	4.0
Tallow	-	4.0	-	4.0	-
Salt	0.30	0.30	0.30	0.30	0.30
Limestone	1.15	1.15	1.15	1.15	1.15
Monocalcium phosphate	0.12	0.12	0.12	0.12	0.12
Vitamin/mineral mix[c]	0.29	0.29	0.29	0.29	0.29
Monensin/tylosin premix[d]	2.23	2.23	2.23	2.23	2.23
Crude protein[e], %	14.2	13.9	14.2	13.9	15.8

[a]Steam-flaked corn. [b]Dry-rolled corn. [c]Provided 8 ppm Cu, 0.1 ppm Co, 50 ppm Mn, 0.25 ppm Se, 50 ppm Zn, 1200 IU/lb vitamin A, and 9 IU/lb vitamin E. [d]Provided 33 ppm Rumensin and 11 ppm Tylan (100% dry basis) in a ground corn carrier. [e]Calculated value.

Table 2. Long Chain Fatty Acid Concentrations in Dietary Fat Sources

Fatty acid	Tallow	Flaxseed
	% of total fatty acids	
C14:0	3.2	-
C16:0	24.9	6.4
C16:1	3.2	-
C18:0	22.5	3.1
C18:1	43.6	20.3
C18:2	2.3	15.9
C18:3	0.3	54.2
C20:5	-	-

Table 3. Performance and Carcass Traits of Finishing Steers

	Diets					
Item	SFC[a]	SFC/ Tallow	DRC[b]	DRC/ Tallow	SFC/ Flax	SEM
No. of steers	16	16	16	16	16	-
Initial weight, lb	886	895	902	888	888	37
Final weight, lb[c]	1228	1224	1193	1184	1224	53
Dry matter intake, lb/day	21.4	20.3	21.2	20.9	20.2	1.2
Gain, lb/day[c]	4.03	3.86	3.44	3.48	3.97	0.33
Feed:gain, lb/lb [c]	5.56	5.26	6.25	5.88	5.00	0.16
Carcass adj. gain, lb/day[g]	4.07	4.01	3.28	3.46	3.92	0.31
Hot carcass weight, lb[c]	761	761	728	728	754	33
USDA Yield grade[c]	2.69	2.81	2.56	2.25	2.63	0.14
USDA Choice, %	50	50	75	56	69	15.8
Marbling score[ef]	Sl^{85}	Sm^{21}	Sl^{94}	Sl^{86}	Sm^{04}	18.9
Fat over 12th rib, in[cd]	0.43	0.40	0.38	0.34	0.42	0.01
Ribeye area, sq in [d]	12.7	13.0	12.4	13.0	12.7	0.03
Kidney, pelvic, & heart fat, %	2.1	2.2	2.1	2.1	2.2	0.10
Liver abscesses, % [d]	25	0	13	0	0	7.9

[a]Steam-flaked corn. [b]Dry-rolled corn. [c]DRC and DRC/Tallow different from SFC and qSFC/Tallow (P<0.10). [d]DRC and SFC different from DRC/Tallow and SFC/Tallow (P<0.10). [e]SFC/Tallow different from Flax (P<0.10). [f]Sl=Slight, Sm=Small. [g](Hot carcass weight/0.6164) – initial weight/85.

Table 4. Plasma Concentrations for Glucose, Urea N, and Total α-Amino N

	Diets					
Item	SFC[a]	SFC/ Tallow	DRC[b]	DRC/ Tallow	SFC/ Flax	SEM
Glucose, mM						
Day 43[c]	4.63	4.84	4.48	4.32	4.78	0.23
Day 71	4.94	4.94	4.69	4.58	4.95	0.39
Day 78, (2 hours after feeding)[cd]	4.76	5.22	4.66	4.68	4.59	0.26
Urea N, mM						
Day 43[cde]	10.6	8.6	11.6	11.2	11.7	0.55
Day 71[ce]	9.7	10.0	12.9	12.0	11.8	0.58
Day 78, (2 hours after feeding)[ce]	14.3	12.8	15.6	15.0	16.2	0.89
Total α-amino nitrogen, mM						
Day 43[c]	2.77	2.70	2.47	2.41	2.86	0.11
Day 71[c]	2.63	2.77	2.54	2.37	2.84	0.12
Day 78, (2 hours after feeding)[c]	2.90	2.96	2.67	2.76	3.15	0.12

[a]Steam-flaked corn. [b]Dry-rolled corn. [c]DRC and DRC/Tallow different from SFC and SFC/Tallow (P<0.10). [d]DRC and SFC different from DRC/Tallow and SFC/Tallow (P<0.10). [e]SFC/Tallow different from Flax (P<0.05).