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Abstract

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Keywords

Cattlemen's Day, 1993; Kansas Agricultural Experiment Station contribution; no. 93-318-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 678; Beef; Beef heifers; Metabolism; Tallow; Thermal stress

EFFECT OF SUPPLEMENTAL FAT AND THERMAL STRESS ON NITROGEN AND ENERGY METABOLISM OF FINISHING HEIFERS

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Summary

Twelve British and British crossed heifers fed whole shelled corn finishing diets were used in a 2 × 2 factorially arranged experiment to study the main effects of and interactions between feeding supplemental tallow (0 vs 4%) and thermal heat stress (55°F vs 90°F). Heifers were maintained in temperature- and humidity-controlled environmental rooms. Neither supplemental fat or thermal stress affected dry matter intake or total tract digestibility of organic matter, starch, NDF, or ADF. However, heat stress elevated water consumption ($P < .01$) and rectal temperature ($P < .01$). When fed at equal intakes, heifers consuming tallow-supplemented diets retained more ($P < .05$) nitrogen, and tallow-supplemented diets had a higher ($P = .08$) ME value than non-tallow diets; these effects were not observed when heifers were fed ad libitum. Adding tallow to diets of finishing cattle may help maintain performance under circumstances where feed intake is restricted.

(Key Words: Beef Heifers, Metabolism, Tallow, Thermal Stress.)

Introduction

Cattle tend to reduce feed intake in hot weather as a means of controlling their rising body temperature. Because fat has a lower heat increment than carbohydrates or proteins, fat supplementation should theoretically reduce the heat of digestion and fermentation, thereby lowering the animal's heat load under thermal stress. Therefore, the purpose of this experiment was to determine the effects of heat stress and supplemental fat on nitrogen retention and on the energy density and nutrient digestibility of a corn-based finishing diet consumed by heifers.

Experimental Procedures

Twelve British and British crossed heifers (avg. wt. 650 lbs) were randomly allotted to one of four treatments: 55°F & 0% tallow, 55°F & 4% tallow, 90°F & 0% tallow, and 90°F & 4% tallow. They were maintained in environmental chambers with 50% relative humidity and 24-hour lighting. The thermoneutral room was 55°F 24 hrs/day, whereas the heat stress room cycled from 74°F to 90°F over 24 hours: 74°F from 2 a.m. to 6 a.m. and 90°F from 2 p.m. to 6 p.m. with 2°F/hr changes between these plateaus.

We used two 30-day periods, each consisting of a 10-day dietary fat adaption period, a 7-day temperature adaption period, a 5-day ad libitum collection period, a 3-day equalized intake adaptation period, and a 5-day equal intake period. The diets were based on whole shelled corn and contained 10% orchardgrass hay. We collected total urine and feces and determined digestibility of organic matter, starch, NDF, ADF, and fat. Digestible energy was calculated by subtracting fecal energy from feed energy. Metabolizable energy (ME) was derived by subtracting both urinary energy and estimated methane losses from the digestible energy. Diet net energy values were calculated from ME (NRC, 1984).

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Results and Discussion

Dry matter intake as a percent of body weight was similar among treatments (Table 1). However, heat stress increased (P = .001) rectal temperature and water consumption (P = .001). The total tract digestibility of starch, NDF, ADF, and organic matter were not affected by tallow or temperature level. Conversely, tallow supplementation increased (P = .05) nitrogen digestibility when heifers were limit fed, but not when they were fed ad libitum. In addition, when heifers were limit fed, supplemental tallow increased (P < .05) nitrogen retention, whereas heat stress decreased (P = .06) nitrogen retention; those trends were not observed with heifers fed ad libitum.

Supplemental tallow increased (P = .08) ration digestible energy, metabolizable energy, and net energy for both maintenance and gain when diets were fed at equalized intakes. However, these responses were not significant when heifers were fed ad libitum. Further, total tract fat digestion was depressed (P = .08) by elevated environmental temperature and was increased (P < .05) by addition of 4% tallow for ad libitum fed heifers. Neither fat nor temperature had any effect on fat digestion in limit-fed heifers. In conclusion, tallow enhanced energy utilization and nitrogen retention at equal (restricted), but not at ad libitum, intakes. With restricted intake, tallow may reduce heat production and lower maintenance energy expenditures. Tallow may help cattle performance under circumstances where consumption is restricted.

Table 1. Effect of Level of Fat and Environmental Temperature on Intake, Digestion, and Metabolism

Item	55 °F 0% tallow	55 °F 4% tallow	90 °F 0% tallow	90 °F 4% tallow	Probability TEMP	Probability FAT	Probability T × F
AD LIBITUM PHASE							
DM intake, % BW	2.79	2.96	2.95	2.64	.67	.71	.26
Water intake, l	13.0	15.4	25.7	25.9	.03	.48	.21
Rectal Temp,	101.7	101.6	103.4	103.6	.001	.75	.43
Digestibility, %							
OM	75.0	73.7	73.7	74.4	.88	.88	.64
Starch	97.5	96.6	96.1	96.5	.24	.64	.33
Fat	66.7	72.3	57.6	68.4	.08	.03	.46
Nitrogen	69.1	68.9	67.7	71.0	.88	.54	.47
ADF	50.6	40.9	47.7	42.6	.90	.15	.64
NDF	53.6	51.4	56.4	56.1	.38	.77	.82
DE, Mcal/lb	1.43	1.46	1.40	1.46	.64	.18	.63
ME, Mcal/lb	1.28	1.33	1.26	1.31	.62	.18	.97
NEm, Mcal/lb	.85	.90	.83	.88	.59	.17	.97
NEg, Mcal/lb	.56	.60	.55	.59	.62	.18	.95
N retention, g/d	64.6	67.1	59.1	58.8	.42	.89	.87
EQUAL INTAKE PHASE							
DM intake, % BW	2.13	2.11	2.13	2.11	.78	.001	.78
Water intake, l	15.3	12.9	19.4	27.4	.03	.48	.21
Rectal Temp, F	101.6	101.6	102.4	102.5	.001	.62	.55
Digestibility, %							
OM	75.7	76.6	74.9	74.6	.53	.89	.78
Starch	96.8	96.8	97.2	97.2	.41	.95	.95
Fat	73.2	82.1	75.2	73.2	.11	.11	.02
Nitrogen	64.8	70.4	64.2	69.2	.73	.05	.89
ADF	45.4	51.3	45.9	44.5	.55	.66	.48
NDF	53.5	55.4	51.6	53.2	.66	.72	.97
DE, Mcal/lb	1.40	1.51	1.39	1.45	.45	.06	.62
ME, Mcal/lb	1.24	1.35	1.23	1.29	.41	.08	.58
NEm, Mcal/lb	.82	.91	.81	.86	.41	.08	.57
NEg, Mcal/lb	.54	.62	.53	.57	.41	.08	.55
N retention, g/d	20.9	37.0	16.3	23.0	.05	.02	.32