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Summary

Two trials were conducted to evaluate feeding sodium chloride salt (NaCl) and soybeans to feedlot cattle in summer and winter seasons. The treatments were 1) control; 2) 1% added salt; 3) 5% added whole soybeans; and 4) the combination of 1% added salt and 5% added whole soybeans. Added salt had a tendency to decrease dry matter intake and increase water intake. Additional salt and soybeans elevated tympanic temperatures. Treatment did not have an effect on performance, carcass quality grade, or dressing percentage.

Introduction

In recent years, the low price that producers received for soybeans allowed soybeans to become a competitively priced source of fat in cattle rations. Supplemental fat may have beneficial effects under both hot and cold environmental conditions. Fat is an energy dense energy source, which could enhance available digestible energy and feed efficiency of cattle exposed to cold stress. However, fat has a lower heat increment than proteins and carbohydrates, which could be beneficial during hot weather, and a disadvantage in cold weather.

During hot weather, increased dietary mineral concentration due to declining feed intake and the potential depletion of key cations from heat stress may be required. Potassium and sodium (Na) are the primary cations involved in the maintenance of acid-base chemistry. Salt (NaCl) is a common feed ingredient, which can be used to regulate feed intake, particularly at levels of 5% or more of the total diet dry matter. However, at levels less than 1% of the diet dry matter, cattle do have an appetite for salt, which tends to stimulate intake. Levels of salt that stimulate or restrict feed intake may vary depending on feeding conditions and type of environmental stress to which cattle are exposed. Effects of switching from low-salt, low-fat diets to diets containing elevated levels of salt and/or fat is unknown. The objectives of this study were to assess effects of switching cattle from a normal feedlot diet to higher salt and/or added fat from soybeans diets during summer and winter feeding periods.

Procedure

Summer Trial

Ninety-six crossbred heifers and forty-eight crossbred steers were used for this trial. Prior to trial initiation, cattle were vaccinated (Bar-Vac 7/Somnus and Express 4; Boehringer Ingelheim Vetmedica Inc., St. Joseph, Mo.) and weighed. Weight and sex were used to allot animals to 18 pens. At trial initiation, heifers and steers were implanted with Revalor-H or Revalor-S (Intervet Inc., Millsboro, Del.), respectively, weighed (mean BW = 878 lb) and sorted into allotted pens. A 3 x 3 Latin square design was utilized in which diet treatments were compared during three nine-day treatment periods. Between each treatment period, the control diet was fed to all cattle during a five-day adjustment period. Diet treatments (Table 1) were: 1) control; 2) 1% added sodium chloride (salt); and 3) 1% added sodium chloride (salt) and 5% added whole soybeans. All cattle were on control diet prior to trial initiation and started on treatment diet on day 1. Following completion of the third period, cattle remained on the last period treatment diet for 39 days, until slaughter.

Dry matter (DMI) and water (DWI) intakes were recorded daily. Body weights were obtained following completion of the latin square (day 43) and the day before slaughter (day 92). Hot carcass weight, yield grade, and marbling score were obtained at slaughter. Tympanic temperatures (TT) were recorded using Stowaway XTI[7] data loggers and thermistors (Onset Corporation, Pocasset, Mass.). The thermistor was inserted approximately four to five inches into the ear canal until the tip was near the tympanic membrane. The loggers recorded temperatures at 1-hour intervals in 20 animals from eight pens (five animals total/treatment) during the last 6 days of the second period. Treatments for the second period were imposed in late July.

Table 1. Composition of diets fed in summer trial (DM basis).

	Treatment		
	Control	Salt	Salt-soybean
Ingredient, %			
Alfalfa	8.0	6.0	7.0
Dry rolled corn	86.0	87.0	81.0
Rumensin/Tylan supplement	2.0	2.0	2.0
Liquid supplement	4.0	4.0	4.0
Salt (NaCl)	—	1.0	1.0
Whole soybeans	—	—	5.0
Nutrient Composition (estimated NRC)			
Crude protein, %	13.0	12.8	14.4
NEg, mcal/lb	0.65	0.65	0.65
Fat, %	3.8	3.8	4.5
Calcium, %	0.63	0.60	0.63
Phosphorus, %	0.32	0.32	0.34
Potassium, %	0.68	0.65	0.74
Sodium, %	0.10	0.50	0.50
DCAD, meq/100g[a]	7.6	8.0	8.7

[a]DCAD = meq (% in diet/equivalent weight) of [(Na + K) – (CL + S)].

Table 2. Composition of diets fed in winter trial (DM basis).

	Treatment			
	Control	Salt	Soybean	Salt-soybean
Ingredient, %				
Alfalfa	6.0	4.0	4.0	3.8
Corn silage	4.0	4.0	8.0	8.0
Dry rolled corn	82.7	83.7	78.0	78.0
Rumensin/Tylan supplement	2.0	2.0	2.0	2.0
Liquid supplement	3.3	3.3	3.0	3.0
Soybean meal	2.0	2.0	—	—
Salt (NaCl)	—	1.0	—	1.0
Whole soybeans	—	—	5.0	5.0
Nutrient Composition (estimated NRC)				
Crude protein, %	13.3	13.0	13.5	13.4
NEg, mcal/lb	0.65	0.65	0.66	0.66
Fat, %	3.81	3.79	4.61	4.59
Calcium, %	0.53	0.51	0.49	0.48
Phosphorus, %	0.33	0.33	0.34	0.33
Potassium, %	0.71	0.68	0.75	0.73
Sodium, %	0.09	0.48	0.08	0.47
DCAD, meq/100g[a]	8.3	7.5	9.1	8.7

[a]DCAD = meq (% in diet/equivalent weight) of [(Na + K) – (CL + S)].

Table 3. Climatic conditions during periods tympanic temperature measurements were obtained.[a]

	Mean Ta, F	Max Ta, F	Min Ta, F	RH, %	THI	WSPD, mph
Summer	78.9	93.3	69.3	69.7	74.4	5.97
Winter	26.8	37.6	16.7	64.7	31.25	4.76

[a]Ta = Ambient temperature; RH = relative humidity; THI (temperature humidity index) = (meanTa-(0.55-(0.55*(RH/100)))*(meanTa-58); WSPD = wind speed.

All data was analyzed using the Proc Mixed procedures of SAS. Carcass data was analyzed with final diet treatment in the model. Dry matter intake and DWI were analyzed using repeated measures in a 3 x 3 Latin square design. The model included the effects of square, period, diet treatment, period day, and the interaction of period day by diet. The specified term for the repeated statement was pen within period. Tympanic temperatures were analyzed using a repeated measures model that included diet treatment, time of day, day, and the interaction of diet treatment by time of day. The specified term for the repeated statement was animal.

Winter Trial

One-hundred sixty-eight crossbred steers were used for this trial. Prior to trial initiation, cattle were vaccinated (Vision 7/Somnus and Titanium 5 PHM Bac 1; Intervet Inc., Millsboro, Del.), dewormed (Safe-Guard; Intervet Inc., Millsboro, Del.), treated for external parasites (Saber; Schering Plough Animal Health, Union, N.J.), and weighed. This weight was used to allot animals to 24 pens. At trial initiation, cattle were implanted (Revalor-S; Intervet Inc., Millsboro, Del.), weighed (mean BW = 895 lb), and sorted to their allotted pens. A 3 x 4 incomplete latin square design was utilized with 10-day treatment periods in which diet treatments were compared. Between each treatment period, an 11-day adjustment period was used in which the control diet was fed to all cattle. Diet treatments (Table 2) were: 1) control diet; 2) 1% added sodium chloride (salt); 3) 5% added soybean diet; and 4) 1% added sodium chloride (salt) and 5% added soybeans. The control diet was fed to all cattle nine d prior to imposing the first treatment period. Following completion of the third period of the latin square, cattle remained on respective diets for an additional 38 days, and were then slaughtered. When including the 10 days from the final period of the latin square, the cattle were on the final diet for 48 days.

Dry matter intake and DWI were recorded daily. Body weights were obtained the day before slaughter. Animals were observed at 0800 during the last four days of each period and the number of animals in each pen showing signs of shivering was recorded. Tympanic temperatures were recorded at 1-hour intervals in three animals from each of two pens (six animals total/treatment) of each treatment for the last eight days of the Periods 1 and 2. Treatment periods were imposed in early January, late January, and mid-February. The TT data were obtained from the same animals in each period.

All data were analyzed using the Proc Mixed procedures of SAS. Dry matter and water intakes were analyzed using repeated measures for an incomplete 3 x 4 Latin square design. The model included the effects of soybeans, salt, period day, period, and all possible interactions. The specified term for the repeated statement was pen within period. Tympanic temperatures were analyzed using a repeated measures model that included soybeans, salt, and time of day with all possible interactions. The specified term for the repeated statement was animal within period.

Results

Mean ambient temperatures (Table 3), during the period TT were obtained were above 10-year normal in both the summer (78.9 vs 72.1°F) and winter (26.8 vs 23.2°F). Based on THI values (mean = 74.4 summer and 31.3 winter), conditions were sufficient to produce moderate stress in both seasons. Generally, a THI outside of the range of 35-74 is considered sufficient to elicit stress responses in beef cattle.

In the winter, the addition of salt (salt and salt-soybean treatments) decreased DMI ($P < 0.10$), increased DWI ($P < 0.05$), and decreased the DMI per DWI ratio ($P < 0.05$). The

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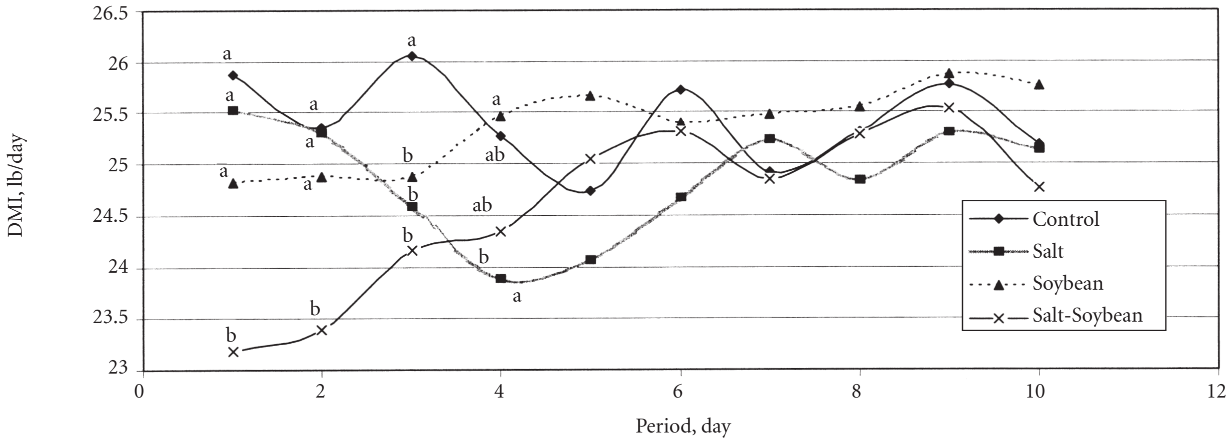

Figure 1. Winter trial daily dry matter intake. Diet treatment * period day interaction (*P* = 0.07)
[ab]Means within a day with unlike superscripts differ (*P* < 0.10).

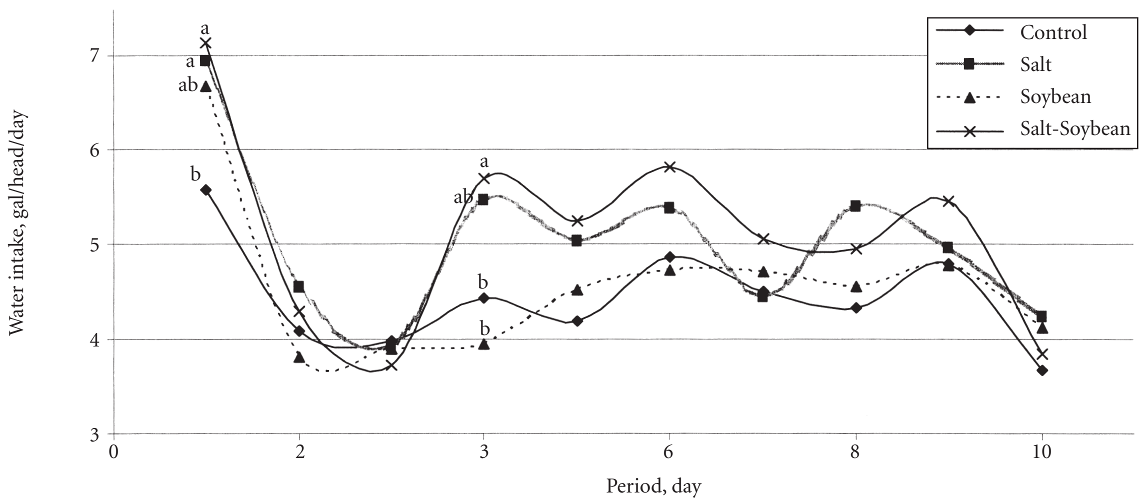

Figure 2. Winter daily water intake. Diet treatment * period day interaction (*P* = 0.01).
[ab]Means within a day with unlike superscripts differ (*P* < 0.05).

combined feeding of salt and soybeans also elevated TT in the winter (Table 4) when compared to the control treatment. In the summer, the addition of salt or soybeans did not affect DMI or DWI (Table 5). However, feeding salt and soybeans in combination still elevated ($P < 0.05$) TT. Even though dietary treatment effects were not observed in intakes during the summer, the addition of salt produced similar trends in DMI, DWI, and DMI per DWI ratio in both seasons. The lack of significance in the summer trial may be partially due to differences in DMI between the two trials. Winter DMI was 3.5 lb greater than summer intakes. This difference would indicate that the winter cattle consumed nearly 0.6 oz more salt per day than the summer cattle.

Table 4. Dry matter intake, water intake (DWI), and tympanic temperature (TT) — Winter latin square trial.

	Treatment				
	Control	Salt	Soybean	Salt-soybean	SEM
DMI[1], lb	25.42[b]	24.85[a]	25.37[b]	24.58[a]	0.383
DWI[1], gal	4.45[d]	5.05[c]	4.55[d]	5.19[c]	0.129
DMI/DWI[1]	6.06[d]	5.53[c]	6.19[d]	5.17[c]	0.102
TT[g]	101.9[a]	101.7[b]	101.8[c]	102.0[d]	0.01

[ab]Means within a row with unlike superscripts differ (*P* < 0.10).
[cdef]Means within a row with unlike superscripts differ (*P* < 0.05).
[g]Salt * soybean interaction (*P* < 0.0001).
[1]DMI = dry matter intake; DWI = daily water intake.

Table 5. Daily dry matter intake, water intake and tympanic temperature (TT) — Summer Latin square trial.

	Treatment			
	Control	Salt	Salt-soybean	SEM
DMI[1], lb	21.43	21.31	21.17	0.198
DWI[1], gal	8.40	8.68	8.41	0.172
DMI/DWI[1], lb/gal	2.69	2.67	2.71	0.098
TT, °F	101.4[a]	101.3[a]	101.9[b]	0.26

[ab]Means within a row with unlike superscripts differ (*P* < 0.05)
[1]DMI = dry matter intake; DWI = daily water intake.

Table 6. Forty-nine day performance data, carcass data, and daily water intake (DWI) — Summer performance trial.[a]

	Treatment			
	Control	Salt	Salt-soybean	SEM
Initial weight, lb	1012	1011	1006	11.0
Final weight, lb	1179	1196	1178	19.9
ADG, lb	3.41	3.77	3.50	0.215
DMI[1], lb	21.31	21.81	21.33	0.479
DWI[1], gal	7.33	7.20	6.82	0.465
DMI/DWI[1]	2.92	3.03	3.25	0.202
F/G	6.35	5.88	6.13	0.270
G/F	0.160	0.172	0.165	0.008
Quality grade[b]	18.50	18.41	18.25	0.283
Yield grade	2.07	1.96	1.98	0.079
Dressing percentage	61.5	61.6	61.5	0.32

[a]Diets provided for 49 d from end of latin square to slaughter.
[b]18 = high select; 19 = low choice.
[1]DMI = dry matter intake; DWI = daily water intake.

Table 7. Carcass data of steers in winter trial after 48 days on respective diets.

	Treatment				
	Control	Salt	Soybean	Salt-soybean	SEM
Quality grade[a]	19.31	19.27	19.29	19.31	0.161
Yield grade	2.64[c]	2.44[b]	2.48[bc]	2.41[b]	0.070
Dressing percentage	62.0	61.5	61.6	62.0	0.78

[a]Quality grade: 19 = low choice, 20 = average choice, 21 = high choice.
[bc]Means within a row with unlike superscripts differ ($P < 0.10$).

The winter trial showed a diet treatment by period day interaction ($P < 0.10$) for DMI (Figure 1). The control and soybean treatment DMI remained fairly level throughout the period, while DMI for the salt treatment group declined over the first four d and then increased to the control DMI level. By day 5, DMI was similar among treatment groups ($P > 0.05$). This indicates that the treatment differences in DMI may be due to switching and then adapting to the new treatment diet. Diet ingredients or combination of ingredients, which can be used to control or regulate DMI, may also be used to limit large increases in DMI and possibly minimize variation in DMI during adverse weather events.

The winter trial also showed a diet treatment by period day interaction ($P < 0.05$) for DWI (Figure 2). On day 1 of the period, DWI was greater for all cattle fed salt and soybean diets when compared to cattle fed the control diet. However, DWI declined for salt-fed cattle on days 2 and 3, but stabilized and became similar to control cattle by day 5 and remained similar for the duration of the period.

No significant differences were found for any treatment in performance data for the summer trial (Table 6). However, in the winter, the addition of salt tended to lower ($P < 0.10$) USDA yield grade (Table 7).

These data suggest that switching to diets containing the combination of added salt and soybeans may elevate body temperature in the summer and winter seasons, even though dry matter intake is depressed. However, added salt, by itself, tends to lower DMI and body temperature, while increasing DWI. Added soybeans by itself did not have an effect on DMI, DWI, or body temperature. Added salt or soybeans had no effect on carcass quality grade or dressing percentage.

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