Potassium for Feedlot Cattle Exposed to Heat Stress

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Summary

Angus crossbred yearling heifers and steers (n = 144 and 168, respectively) were used to evaluate effects of feeding soybeans and additional potassium (K) on performance and tympanic temperature (TT) of cattle under heat stress and seasonal summer conditions. In Experiment 1, cattle fed diets supplemented with potassium carbonate had lower ADG and tended to have decreased water intake, G:F, and dressing percent. In Experiment 2, cattle fed diets supplemented with K with or without whole soybeans had lower or tended to have lower TT than control cattle during the hottest portion of the day (between 1300 and 2100 hours).

Introduction

Because fat has a low heat increment to metabolizable energy ratio, it may be beneficial to feed under hot environmental conditions. In addition, the low price producers periodically receive for soybeans may allow soybeans to be economically competitive as a source of fat in cattle rations.

During hot weather, declining feed intake requires increased dietary mineral concentration due to depletion of potassium (K) and sodium (Na) as a result of heat stress. Research (2007 *Nebraska Beef Cattle Report,* pp. 77-79; *2006 Nebraska Beef Cattle Report*, pp. 62-65) has evaluated effects of supplemental salt (NaCl) and potassium bicarbonate ($KHCO_3$) in feedlot diets. The objectives of the following study were to assess effects of providing fat in the form of soybeans and supplemental $KHCO_3$ or potassium carbonate (K_2CO_3) for cattle finished in the summer.

Procedure

Experiment 1

One hundred forty-four crossbred, previously vaccinated (Vision® 7/ Somnus, Titanium® 5 PHM Bac® 1) heifers were implanted with Revalor®-H, weighed on two consecutive days and allotted to one of 24 pens. For a 71-day feeding period, three replicates were randomly assigned to four treatments arranged in a 2 x 2 factorial design. The diet treatments (Table 1) were 1) Control (CONTL), 2) a diet containing 1.75% K_2CO_3, 3) a diet containing 5% whole soybeans (SOYBN), and 4) a diet containing 1.75% K_2CO_3 and 5% whole soybeans (SOYK2).

Dry matter (DMI) and water intakes (DWI) were recorded daily. Treatment comparisons were also made for DMI and DWI during two five-day hot (days 21 to 25 and 62 to 66) periods and one four-day cool (days 35 to 38) period during the experiment.

Performance data and intakes were analyzed using Proc Mixed procedures of SAS (SAS Inst., Inc., Cary, N.C.). The model included K, soybeans, and the interaction of K by soybeans as fixed effects and replicate as a random effect.

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Table 1. Composition of diets fed in Experiment 1.

Ingredient	CONTL	K_2CO_3	SOYBN	SOYK2
Alfalfa	5.75	4	6	4
Corn silage	6	4	8	5
Dry-rolled corn	80.75	82.75	76.5	79.75
Rumensin-Tylan premix	2	2	2	2
Liquid supplement	3.5	3	3	3
Soybean meal	2	2.5	—	—
Whole soybeans	—	—	4.5	4.5
K_2CO_3	—	1.75	—	1.75
Nutrient composition				
NEg, Mcal/lb	0.650	0.650	0.650	0.651
Calcium, %	0.56	0.47	0.51	0.48
Phosphorus, %	0.33	0.33	0.33	0.33
Potassium, %	0.73	1.67	0.76	1.70

Table 2. Composition of diets fed in Experiment 2.

Ingredient	CONTL	$KHCO_3$	SOYK2	SOYKH
Alfalfa	7	4	5	4.75
Corn silage	6	6	7	6
Dry-rolled corn	80.5	80	77.5	78
Rumensin-Tylan premix	2	2	2	2
Liquid supplement	3	2.5	2.5	2.5
Soybean meal	1.5	3.25	—	—
Whole soybeans	—	—	4.5	4.5
K_2CO_3	—	—	1.5	—
$KHCO_3$	—	2.25	—	2.25
Nutrient composition				
Crude protein, %	12.99	13.01	13.09	13.02
NEg, Mcal/lb	0.650	0.648	0.650	0.648
Calcium, %	0.52	0.42	0.44	0.43
Phosphorus, %	0.32	0.33	0.33	0.33
Potassium, %	0.72	1.57	1.57	1.58

Table 3. Performance and carcass data for cattle fed in Experiment 1.

	CONTL	K_2CO_3	SOYBN	SOYK2	SEM	K	*P*-value SOY	K*SOY
Initial wt, lb	1007	1007	1012	1015	2.8	0.50	0.02	0.54
Actual final wt, lb[1]	1218	1204	1235	1211	8.1	0.03	0.16	0.52
Actual ADG, lb	2.98	2.78	3.15	2.75	0.111	0.02	0.54	0.39
DMI, lb	20.85	20.60	21.53	19.92	0.418	0.02	0.99	0.09
F/G	7.01	7.48	6.86	7.29	0.238	0.08	0.49	0.94
G/F	0.143	0.135	0.146	0.138	0.0045	0.09	0.48	0.95
DWI,[2] gal	9.08	7.38	8.47	7.95	0.474	0.06	0.96	0.24
DMI/DWI[2]	2.30	2.81	2.57	2.51	0.143	0.18	0.90	0.11
Carcass wt, lb	768	759	778	763	5.1	0.03	0.16	0.51
Marbling[3]	564	616	623	570	18.9	0.98	0.72	0.01
Yield grade	2.68	2.81	3.08	2.79	0.121	0.50	0.14	0.11
Actual dressing percent[4]	62.04	61.81	62.27	61.60	0.246	0.08	0.98	0.38

[1]Based on hot carcass weight, adjusted to 63% dressing percent.
[2]DWI = Daily water intake.
[3]450 = slight^{50}, 500 = small^{00}, 550 = small^{50}.
[4]Based on full weight, as recorded on the day before harvest (day 71).

Table 4. DM and water intake for hot and cool period in Experiment 1.

	CONTL	K_2CO_3	SOYBN	SOYK2	SEM	K	*P*-value SOY	K*SOY
Dry matter intake[1]								
Hot1	20.32^{ab}	20.74^{ab}	22.08^{a}	19.63^{b}	0.789	0.20	0.68	0.08
Cool	18.40^{ab}	19.53^{ab}	20.33^{a}	18.17^{b}	1.371	0.55	0.74	0.07
Hot2	22.50	22.55	21.80	20.73	0.509	0.33	0.02	0.28
Water intake[1]								
Hot1	9.77	8.35	9.09	8.42	0.495	0.05	0.47	0.38
Cool	8.27	7.24	7.83	7.29	1.045	0.44	0.84	0.80
Hot2	10.52	7.901	9.79	8.85	0.786	0.05	0.78	0.40
Dry matter/water intake[1]								
Hot1	1.97	2.66	2.40	2.410	0.178	0.10	0.65	0.11
Cool	2.22	2.83	2.70	2.51	0.245	0.43	0.75	0.18
Hot2	2.16	2.86	2.22	2.35	0.151	0.04	0.20	0.11

[1]Hot1 period = days 21-25, Cool period = days 35-38, Hot2 period = days 62-66.

Table 5. Panting scores (percent not panting) during days 16 to 22 for Experiment 2[1].

Period	CONTL	K_2CO_3	SOYBN	SOYK2	SEM	K	*P*-value SOY	K*SOY
Cool	76.6^{a}	96.7^{b}	74.4^{a}	82.6^{ab}	0.80	0.05	0.82	0.09
Hot	12.2	10.4	14.6	16.8	2.06	0.50	0.37	0.73

[1]Panting scores were compared by transforming lsmeans and SEM with (sin x)2. Cool = days 16 to 18 and Hot = days 19 to 22.
[ab]Means within a row with unlike superscripts differ (*P* < 0.05).

Table 6. Tympanic temperatures (°F) during days 16 to 22 for Experiment 2[1].

Period	CONTL	KHCO3	SOYK2	SOYKH	SEM	Trt	Time	Trt*Time
Cool	102.1	102.1	102.2	101.9	0.18	0.43	<.0001	0.92
Hot	102.8	102.1	102.5	102.2	0.29	0.20	<.0001	<.0001
Overall	102.5	102.1	102.4	102.0	0.24	0.25	<.0001	.0005

[1]Cool = days 16 to 18 and Hot = days 19 to 22.

Experiment 2

One hundred sixty-eight crossbred, previously vaccinated (Vision 7 and Titanium 5 PHM Bac 1) and implanted (Ralgro®) steers were reimplanted (Revalor-S), weighed on two consecutive days, and allotted to one of 24 pens. Three replicates were randomly assigned to four treatments (Table 2): 1) a control diet (CONTL), 2) a diet containing 2.25% $KHCO_3$, 3) a diet containing 5% whole soybeans and 1.5% K_2CO_3 (SOYK2), and 4) a diet containing 5% whole soybeans and 2.25% $KHCO_3$ (SOYKH).

Dry matter and DWI were recorded daily. Additional body weights were obtained on day 38 and the day before harvest (day 83). At slaughter, hot carcass weight, yield grade, and marbling score were recorded. On days 16-22, TT were recorded at 1-hour intervals in three heifers per pen in one replicate using a Stowaway XTI® data logger (Onset Corporation, Pocasset, Mass) and thermistor. This interval contained three cool days (Cool = day 16 to 18) and four hot days (Hot = days 19 to 22). During this period, the percentage of cattle panting at 1500 hours was also recorded. Treatment comparisons of DMI and DWI were also made.

Performance data were analyzed similar to Experiment 1. Tympanic temperatures were analyzed using a repeated measures model that included diet treatment, time of day, and the interaction of diet treatment by day. The specified term for the repeated statement was animal.

Results

For Experiment 1, periods of heat stress were found on days 21 to 25 and 62 to 66 in which daily average THI [THI = ambient temperature – (0.55 – (0.55 x (relative humidity/100))) x ambient temperature – 58)] approached or exceeded 74. The THI during these days peaked around 80, which is considered a danger category based on the Livestock Safety Index.

Cattle provided K_2CO_3 diets had significantly lower gain and feed intake than CONTL and soybean only supplemented cattle (Table 3). These cattle also tended to have poorer F:G and lower DWI, which may be a result of lower DMI. Actual dressing percentage also tended to be lower in K supplemented cattle.

A K by soybean interaction ($P = 0.08$) during the first hot and the cool periods, suggests that supplementing cattle with soybeans alone enhanced DMI while supplementing with a combination of soybeans and K depressed DMI (Table 4). However, in the second hot period, both soybean treatments suppressed DMI. Potassium supplementation also suppressed DWI in both hot periods. Thus, DMI/DWI tended to be greater for the K supplemented cattle. No differences were found among treatments for TT, which happened to be obtained during the cool period.

In Experiment 2, the hot period was similar in THI to those found in Experiment 1. However, for the entire experiment, the THI was over three units lower than in Experiment 1. Performance differences among treatments were not found (data not shown). During the cool period, soybean and K supplemented groups had lower DMI than CONTL (data not shown). Water intake and DMI/DWI were not affected during any period; although DMI/DWI followed the same trend as was found in Experiment 1 with the SOYK2 treatment having the lowest ratio when compared among all treatments including the control group.

In Experiment 2, treatment differences occurred during the cool period for the percentage of cattle not panting. Cattle supplemented with $KHCO_3$ had the greatest number of cattle not panting when compared with CONTL and the SOYK2 treatments (Table 5). In addition, no treatment differences were observed in TT during the period temperatures were obtained (Table 6). However, treatment by time interactions were found for TT. In general, during the hottest portion of the day all supplemented groups had lower or tended to have lower TT than control cattle groups.

In general, feeding K_2CO_3 decreased ADG and tended to lower DWI, possibly by decreasing DMI, especially when fed with soybeans. Supplementing $KHCO_3$ by itself or with soybeans decreased TT, when compared to control cattle.

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