

Impacts of form of salt-limited supplement on supplement intake behavior and performance with yearling heifers grazing dryland pastures

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INTRODUCTION

One of the greatest nutritional challenges that western beef producers face is the need for supplemental inputs, especially in arid and high elevation rangelands where seasonal deficiencies of nutrients are frequent (DelCurto et al., 2000). Producers who are dependent on forage resources as a main source for feed must develop strategies that maximize forage use while minimizing supplemental inputs to reduce costs and maintain acceptable levels of beef cattle production (DelCurto et al., 2000). To offset seasonal deficiencies in nutrients, self-fed salt-limited supplements are used to increase forage intake and improve animal performance (McCollum and Horn, 1990; Bowman and Sowell, 1997; Bodine et al., 2001). Self-fed supplements often use salt as a mechanism to limit intake thus reducing the potential of animals over consuming supplements and as a result, substituting or reducing low-quality forage intake. However, studies evaluating the effectiveness of salt as a supplement intake-limiter are minimal and have shown conflicting results.

Salt has been reported as an effective supplement intake-limiter (Riggs et al., 1953; Beeson et al., 1957; Schauer et al., 2004), however, cows consuming a self-fed cottonseed supplement with

approximately 25% salt had increased supplement intake compared with cows consuming soybean pellets or cottonseed cake containing no added salt (Pickett and Smith, 1949). In addition, supplements containing salt as an intake-limiter have been shown to have either no effect or increased forage intake and performance compared to other supplement intake limiters (Chicco et al., 1971; Harvey et al., 1986; Schauer et al., 2004). However, recent research has found that self-fed supplements containing salt as an intake-limiter can have high amounts of variation in supplement intake between animals as well as days (Williams et al., 2018; Wyffels et al., 2018), which may result in negative effects on animal performance (Harvey et al., 1986; Bowman and Sowell, 1997).

It has been proposed that supplement form (pelleting vs. loose) can mediate the effectiveness of using salt as an intake-limiter (Hentges et al., 1967; Kunkle et al., 2000), however, this observation is not readily available in science-based literature. Therefore, the objectives of this study were 1) to evaluate the effects of salt as an intake-limiter on supplement intake behavior and animal performance; and 2) evaluate the difference between a loose and pelleted form of a salt-limited protein supplement. We hypothesize that supplemented cattle will perform better than non-supplemented cattle and that the pelleted form of supplement will have a masking effect of salt, resulting in increased supplement intake.

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MATERIALS AND METHODS

Experimental procedures described herein were approved by the Agriculture Animal Care and Use Committees of Montana State University (no. 2017-AA09). All animals used in this study were provided by the Montana Agricultural Experiment Station. This study was conducted at the Bozeman Agriculture Research and Teaching (BART) farm at Montana State University in Bozeman, Montana. The average precipitation is 46.9 cm with snow representing 59.3%. The average temperature is 9.74 °C with 113 total growing season days.

This study was conducted with Angus crossbred heifers (14 mo of age; year 1, BW = 449 kg; year 2, BW = 328 kg) grazing a 93 ha pasture during 2 yr ($n = 57$ heifers in year 1, $n = 58$ heifers in year 2) from June 23, 2017 to September 15, 2017 and June 5, 2018 to August 27, 2018. Heifers were stratified by BW and BCS and, within stratum, randomly allotted to one of three supplement treatments: 1) a control without a salt-limited supplement; 2) a 25 % salt-limited supplement in pelleted form ad libitum; and 3) a 25% salt-limited supplement in loose form ad libitum. The pelleted and loose forms of the supplement were isonitrogenous and formulated to meet the needs of yearling cattle on summer pasture (Table 1). The target

Table 1. Ingredient composition and chemical composition of supplements developed for yearling heifers grazing summer pastures

Ingredient	Loose	Pelleted
	Percent	Percent
Wheat midds, STD	57.10	53.54
Salt, bulk	25.00	25.00
Soybean-Hi Pro	8.50	9.50
Calcium carbonate	5.50	5.45
Molasses, cane	—	5.00
Lots-O-Lass	2.50	—
Bentonite powder	1.00	1.00
Phos 21% dical	0.15	0.25
CHS TM-Range ¹	0.10	0.10
Bovatec 91-Dry ²	0.07	0.07
Selenium 1600	0.06	0.06
CHS PN VT-Range ¹	0.02	0.02
Chemical		
TDN	48.68	47.64
CP	14.14	14.09
ADF	6.56	6.23
NDF	21.09	19.92

ADF = acid detergent fiber; CP = crude protein; DM = dry matter; NDF = neutral detergent fiber; TDN = total digestible nutrients.

¹CHS Inc., Sioux Falls, SD.

²Bovatec by Zoetis Services LLC, Parsippany, NJ.

daily intake was 0.91 kg per heifer. Each individual heifer was considered an experimental unit. Each individual heifer was equipped with an electronic ID tag (Allflex USA, Inc., Dallas–Fort Worth, TX) attached to the exterior of the left ear for the measurement of individual supplement intake, number of visits, visit length, and intake rate using a SmartFeed Pro self-feeder system (C-Lock Inc., Rapid City, SD) which provided a total of four feeding stations. Two feeding units supplied the loose supplement and two units supplied the pelleted supplement with the control animals locked out of all four units. Weights and BCSs were collected on days 0, 42, and 84 following a 16-h shrink. Pasture production was measured by clipping a 0.25 m² plot at 10 sites on days 0, 42, and 84 (Table 2). All clipped samples composited by time period and sent to a commercial laboratory (Dairy One, Ithaca, NY) and analyzed for dry matter, crude protein, total digestible nutrients, neutral detergent fiber, and acid detergent fiber.

The effects of supplement form on daily supplement intake, time spent at the supplement feeder, and the rate of supplement intake were analyzed using an analysis of variance (ANOVA) with generalized mixed models using individual animal as a random effect. The effects of salt-limited supplement and supplement form on animal performance, and the coefficient of variation (CV) of supplement intake were analyzed using ANOVA with generalized linear models for a complete randomized design. Data were plotted and log-transformed if needed to satisfy assumptions of normality and homogeneity of variance. Statistical significance was accepted at an alpha of 0.05. All statistical analyses were performed in R (R Core Team, 2017).

RESULTS AND DISCUSSION

Influence of supplementation and form on performance variables are listed in Table 3.

Table 2. Forage quantity (kg/ha) and quality (%) of improved summer pastures grazed by yearling heifers more than 2 years in Bozeman, MT

	Production	DM	TDN	CP	NDF	ADF
Year 1						
Day 42	1,915	93.7	61	8.9	57.7	35.1
Day 84	719	93.3	59	5.3	65.2	42.1
Year 2						
Day 0	2,181	92.3	61	9.9	57.5	36.1
Day 42	1,082	94.7	57	5.8	72.1	45.4
Day 84	659	94.9	60	5.9	60.8	37.2

ADF = acid detergent fiber; CP = crude protein; DM = dry matter; NDF = neutral detergent fiber; TDN = total digestible nutrients.

Table 3. Influence of energy supplementation and form of supplement on yearling heifer performance over two summers grazing improved dryland pastures

	Treatments ¹			SEM ²	P values		
	Control	Loose	Pelleted		TRT ³	YR ⁴	TRT × YR ⁵
Initial							
Body wt, kg					0.99	<0.01	0.88
Year 1	449.0	449.0	449.0	6.23			
Year 2	330.0	324.0	329.0	6.18			
Body cond.					0.88	<0.01	0.93
Year 1	5.14	5.11	5.14	0.06			
Year 2	4.49	4.40	4.47	0.06			
0 to 42 d							
Δ Body wt, kg	45.80	43.80	42.40	1.44	0.62	0.20	0.62
Δ Body cond.					0.26	<0.01	0.85
Year 1	0.13	0.29	0.17	0.07			
Year 2	0.50	0.61	0.46	0.55			
42 to 84 d							
Δ Body wt, kg					0.84	<0.01	0.21
Year 1	23.0	24.7	23.0	2.28			
Year 2	49.1	54.0	57.1	2.22			
Δ Body cond.					0.34	0.03	0.01
Year 1	0.39	0.52	0.37	0.08			
Year 2	0.15	-0.75	0.25	0.08			
0 to 84 d							
Δ Body wt, kg					0.69	<0.01	0.42
Year 1	67.0	67.7	64.7	2.58			
Year 2	96.8	97.7	100.4	2.57			
Δ Body cond.					<0.01	0.22	<0.01
Year 1	0.53	0.79	0.54	0.07			
Year 2	0.65	0.54	0.71	0.07			

¹Treatments are 1) control, no supplement, 2) supplement in loose form, 3) supplement in pelleted form.

²SEM = Standard Error ($N = 20$).

³Treatment main effect.

⁴Year main effect.

⁵Treatment by year interaction.

Supplementation and form of supplement did not influence performance variables with yearling heifers grazing improved dryland summer pastures ($P > 0.05$). Heifers in year 2 weighed less, gained more during days 42 to 84, and displayed a greater overall weight gain and body condition change ($P < 0.01$) than heifers in year 1. The only treatment effect and treatment × year interaction was on overall body condition change, where loose had increased body condition change in year 1, but decreased body condition change in year 2 compared to pelleted and control heifers ($P < 0.01$). Supplement intake displayed a treatment × period interaction ($P < 0.01$; Table 4), although treatment did not interact with year effects ($P > 0.05$). Intake (kg/d and g/kg BW) were lowest for both treatments during 0- to 42-d period and the pelleted group consumed more supplement with the greatest magnitude of difference

observed in the 42 to 84 d period. Intake rate showed a treatment × year interaction ($P < 0.01$) with heifers fed pelleted supplements consuming the supplement at a faster rate ($P < 0.01$) and the magnitude of difference was greatest during the 42-84 d period ($P < 0.01$) and spent less time at the feeder during the 0 to 42 d period ($P < 0.01$). In contrast, intake CV was not influenced by treatment ($P = 0.21$), but displayed a period and year effect ($P = 0.03$) with higher variation in the first period (0 to 42 d) and greater variation in year 2.

IMPLICATIONS

Our results suggest that salt-limited supplements have a high degree of overall intake variation including variation between animals, over time periods and across years. Physical form modification,

Table 4. Influence of physical form of supplement, loose vs. pelleted, on supplement intake behavior of yearling cattle grazing dryland pastures

Item	Treatments ¹		SEM ²	P values				
	Loose	Pelleted		TRT ³	PD ⁴	YR ⁵	TRT × PD ⁶	TRT × YR ⁷
Intake, kg				<0.01	<0.01	0.80	<0.01	0.58
0 to 42 d	0.42	0.59	0.05					
42 to 84 d	0.93	1.35	0.05					
Intake, g/kg BW				<0.01	<0.01	<0.01	<0.01	0.93
0 to 42 d	1.16	1.53	0.14					
42 to 84 d	2.19	3.22	0.14					
Intake rate g/min				<0.01	<0.01	<0.01	0.09	<0.01
Year 1	80.4	226.6	6.90					
Year 2	79.8	137.5	7.03					
Time spent at supp.				0.12	<0.01	<0.01	0.03	0.24
0 to 42 d	10.10	7.13	0.90					
42 to 84 d	14.87	14.14	0.90					
Intake, CV				0.21	0.03	0.03	0.28	0.56
0 to 42 d	137.4	99.9	13.41					
42 to 84 d	95.2	87.2	13.53					

¹Treatments are 1) control, no supplement, 2) supplement in loose form, 3) supplement in pelleted form.

²SEM = Standard error ($N = 20$).

³Treatment main effect.

⁴Period main effect.

⁵Year main effect.

⁶Treatment × period interaction.

⁷Treatment × year interaction.

such as pelleting, could have a masking effect as indicated by the higher intake and intake rate of supplement. Variation in supplement intake, however, was not influenced by pelleting of the supplement. This research will contribute to the continued efforts to refine strategic supplementation practices that provide the right amount of nutrients, to the target animals, at the right time.

Conflict of interest statement. None declared.

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