Utilizing an Electronic Feeder to Measure Mineral Intake, Feeding Behavior and Growth Performance of Cow-calf Pairs Grazing Native Range

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Individual animal mineral supplement intake measurements allow specific animal responses to be evaluated. Current supplementation practices do not allow measurement of individual animal mineral intake; as a result, mineral intake is reported on a group basis. The objective of this study was to evaluate an electronic feeder to monitor individual animal mineral intake and feeding behavior, and their relationship with growth performance and concentrations of mineral in the liver. The results indicate that mineral intake by grazing cattle is variable and mineral intake corroborated with concentrations in the liver.

Summary

Crossbred Angus cow-calf pairs (n = 28 pairs) at the Central Grasslands Research Extension Center (Streeter, N.D.) were used to evaluate an electronic feeder to monitor mineral intake and feeding behavior, and their relationship with growth performance and concentrations of mineral in the liver. Cows and calves were fitted with radio frequency identification (RFID) ear tags that allowed access to an electronic feeder (SmartFeed system; C-Lock Inc., Rapid City, S.D,) containing mineral (Purina Wind and Rain Storm, Land O'Lakes Inc., Arden Hills, Minn.).

Mineral intake, number of visits, time of visits and duration at the feeder were recorded for a 95-day monitoring period while pairs were grazing native range. Liver biopsies were conducted on cows on the final day of monitoring and analyzed for mineral concentrations.

Data were analyzed in SAS, with mineral intake and feeding behavior compared among cows and calves with the GLM procedure, correlations calculated among cow feeding behavior, calf intake and growth performance analyzed with the CORR procedure, and a comparison of liver mineral concentrations among cows of HIGH (greater than 90 grams per day [g/d]) and LOW (less than 90 g/d) mineral intake made with the GLM procedure.

Mineral intake was greater ($P < 0.01$) in cows (81.1 ± 8.2 g/d) than in calves (44.2 ± 8.6 g/d), but both classes of cattle attended the mineral feeders a similar ($P = 0.71$) proportion of the days during the experiment (overall mean of only 20 percent, or once every five days). Interestingly, the daily mineral feeding recommendation (113.4 g) was exceeded by calves on days they visited the feeders (222.3 ± 27.3 g), and calves had lower ($P < 0.01$) intake on mineral feeding days compared with cows (356.2 ± 26.2 g).

During the grazing period, calves gained 1.17 ± 0.02 kilograms per day (kg/d), whereas cows lost 0.35± 0.02 kg/d, but cow mineral intake and feeding behavior were not correlated ($P \geq 0.12$) with calf intake, feeding behavior or average daily gain (ADG).

Cows with HIGH mineral intake had greater ($P < 0.01$) concentrations of selenium (Se) (2.92 vs. 2.41 micrograms per gram [ug/g]), copper (Cu) (247.04 vs. 115.57 ug/g) and cobalt (Co) (0.506 vs. 0.266 ug/g), compared with LOW mineral intake cows, but liver concentrations of iron (Fe), zinc (Zn), molybdenum (Mo) and manganese (Mn) did not differ ($P \geq 0.22$).

We were able to monitor mineral intake and feeding behavior successfully with the electronic feeder evaluated, and the divergence in mineral intake observed with the feeder was corroborated by concentrations of mineral in the liver.

Introduction

Diet alone does not supply sufficient amounts of minerals; therefore, supplementation is necessary to optimize animal health and performance (NASEM, 2016). Supplementation of cattle grazing poor-quality range vegetation will improve forage utilization and animal performance (Köster et al., 1996 Caton and Dhuyvetter, 1997).

For effective supplementation, animals must consume the target amount of mineral to ensure desired mineral intake. Research clearly has documented that intakes of minerals are variable among animals, with some cattle overconsuming or under consuming supplements (Greene, 2000).

Mineral intakes will vary depending on the season of the year, individual animal requirements, animal preference, availability of fresh minerals, mineral palatability, physical form of minerals, salt content of water, mineral delivery method, soil fertility and forage type, forage availability and animal social interactions (Bowman and Sowell, 1997; McDowell, 2003). Individual animal mineral supplement intake measurements allow specific animal responses to be evaluated.

Current supplementation practices do not allow measurement of individual animal mineral intake; as a result, mineral intake is reported on a group basis. Furthermore, the use of electronic monitoring systems in the beef industry has been limited and primarily has been used in research settings to examine the effects on feed intake in relation to cattle growth performance (Islas et al., 2014), health status (Wolfger et al., 2015) or animal movement in extensive pasture settings (Schauer et al., 2005).

These technologies could be adapted easily for use in beef cattle production systems to monitor activity, feeding or drinking behavior, or as tools for monitoring inventories in intensive or extensive production systems. Therefore, our objective was to evaluate an electronic feeder to monitor individual animal mineral intake and feeding behavior, and their relationship with growth performance and concentrations of mineral in liver.

Procedures

All animal procedures were conducted in accordance to the rules of the Institutional Animal Care and Use Committee at North Dakota State University.

Electronic Feeder Device

The SmartFeed system used to deliver mineral supplement and measure intake was developed by C-Lock Inc. (Rapid City, S.D.). SmartFeed is a portable, self-contained feeding device. It features a stainless steel feed bin suspended on two load cells, a radio frequency identification (RFID) tag reader and antenna, an adjustable framework to allow access to one animal at a time, and a data acquisition system that records RFID tags and feed bin weights at 1 hertz (Reuter et al., 2017).

The SmartFeed must be placed on level ground and firmly anchored because the animals will move it if possible. Previous research with the system developed algorithms to process the raw data signals from SmartFeed to account for rapid animal exchanges at the feeder and noise in the weight signal that results from animals pushing on the feed bin (Reuter et al., 2017).

The current feeder was fastened securely to the fence line to ensure that the animals would not push the feeder around in the pasture. The feeder was covered with a plywood shell to protect the feed bin and equipment from wind and rain. Mineral was monitored visually and through the online portal, where intake and monitoring of the device can be done remotely.

Animal Measurements

Crossbred Angus cow-calf pairs (n = 28) at the Central Grasslands Research Extension Center (Streeter, N.D.) were used to evaluate an electronic feeder to monitor mineral intake and feeding behavior, and their relationship with growth performance and concentrations of mineral in liver. Initial two-day body weights and body condition scores were collected prior to cattle being released onto pasture.

Cow-calf pairs were weighed every 28 days during the course of the grazing season. Final two-day body weights and body condition scores were collected on pasture prior to weaning.

Cows and calves were fitted with RFID ear tags that allowed access to the SmartFeed system that contained mineral (Purina Wind and Rain Storm, Land O'Lakes Inc., Arden Hills, Minn.). Mineral intake, number of visits, time of visits and duration at the feeder were recorded during a 95-day monitoring period while pairs were grazing native range.

Samples of liver were collected on the final day of monitoring via biopsy from a subset of cows with the greatest and least attendance at the mineral feeder throughout the grazing period.

Liver biopsy sites were clipped of hair, scrubbed twice with betadine and cleaned with gauze between scrubbings. Then we applied alcohol to the area, and the area was wiped with gauze until the gauze was clean after wiping. We then applied a final coating of alcohol and allowed it to air-dry.

Following that, we administered local anesthetic at the target biopsy site. After applying the anesthetic, we sprayed alcohol on the area and allowed it to air-dry.

We obtained a liver biopsy on the right side of the animal through an incision made between the 10th and 11th intercostal space at an intersection with a line drawn horizontally from the greater trochanter. We took a core sample of liver via Tru-Cut biopsy trochar (14 g; Becton Dickenson Co., Franklin Lakes, N.J.).

After obtaining liver biopsies, we applied a topical antibiotic (Aluspray; Neogen Animal Safety, Lexington, Ky.) to the surgical site and administered an injectable NSAID (Banamine; Merck Animal Health, Madison, N.J.). We stored biopsy samples in vacuum tubes designed for TM analysis (potassium EDTA; Becton Dickenson, Rutherford, N.J.) at minus 20 C° until further analysis.

Liver samples were sent to the Michigan State Diagnostic Laboratory and were evaluated for concentrations of minerals. Results were used to evaluate whether mineral feeder attendance was related to liver mineral content.

Analysis

Data were analyzed in SAS (SAS Inst. Inc., Cary, N.C.), with mineral intake and feeding behavior compared among cows and calves via PROC GLM with significance at $P < 0.05$. Correlations were calculated among cow feeding behavior, and calf intake and growth performance with PROC CORR. Comparisons of liver mineral concentrations among cows of HIGH (greater than 90 g/d) and LOW (less than 90 g/d) mineral intake were analyzed with PROC GLM.

Results and Discussion

Mineral intake was greater ($P < 0.01$) in cows (81.1 ± 8.2 g/d) than in calves (44.2 ± 8.6 g/d), but both classes of cattle attended the mineral feeders a similar ($P = 0.71$) proportion of the days during the experiment (overall mean of only 20 percent, or once every five days). Mineral intakes fall within the range of 56 to 114 g/d per animal suggested by Greene (2000) as a target for free-choice mineral supplements.

Interestingly, the daily mineral feeding recommendation (113.4 g) was exceeded by calves on days they visited the feeders (222.3 ± 27.3 g/d), and calves had reduced ($P < 0.01$) intake on feeding days, compared with cows (356.2 ± 26.2 g). During the grazing period, calves gained 1.17 ± 0.02 kg/d, whereas cows lost 0.35±

0.02 kg/d, but cow mineral intake and feeding behavior were not correlated ($P \geq 0.12$) with calf intake, feeding behavior, or ADG.

Comparatively, steers that had access to a GrowSafe system supplying mineral supplement and were grazing spring-season and fall-season pastures (36 ± 2d) consumed 96.3 and 85.4 g/d of mineral, respectively (Manzano et al., 2012). These steers consumed more mineral than the cows and calves in the current study but overall still fell within the suggested target range.

Furthermore, greater intake by cows vs. calves may be due to social interactions of dominant animals that often consume large amounts of supplement and prevent other animals from consuming desired amounts (Bowman and Sowell, 1997). With the proportion of days during the experiment that cattle were consuming mineral, the location of the mineral feeder and grazing behavior may explain variation in intake during the grazing period.

Mineral feeders were located down the fence line in a corner of the pasture away from the water source. However, further observations of cattle movements would need to be determined to understand frequency of attendance at the mineral feeder.

Concentrations of mineral in liver of cows with divergent mineral intake are reported in Table 1. Cows with HIGH mineral intake had greater ($P < 0.01$) concentrations of Se (2.92 vs. 2.41 ug/g), Cu (247.04 vs. 115.57 ug/g) and Co (0.506 vs. 0.266 ug/g), compared with LOW mineral intake cows, but liver concentrations of Fe, Zn, Mo and Mn did not differ ($P \geq 0.22$).

Selenium liver concentrations for HIGH cows showed levels of high adequate classification (greater than 2.50 ug/g dry matter [DM]; Kincaid, 1999) and for LOW mineral intake cows, levels were adequate (1.25 to 2.50 ug/g DM; Kincaid, 1999).

Liver Cu concentrations are defined as adequate at 125 to 600 ug/g DM by Kincaid (1999) or normal, greater than 100 ug/g DM by Radostits et al. (2007). HIGH and LOW cows would be considered adequate to normal for liver Cu concentrations.

Liver Co levels for HIGH and LOW cows were adequate (0.10 to 0.40 ug/g DM). As defined by Kincaid (1999), liver mineral concentrations for Fe, Zn, Mo and Mn were adequate for HIGH and LOW groups.

In conclusion, we were able to monitor mineral intake and feeding behavior successfully with the electronic feeder evaluated, and the divergence in mineral intake observed with the feeder was corroborated by concentrations of mineral in the liver.

Table 1. Concentrations of mineral in liver of cows with divergent mineral intake[1] (high or low).

	Intake Category			
Item	**High**	**Low**	**SE**	**P-Value**
Se, ug/g	2.92[x]	2.41[y]	0.10	0.0027
Fe, ug/g	202.31	220.0	21.90	0.5757
Cu, ug/g	247.04[x]	115.57[y]	21.57	0.0005
Zn, ug/g	110.70	118.68	16.51	0.7371
Mo, ug/g	3.98	3.75	0.29	0.5948
Mn, ug/g	9.74	8.84	0.497	0.2168
Co, ug/g	0.506[x]	0.266[y]	0.045	0.0018

[x,y]Means within row lacking common superscript differ significantly.
[1]Divergent mineral intake classified cows as HIGH (greater than 90 g/d) or LOW (less than 90 g/d) mineral intake.

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