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MINERAL AND VITAMIN STATUS OF STEERS UNDER VARIOUS MANAGEMENT PRACTICES IN EASTERN OREGON AS DETERMINED BY HEPATIC, PLASMA AND HAIR SAMPLES[1]

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Summary

Objectives of this study were to monitor mineral status of range steers throughout a complete year by determining mineral content in liver biopsies, both pigmented and white hair, and in blood plasma; and used these criteria to test the effectiveness of feeding mineralized salt. Samples were taken, starting shortly after weaning and at 5 times during the year, which represented major feed changes, from 44 steers at 2 locations. Half of the steers at each location received a commercial trace mineral salt mix with bonemeal and at 1 location .0025% Se added to the mix and half received plain iodized salt. Weights were taken at each sampling time, forage samples were analyzed for mineral content throughout the year and intake of the mineral mixes recorded. Weight gains at 1 location for the year were 157±5.8 and 167±3.3 kg for the control group and mineralized salt group (P>.05), respectively, and 225±4.6 and 240±9.8 kg at the other (P>.05). However, the mineralized salt plus Se did provide higher gains (P<.01) during the winter on the latter group. Marginal to deficient conditions existed for Cu, Zn, Co, Se, and P at various times at one or both of the locations. The mineral mixes alleviated the deficiency for Se, Co and at times Zn, but was not effective for Cu or P. There was little correlation between mineral content of hair samples and levels in the liver or plasma. Mineral content of the plasma was not always reflective of that in the liver. Data also shows that sampling at a single time may lead to erroneous conclusions.

Introduction

Animal performance can be affected by the levels of trace elements in their diet. However, without the onset of symptoms of acute deficiency, it is difficult to establish the nutritional status with respect to these components, particularly with the complex interactions that exist. Ultimately tissue levels have to be correlated with dietary intake and performance. Many beef producers in eastern Oregon routinely provide trace mineral supplements on the assumption some deficiencies exist.

Copper (Cu) deficiency is suggested from various studies, based on plasma and hepatic levels in cattle from different areas in Oregon (Dent et al., 1956; Adams and Haag, 1957; Raleigh and Wallace, 1962) and the Cu and molybdenum (Mo) levels in feeds (Dent et al., 1956; Kubota et al., 1967). Kubota and Allaway (1972) classified western Oregon as deficient and eastern Oregon as "variable" regarding the selenium (Se) level of forages. Marginal zinc (Zn) deficiencies are considered a possibility in Oregon (Mayland, 1977). Kubota (1968) classified the Western United States as an area adequate in cobalt (Co).

The objectives of this study were to monitor mineral status of range steers on a year-round basis via mineral content in liver biopsies, both pigmented and white hair, and blood plasma as indicators of mineral status and needs; and to test the effectiveness of feeding trace mineralized salt.

Materials and Methods

The investigation was conducted at 2 locations, 1 in northeastern Oregon at Union and 1 in southeastern Oregon at Burns. Management practices and mineral needs are quite different between the 2 regions.

Twenty-two Hereford X Angus and 22 Hereford X Simmental steers were selected at weaning from experimental herds at Burns and Union, respectively. These groups were stratified by weight into 2 groups at each location and randomly assigned to receive plain salt or a trace mineralized salt and bonemeal at Burns and bonemeal plus Se at Union (table 1). Salt supplements were fed on a free choice basis.

Samples and shrunk weights were taken 5 times throughout the year at each location. Steers were weaned and weighed at Burns September 11, 1985, with samples taken on September 19. Subsequent weights and samples were taken on October 29, 1985, May 15, 1986, July 19, 1986, and October 9, 1986. The September 19 sample period represents the period up to and shortly following weaning; with the October 29 sample following flood meadow aftermath; May 15, meadow hay through the winter; July 19, high quality crested wheatgrass; and October 9, mature crested wheatgrass. Steers were weaned and weighed at Union September 18, 1985, with samples taken on September 25. Additional weights and samples were taken on November 23, 1985, April 7, 1986, June 26, 1986, and September 17, 1986. The September 25 sample period represents the period up to and shortly following weaning; with the November 23 sample following fescue pasture most of the period, and rain damaged second cutting alfalfa the last 15 days; April 7, rain damaged second cutting alfalfa through the winter; June 26, fescue pastures for the first half; and high quality forested range the latter half; and September 17, mature forested range.

Liver samples were collected by the technique of Bone (1954) through an incision between the eleventh and twelfth ribs about 25 to 30 cm ventrolateral to the junction of the spine and ribs. Hair samples were taken from both pigmented (at the biopsy site) and nonpigmented sites (neck, cheeks and on the forehead when that was the only white hair available). Coarse hair was shaved off to about .65 cm or less with the sample taken from the remaining hair close to the hide. Plasma samples were also obtained. Feed samples were collected on a monthly basis or when new pastures were utilized throughout the experimental period.

A Jarrell-Ash atomic absorption spectrophotometer was used to measure Cu and Zn concentrations on

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diluted plasma samples and in the feed and livers after acid digestion. The Co levels in the feed and liver, Mo levels in feed, liver and plasma and manganese (Mn) in feed, liver and plasma were determined on a Perkin Elmer 30-30 with a Zeeman background corrector after acid digestion. A mixture of nitric and perchoric acids were used for all acid digestions. Selenium in the feed and tissues were done according to a fluorometric (Watkinson, 1966). The method of Chow and Omaye (1983) was used to determine vitamin E levels in plasma. A bovine liver reference standard (NBS) was used in all analyses.

Results and Discussion

Daily gains are presented in table 2. There was a slight positive response to trace mineralized salt but was only significant for the winter period at Union. Based on past history, this was probably a response to the Se addition.

Intake of minerals from the mineral supplements and requirements based on body weight for steers at Union and Burns are presented in tables 3 and 4. The heavier Union steers consumed less supplement, therefore a smaller percentage of their mineral requirements were supplied by the supplement. Half or more of the requirement for Cu, Zn, Mn and Co was supplied by the supplement in Burns and for Se, Zn and Co at Union. Only small fractions of magnesium (Mg) or phosphorus (P) requirements were provided by the supplement at both locations. Mineral composition of the forages consumed is presented in table 5.

Vitamin E levels in the plasma (table 6) varied considerably throughout the year and between locations and ranged from 1.4 to 11.5 μg/ml. In contrast, vitamin A levels did not significantly fluctuate throughout the year and ranged from .8 to 1.2 γg/ml (not shown).

Mineral concentration of pigmented and white hair are presented in table 7. It does not appear that the use of hair mineral content as an indication of mineral status is feasible. The mineral content is affected by season, breed, hair color within and between breeds, age and body location. Hair Se levels did give a rough estimate of Se status. The disadvantage connected with hair samples though of thoroughly washing, foreign contamination, location on animal, etc., would appear to outweigh the use of hair in lieu of blood Se to assess Se status.

Hepatic and plasma mineral levels in steers at Burns and Union throughout the year are presented in table 8. Marginal to deficient conditions existed for Cu at all sample periods at Union and sampling periods 3, 4, and 5 at Burns. The mineralized salt did not significantly alleviate the Cu problem. Zinc levels were deficient following weaning at Burns and following the winter period at Union, with the supplement providing little relief. Selenium levels were adequate at Burns and deficient at Union throughout the year. The inclusion of 25 ppm of Se in the salt mix alleviated the deficiency at Union. Cobalt was borderline to deficient at Burns during the winter, with the mineralized salt providing adequate Co to correct the deficiency. Phosphorus levels were adequate throughout at both locations with the exception of the summer period at Union. Bonemeal at the rate of 12.5% of the salt-mineral mix did not significantly elevate P plasma levels.

In conclusion, hair does not appear to be a reliable indicator of mineral status or needs and mineral content of the plasma was not always reflective of that in the liver. Data also indicate sampling at a single time may lead to erroneous conclusions.

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TABLE 1. MINERAL COMPOSITION OF TRACE MINERALIZED (TM) LOOSE SALT SUPPLEMENTS USED AT UNION AND BURNS.

Mineral	1[a]	2[b]
	%	%
Manganese	.180	.160
Iron	.200	.210
Magnesium	.037	.350
Cobalt	.006	.011
Copper	.035	.030
Iodine	.010	.011
Zinc	.350	.350
Sodium Chloride	97-99	97-99

[a]Used at Burns for the duration of the trial and fed in a two compartment box with half containing TM salt and other half 50% TM salt and 50% bonemeal. Used at Union until August 1 with .0025% Se and 12.5% bonemeal.

[b]Used at Union from August 1 to September 17 with .0025% Se and 12.5% bonemeal.

TABLE 2. AVERAGE DAILY GAIN (kg/day) OF STEERS DURING THE DIFFERENT SEASONS AT BURNS AND UNION.

	Union			Burns		
Season	Days	Salt	TM[a]	Days	Salt	TM[a]
Fall	63	.39	.45	48	.42	.43
Winter[b]	138	.35	.47	198	.52	.58
Spring	80	.91	.91	61	.96	.75
Summer	83	.95	.89	86	-.29	-.15
Overall	364	.62	.66	393	.40	.42

[a]Trace mineralized salt.

[b]Winter gains at Union were different ($P<.05$).

TABLE 3. BODY WEIGHTS OF STEERS AND ESTIMATED DAILY DIETARY MINERAL REQUIREMENTS OF THE STEERS AT UNION AND AMOUNTS SUPPLIED BY THE TRACE MINERALIZED SUPPLEMENT PER DAY DURING THE DIFFERENT SEASONS OF THE TRIAL.

Season	Body weight end of season	Intake[a] of roughage	Copper: Required[b] in diet	Copper: Supplied by TM	Selenium: Required[b] in diet	Selenium: Supplied by TM	Zinc: Required[b] in diet	Zinc: Supplied by TM	Cobalt: Required[b] in diet	Cobalt: Supplied by TM	Manganese: Required[b] in diet	Manganese: Supplied by TM
	kg	kg	mg	mg	mg	mg	mg	mg	mg	mg	mg	mg
Fall	263	5.3	42	12.4	1.06	.88	159	124	.53	2.1	212	64
Winter	328	6.6	53	11.2	1.32	.80	198	112	.66	1.9	264	57
Spring	401	8.0	64	15.6	1.60	1.12	240	156	.80	2.7	320	80
Summer	474	9.5	76	11.2	1.90	.80	285	112	.95	2.6	380	68

[a]Estimated as 2% body weight

[b]NRC, 1984 - Cu, 8 mg/kg; Se, .2 mg/kg; Zn, 30 mg/kg; Co, .1 mg/kg; Mn, 40 mg/kg.

TABLE 4. BODY WEIGHTS OF STEERS AND ESTIMATED DIETARY MINERAL REQUIREMENTS OF THE STEERS AT BURNS AND AMOUNTS SUPPLIED BY THE TRACE MINERALIZED SUPPLEMENT PER DAY DURING THE DIFFERENT SEASONS OF THE TRIAL.

Season	Body weight end of season	Intake[a] of roughage	Copper: Required[b] in diet	Copper: Supplied by TM	Zinc: Required[b] in diet	Zinc: Supplied by TM	Cobalt: Required[b] in diet	Cobalt: Supplied by TM	Manganese: Required[b] in diet	Manganese: Supplied by TM
	kg	kg	mg	mg	mg	mg	mg	mg	mg	mg
Fall	194	3.9	31	19.6	117	196	.39	3.4	156	101
Winter	308	5.9	47	19.6	177	196	.59	3.4	236	101
Spring	354	7.1	57	29.1	213	291	.71	5.0	284	149
Summer	341	6.8	54	29.1	204	291	.68	5.0	272	149

[a]Estimated as 2% body weight, except for actual measured intake of hay during winter.

[b]NRC, 1984 - Cu, 8 mg/kg; Zn, 30 mg/kg; Co, .1 mg/kg; Mn, 40 mg/kg.

TABLE 5. MINERAL COMPOSITION OF FORAGES CONSUMED BY STEERS AT UNION AND BURNS (mg/kg OF DRY MATTER).

Season	Union: Cu	Union: Mo	Union: Se	Union: Zn	Union: Co	Union: Mn	Burns: Cu	Burns: Mo	Burns: Se	Burns: Zn	Burns: Co	Burns: Mn
Fall	2.7	-	.01	14.1	.07	43	3.2	1.6	.21	28.3	.04	68
Winter	9.5	9.6	.03	18.2	.28	-	3.5	2.3	.22	26.7	.08	53
Spring[a]	5.7	-	.02	18.8	-	-	4.5	-	.02	19.1	-	-
							2.7	-	.02	13.9	-	-
Summer[a]	5.2	-	.02	23.6	-	-	1.2	-	.01	12.0	.09	21
	2.6	-		23.4	.10	61	1.1	6.9	.02	11.8	.17	31
	1.9	3.7	.03	21.3	.07	92	.9	5.1	.02	1.9	.24	40
	1.5	4.6	.02	27.0	.14	64	1.2	5.3	.01	1.3	.18	32

[a]Represents samples taken periodically throughout the grazing season, with early dates listed first.

TABLE 6. PLASMA LEVELS OF VITAMIN E OF STEERS AT UNION AND BURNS AT DIFFERENT STAGES OF THE TRIAL.

	Vitamin E (µg/ml)			
	Union		Burns	
Stages	Salt	TM[a]	Salt	TM[a]
Weaning	7.9	8.3	7.5	7.1
Fall	3.8	3.8	4.2	4.8
Winter	1.8	1.4	5.3	5.8
Spring	8.7	8.8	11.5	10.2
Summer	7.7	8.4	5.1	5.4

[a]Trace mineralized supplement

TABLE 7. AVERAGE MINERAL CONCENTRATION OF HAIR (COLORED VS WHITE).

		Union			Burns		
Treatments:hair		Cu	Zn	Se	Cu	Zn	Se
Salt:	colored	4.9	127	.21	4.9	142	.60
	white	6.0	150	.18	6.3	150	.41
TM[a]:	colored	5.4	135	.39	5.3	140	.50
	white	6.5	148	.30	6.7	157	.32

[a]Trace mineralized salt.

TABLE 8. HEPATIC AND PLASMA MINERAL LEVELS IN STEERS AT BURNS AND UNION FOR IODIZED SALT (S) AND TRACE MINERALIZED SUPPLEMENT (TM)[a]

	Cu				Zn				Se				Mo				Co		P	
Sample Period	Liver S	Liver TM	Plasma S	Plasma TM	Liver S	Liver TM	Plasma S	Plasma TM	Liver S	Liver TM	Plasma S	Plasma TM	Liver S	Liver TM	Plasma S	Plasma TM	Liver S	Liver TM	Plasma S	Plasma TM
Burns	µg/g		µg/ml		µg/g		µg/ml		µg/g		µg/ml		µg/g		µg/ml		ng/g		mg/1	
1	49	39	.71	.70	116	116	1.10	.90	.50	.50	.03	.04	3.2	3.6	–	–	290	270	5.0	6.1
2	34	46	.74	.75	81	81	.61	.61	1.12	.74	.08	.07	3.1	4.1	–	–	80	250	6.2	5.4
3	8	11	.43	.57	76	74	1.35	.90	1.47	1.60	.08	.08	2.5	2.6	–	–	55	550	–	–
4	7	7	.47	.62	81	90	.88	1.05	.45	.51	.03	.03	4.9	4.9	–	–	150	260	6.9	7.4
5	15	20	.70	.72	95	95	.87	.76	.40	.41	.03	.03	4.2	6.1	–	–	430	380	5.6	6.0
Union																				
1	19	12	.63	.66	117	113	.90	.89	.51	.51	.02	.02	4.8	5.1	.46	.70	155	155	5.6	5.0
2	11	12	.43	.53	99	91	.80	.89	.22	.73	.02	.06	7.1	6.4	.57	.57	130	180	7.0	6.1
3	41	59	.44	.52	79	86	.60	.74	.26	1.08	.02	.06	11.5	10.0	1.60	1.25	230	245	7.8	8.7
4	11	17	.51	.62	88	82	.90	.91	.22	1.10	.02	.06	4.9	4.9	.22	.20	165	200	6.5	6.3
5	26	34	.71	.72	85	84	.89	.88	.27	.92	.02	.08	4.1	6.1	.21	.15	180	205	4.3	4.7

[a] Deficient levels for plasma Cu .59 µg/ml and 25 µg/g for liver
plasma Zn .80 µg/ml and 60 µg/g for liver
plasma Se .03 µg/ml and .25 µg/g for liver
plasma P 4.5 mg/1
plasma Co 60 ng/g