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Abstract

A National Forage Survey was conducted in 18 states to determine the trace mineral and related nutrient content of forages grown in the United States. Most forages sampled were harvested hays utilized as winter feed for beef cow herds. The trace element most commonly deficient in the forages sampled was zinc. Copper and cobalt levels were adequate in 36 and 34.1% of the samples, respectively. In contrast, manganese was adequate (above 40 ppm) in 76% of the samples and was deficient (below 20 ppm) only in 4.7%. The copper antagonists, such as iron and molybdenum, were marginal to high in 28.7% and 57.8% of the samples, respectively, indicating that both of these elements are often present in levels that can cause a reduction in copper availability. Of the 352 samples collected in 18 states, the trace mineral most likely to be deficient was zinc, followed by selenium and cobalt.

Keywords

Cattlemen's Day, 1996; Kansas Agricultural Experiment Station contribution; no. 96-334-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 756; Beef; Trace minerals; Forage survey; Forages

NATIONAL FORAGE SURVEY RESULTS: TRACE MINERAL AND RELATED NUTRIENT LEVELS

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Summary

A National Forage Survey was conducted in 18 states to determine the trace mineral and related nutrient content of forages grown in the United States. Most forages sampled were harvested hays utilized as winter feed for beef cow herds. The trace element most commonly deficient in the forages sampled was zinc. Copper and cobalt levels were adequate in 36 and 34.1% of the samples, respectively. In contrast, manganese was adequate (above 40 ppm) in 76% of the samples and was deficient (below 20 ppm) only in 4.7%. The copper antagonists, such as iron and molybdenum, were marginal to high in 28.7% and 57.8% of the samples, respectively, indicating that both of these elements are often present in levels that can cause a reduction in copper availability. Of the 352 samples collected in 18 states, the trace mineral most likely to be deficient was zinc, followed by selenium and cobalt.

(Key Words: Trace Minerals, Forage Survey, Forages.)

Introduction

Harvested and grazed forage represents the major cost associated with cow-calf and stocker production. Although forage analysis is encouraged as a profitable management practice, only a limited number of producers traditionally utilize forage testing to determine supplementation strategies. Even fewer producers utilize trace mineral analyses of their forages.

Reported below are the results of a National Forage Survey conducted in 18 cooperating states to determine the nutrient and trace mineral profiles of various forages commonly used by cow-calf producers.

Experimental Procedures

To determine the health status and production practices used by producers, the USDA Animal and Plant Health Inspection Veterinary Services conducted a 48-state survey involving 2,539 cow-calf producers. This project, which took 16 months, profiled cow-calf health and production parameters and has been published in a series of five national reports entitled "Cow-Calf Health and Productivity Audit (CHAPA) Reports".

As a component of this national audit, 18 states were designated to participate in a National Forage Survey, as follows:

State	No. of Samples Submitted
Alabama	8
Arkansas	16
California	7
Colorado	17
Florida	4
Georgia	8
Iowa	25
Kansas	28
Kentucky	10
Mississippi	20
Missouri	23
Nebraska	47

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New Mexico	9
Oklahoma	19
Tennessee	17
Texas	45
Virginia	11
Wyoming	38
TOTAL:	352

Producers participating in the survey were offered the opportunity to have a single sample of harvested forage collected and analyzed without cost. All samples were collected by state and federal veterinary personnel and mailed to Kansas State University. All cooperating veterinary personnel were trained in proper forage sampling procedures to ensure that uniform samples were collected for analysis. Samples were collected using a standard forage probe.

Samples were dried in the Nutrition Lab at Kansas State University and then were ground and submitted to a commercial lab (Peterson Labs, Hutchinson, KS) for analysis. Samples were analyzed for crude protein (CP), acid detergent fiber (ADF), phosphorus (P), copper (Cu), cobalt (Co), iron (Fe), manganese (Mn), molybdenum (Mo), and zinc (zn).

For analytical purposes, forages were combined into nine categories as follows.

Alfalfa/Alfalfa Mix Thirty nine samples were coded as alfalfa and 25 were classified as alfalfa mix, predominantly grass-alfalfa combinations.

Brome Eight samples were clearly designated as brome.

Bermuda Of 36 samples designated as bermuda, one was a bermuda grass/orchard grass mix.

Fescue/Fescue Mix This category included 16 samples designated as fescue and 10 as fescue-clover combinations.

Sudan/Sudan Sorghum This classification included sorghum silage, forage sorghums, baled sorghams, sorghum forage, and straight sorghums and sudans.

Cereal Forages The designatio n included 17 samples of wheat, oats, and barley.

Grass The grass category included 139 samples considered native or local for the respective state and may have included brome mixes, timothy, mixed grasses, and other grass-hay combinations.

Silage The nine samples classified as silage were coded predominantly corn silage. (Three sorghum silage samples were included in the sudan/sudan sorghum category.

Other This group included 26 forages not fitting into other categories and is not discussed in the report.

Results and Discussion

The means of nutrient and trace mineral analyses are shown in Table 1. To help interpret the trace mineral values, Table 2 indicates the amounts of the trace elements needed to meet dietary needs. In the case of antagonistic trace elements, such as iron and molybdenum, amounts that would lead to problems with copper are shown.

Copper. In the national samples, 36% were classified as having adequate levels of copper, with 14.2% being deficient (below 4 ppm; Table 3). For most of the forage samples collected, the mean values for copper fell in the range of 5-8 ppm. This is usually adequate if high levels of antagonists, such as iron and molybdenum in the forage or sulfur in the water, are not present to cause a copper "tie-up".

Of concern was the fact that 28.7% of the forage samples contained levels of iron that could be antagonistic to a copper. Of even greater concern was the fact that 57.8% of the samples contained molybdenum le vels that were high enough to tie up copper.

Zinc. This was the most commonly deficient trace element. Only 2.5% of the samples contained adequate zinc (at least 40 ppm), and

63.4% of the samples were classified as deficient (below 20 ppm zinc).

Cobalt. On a national basis, 34.1% of the samples contained adequate cobalt, whereas 48.6% were classified as deficient. However, part of this high deficiency level may reflect limitations in the laboratory procedures. The small levels of cobalt (commonly less than .2 ppm) in most forage samples a re near the detection limits of practical laboratory techniques.

Manganese. Of all the trace minerals analyzed, manganese was the one most commonly present in a high enough le vel to meet the dietary requirements of cattle. Because manganese is fairly poorly digested, it's important that the forage contain an adequate level. Seventy-six percent of the samples sampled nationally had an adequate level.

Selenium. On a national basis, 19.7% of the samples collected were classified adequate in selenium and 44.3% were classified as deficient. Selenium varies widely throughout the United States, often being deficient in certain areas and in excess in others. Even more of a problem is the fact that some st ates have regions of both deficiency and toxicity. In the National Survey, 16.7% of the sam ples were classified as having excess (>.4 ppm) selenium.

Table 1. Nutrient Profile, National Forage Survey

Forage	No.	Nutrient Analysis,[1] %				Trace Mineral Analysis, ppm						Trace Mineral Antagonist, ppm	
Type	Samples	D.M.	Protein	ADF	P	Cu	Mn	Zn	Co	Se[2]	Cu:Mo Ratio	Fe	Mo
Alfalfa/Alfalfa Mix	64	87.3	16.4	38.9	.25	7.4	51	19.1	.26	321	5.2:1	20	2.1
Brome	8	85.3	11.1	43.3	.26	5.7	67.7	13.6	.17	147	4.8:1	165.5	1.8
Bermuda	36	90.5	9.6	39.4	.21	8.5	125.2	22.4	.22	202.9	14.7:1	121.8	.9
Fescue	26	88.5	10.9	42.7	.27	6.2	122.3	17.8	.22	63.2	11.9:1	99.7	.99
Sudan and sorghum	27	81.1	7.9	43.1	.21	7.5	57	24.4	.33	216.9	8.3:1	363.7	1.4
Cereal	17	87.7	10.9	41.2	.21	5.5	69.4	15.1	.17	184.5	5.4:1	148	1.3
Grass	139	85.4	10.0	42.1	.20	6.6	111.0	19.2	.28	177.4	7.5:1	239.8	1.5
Silage	9	33.5	7.3	35.1	.22	5.3	52.1	18.3	.25	153.8	5.1:1	157.3	1.5

[1]Protein, ADF and phosphorus reported on a DM basis.

[2]Se = selenium and reported as ppb; Mn = manganese; Cu = copper; Mo = molybdenum; Co = cobalt.

Table 2. Classification of Trace Elements Relative t o Their Ability to Meet Dietary Requirements or Cause an Antagonistic Problem with Other Trace Elements

Trace Minerals	Deficient, ppm	Marginal, ppm	Adequate, ppm
Copper	below 4	4-7	7+
Manganese	below 20	20-40	above 40
Zinc	below 20	20-40	above 40
Cobalt	below .1	---	.1-.25
Selenium	below .1	.1-.15	.15-.3
Copper:Mo Ratio	below 4:1	4-4.5:1	4.5-5:1

Trace Mineral Antagonist	Ideal ppm	Levels above This Can Cause Copper Tie Ups ppm
Iron	50-200	400*
Molybdenum	below 1	above 3**

* Above this level can cause a copper tie up.
**Above 1 can cause copper tie up -- ratio of copper to molybdenum should be 4:5 or above.

Table 3. The Trace Mineral Classification for the 352 Forage Samples

					Antagonist Levels	
Trace Element	Adequate	Deficient	Marginal	High	Marginal	Very High
Copper	36%	14.2%	49.7%	---		
Manganese	76%	4.7%	19.3%	---		
Zinc	2.5%	63.4%	34.1%	---		
Cobalt	34.1%	48.6%	17.3%	---		
Selenium (n=305)	19.7%	44.3%	19.3%	16.7%		
Iron	62.8%	8.4%	---	---	17%	11.7%
Molybdenum	42.2%	---	---	---	48.6%	9.2%