Nutrient and Toxic Factors in Sweet Clover

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Research was conducted to evaluate the nutritive value of sweet clover forage and assess the incidence and range of dicoumarol levels. Average nutrition composition (100% DM) was: crude protein-15.45%, acid detergent fiber-40.46%, acid detergent lignin-7.08%, ash-8.39%, calcium-1.10%, phosphorus-0.18%, magnesium-0.40%, potassium-2.04%. Dicoumarol levels ranged from zero to 164.7 ppm, with 64.6% of the 277 samples analyzed containing less than the presently recognized toxic level of 10 ppm. Round bales were significantly (P = 0.05) higher in dicoumarol concentration, with a mean of 22.9 ppm, than stacks or silage, with mean levels of 1.8 ppm and 0.6 ppm respectively.

INTRODUCTION

The most recent estimate of sweet clover production in North Dakota was 300,000 tons produced on approximately 230,000 acres (Census of Agriculture, 1974). Associated with the feeding of improperly cured sweet clover is the possibility of sweet clover poisoning (Roderick and Schalk, 1931). The North Dakota Veterinary Diagnostic Laboratory has confirmed a yearly average of 80 animal losses to this disease over the last four years.

Sweet clover is a forage crop of significant usage in North Dakota and because of limited literature on the subject, this research was conducted to evaluate the nutritive value of sweet clover forage in a study which also assessed the incidence and range of dicourmarol levels (Benson, 1980).

EXPERIMENTAL PROCEDURE

Sweet clover samples were collected from Grand Forks, McLean, Nelson and Rolette counties, as these were areas in the state which indicated the highest incidence of sweet clover poisoning in the past.

This was a two year research project with the 1978 crop samples collected in December 1978 and January 1979 and the 1979 crop collection occurring in October and November, 1979. Forty-two cooperators were involved in 1978 and 29 in 1979.

Core samples were taken from round bales and grab samples were collected from the other methods of harvest (stacks, silage, small bales). Two hundred seventy-seven samples were assayed for dicoumarol level as measured in ppm (Casper et al., 1980).

A composite of all samples of each type (bales, stacks, silage) of sweet clover on a given farm was made for nutrient analysis. Eighty composites were assayed for crude protein, acid detergent fiber, acid detergent lignin, calcium, phosphorus, magnesium, and potassium.

Obtaining representative samples from bales as well as from farms was found to be a significant problem. A large variation of within farm levels of dicoumarol existed and indicated the need for more samples to be collected per farm to more accurately determine farm averages. A statistical analysis of the data indicated that under ideal conditions 24 bales should be sampled per farm to reliably predict the average dicoumarol level. On a pratical basis, as many samples as possible should be used to obtain the most representative sample possible.

This research has shown that sweet clover hay can be comparable to alfalfa in feeding value and should be recognized as a valuable forage crop. The incidence of dicoumarol above the 10 ppm level is considerable and management practices probably play an important role in this occurrence. More research is needed to determine toxic levels and managerial techniques that will reduce the chance of sweet clover poisoning and preserve forage quality.

RESULTS AND DISCUSSION

The data obtained from this study are listed in Table 1.

Protein content ranged from 8.8 to 24.6 per cent, and acid detergent fiber values range from 29 to 52.6 per cent. This range in values is seen not only in the overall analysis but is apparent as well in the yearly breakdown. The 1978 sweet clover averaged 16.2 per cent protein and ranged in value from 9.6 to 24.6 per cent. A similar range, 8.8 to 20.0 per cent, was seen in 1979. Acid detergent fiber content in 1978 ranged from 29.0 to 52.6 per cent with similar results, 30.6 to 49.1 per cent, in 1979. These values indicating sweet clover samples can be comparable to alfalfa for feeding value. Comparing sweet clover to good quality alfafa, Sotola (1940) found

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TABLE 1. PER CENT NUTRIENT COMPOSITION OF SWEET CLOVER ON 100% DRY MATTER BASIS

	Mean	Std. Dev.	Min. Value	Max. Value	SEM[1]
		Overall Average[2] N = 80[3]			
Protein	15.45	3.61	8.8	24.6	0.40
Fiber	40.46	6.26	29.0	52.6	0.70
Lignin	7.08	1.75	4.4	16.2	0.20
Ash	8.39	1.98	4.16	19.08	0.22
Ca	1.10	0.34	0.58	1.41	0.04
P	0.18	0.05	0.09	0.42	0.00
Mg	0.40	0.14	0.21	0.98	0.02
K	2.04	0.52	0.76	4.50	0.06
		1978 Crop Averages N = 49[3]			
Protein	16.20	3.75	9.6	24.6	0.54
Fiber	40.26	6.92	29.0	52.6	0.99
Lignin	6.64	1.46	4.4	10.0	0.21
Ash	8.12	1.32	4.16	11.22	0.19
Ca	1.04	0.27	0.58	1.67	0.04
P	0.17	0.04	0.09	0.26	0.00
Mg	0.34	0.08	0.21	0.50	0.01
K	1.87	0.42	0.76	2.61	0.06
		1979 Crop Averages N = 31[3]			
Protein	14.26	3.06	8.8	20.0	0.55
Fiber	40.79	5.12	30.6	49.1	0.92
Lignin	7.77	1.96	5.5	16.2	0.35
Ash	8.80	2.70	5.74	19.08	0.48
Ca	1.20	0.42	0.66	2.41	0.07
P	0.20	0.05	0.12	0.42	0.01
Mg	0.48	0.18	0.26	0.98	0.03
K	2.30	0.54	1.32	4.50	0.10

[1]Standard error of the mean.
[2]Average of all nutrient assays from both years.
[3]Number of samples; each run in duplicate.

sweet clover contained 88.1 to 112.1 per cent as much digestible crude protein and 86.6 to 103.8 per cent as much total digestible nutrients.

A comparison on how the method of harvest affected the protein level is shown in Table 2. Silage and round bales were significantly higher in protein level than stacks ($P < 0.0001$). The stage of maturity at time of harvest and individual management practices may have had a greater effect on the quality than harvest methods.

Dicoumarol levels in the 277 samples ranged from zero to 164.7 ppm. A comparison of the mean dicoumarol levels as affected by method of harvest is shown in Table 3. Small bales were significantly higher in dicoumarol levels than all other types ($P < 0.0001$). It should be noted, however, that only seven samples were obtained from small bales.

Round bales were significantly higher in dicoumarol than stacks and silage. The highest concentration of dicoumarol within the round bales was found in the outer half of the bale when the core samples were partitioned into inner and outer sections. Both of these methods of harvest, round and small bales, contained average dicoumarol levels above the recognized toxic level of 10 ppm (Linton et al., 1963). Silage, as expected, if cured properly, did not contain an appreciable amount of dicoumarol.

Stacks, although their average level of dicoumarol was less than the known toxic level, should not be considered in the same class as silage as being essentially free of dicoumarol. Dicoumarol levels in stacks ranged from 0.0 to 39.5 ppm. The results of this research confirmed suspicions that round bales are prone to have higher dicoumarol levels than stacks.

The effect crimping had on the dicoumarol level was also investigated. This conceivably could have been a step in reducing dicoumarol formation because the theory behind crimping is to reduce drying time and provide for more uniform curing. No significant difference in dicoumarol levels was seen, however, between crimped and non-crimped sweet clover.

Obtaining representative samples from bales as well as from farms was found to be a significant problem. A large variation of within farm levels of dicoumarol existed and indicated the need for more samples to be collected per farm to more accurately determine farm averages. A statistical analysis of the data indicated that under ideal conditions 24 bales should be sampled per farm to reliably predict the average dicoumarol level.

TABLE 2. COMPARISON OF AVERAGE PROTEIN LEVELS AS AFFECTED BY DIFFERENT METHODS OF HARVEST.

Harvest Method	N	Per Cent Crude Protein[1,2]
Silage	7	17.8[a]
Round Bales	39	16.9[a]
Small Bales	3	14.4[a,b]
Stacks	29	13.4[b]

[1]Protein analysis on a 100% dry matter basis.
[2]Means within a column with different superscripts are significantly different (p = .05).

TABLE 3. COMPARISON OF DICOUMAROL LEVELS AS AFFECTED BY METHODS OF HARVEST.

Method of Harvest	N	Dicoumarol Level, ppm[1,2] Mean ± Std. Dev.	Range
Small Bales	7	51.5[a] ± 31.62	14.4-95
Round Bales	173	22.9[b] ± 31.05	0.0-164.7
Stacks	78	1.8[c] ± 6.33	0.0-39.5
Silage	14	0.6[c] ± 2.15	0.0-8.0

[1]Means within a column with different superscripts are significantly different (P = .05); Duncans Multiple Range Test.
[2]It is recognized that one of the assumptions for analysis of variance (within treatment variances equal) is not met with this data.

On a pratical basis, as many samples as possible should be used to obtain the most representative sample possible.

This research has shown that sweet clover hay can be comparable to alfalfa in feeding value and should be recognized as a valuable forage crop. The incidence of dicoumarol above the 10 ppm level is considerable and management practices probably play an important role in this occurrence. More research is needed to determine toxic levels and managerial techniques that will reduce the chance of sweet clover poisoning and preserve forage quality.

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the next pregnancy. Respiratory infections result in protective titers that persist for three to four months (2). The majority of foals, it has been suggested, convert from passive immunity to active immunity without clinical disease (6). One or a combination of the previously mentioned factors could account for the 72% of sera which have less than "protective" titers.

Based on the evidence that the majority of the horses are susceptible to EHV, one could conclude that the majority of horse owners and breeders either have not instituted an immunization program or the immunization programs have not been effective based on serum titer.

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TABLE 1. Serum Neutralization Titers for Equine Rhinopneumonitis

SN TITER RECIPROCAL OF LOG TITER	4	4	8	16	32	64	128	256	TOTAL
Number of Samples	85	5	95	124	112	81	105	91	698
Percent of Total	12	1	13	18	16	12	15	13	100