NITRATE CONTENT OF SOME SOUTH DAKOTA PLANTS[1]

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Several cases of oat hay poisoning of cattle have been reported recently in Colorado, Wyoming, and western South Dakota. The high nitrate content of the oat hay has been shown to be responsible for its toxicity.[2] Pigweeds (**Amaranthus retroflexus L.**) and sorghum having high concentrations of nitrate nitrogen have also been reported as being toxic to cattle.[2, 3] It seemed probable that other common plants found in South Dakota might contain high concentrations of nitrate nitrogen and thus cause occasional losses of livestock. In view of this an investigation of the nitrate content of plants was begun late in the summer of 1939.

The following method was used in the analysis of the plant samples for nitrates:

Five grams of the finely-ground, air-dry sample was placed in a 250cc volumetric flask. About 100 cc of boiling distilled water was added to the flask and it was placed on a steam bath for two hours, during which time it was shaken occasionally. Then about 125cc of distilled water and 5cc of a solution of saturated neutral lead acetate were added to the flask and its contents were mixed and allowed to cool to room temperature. After making up to volume the mixture was shaken well and filtered. 150cc of the filtrate, 100cc of distilled water, 25cc of 5% NaOH solution, a small amount of paraffin and a few glass beads were placed in a kjeldahl flask and the mixture was boiled for 30 minutes. (A blank containing 150cc of distilled water in place of the extract was run simultaneously.) After cooling to almost room temperature, 200cc of distilled water and three grams of Devarda's alloy were added to the flask and the ammonia resulting from

[1]Approved for publication as Journal Series No. 138, by the Director of the South Dakota Agricultural Experiment Station.

[2]Bradley, W. B., Eppson, H. F., and Beath, O. A. Nitrate as the cause of oat hay poisoning. J.A.V.M.A. 94:541-543 (1939).

[3]Franzke, C. J., Puhr, Leo F., and Hume, A. N. A study of sorghum with reference to the content of HCN. S. Dak. Agri. Expt. Sta. Tech. Bull. 1 (1939).

the reduction of the nitrate nitrogen was distilled over into standard HCl solution. After back-titrating with standard NaOH solution the amount of nitrate nitrogen was calculated. The nitrate nitrogen is reported in this study as the percent of KNO_3 in the air-dry sample, unless otherwise indicated.

Table 1 gives the analyses of some oat hay samples analyzed by this laboratory during the past year.

TABLE 1

The KNO_3 content of some oat hay samples

Lab. No.	County in which sample was grown.	% KNO_3
2663	Meade	3.48
2664	Meade	3.12
2666	Meade	4.69
2667	Meade	2.06
2669	Meade	0.44*
2670	Meade	4.49*
2673	Meade	1.93
2678	Meade	5.58*
2679	Meade	3.21
2680	Meade	1.10
2682	Meade	1.54
2665	Custer	4.00
2674	Custer	0.41
2675	Custer	3.23
2668	Mellette	5.14
2681	Mellette	2.21
2671	Pennington	5.99
2672	Pennington	5.34
2676	Perkins	1.87
2677	Perkins	3.19

*Moisture-free basis.

Since most of the samples listed in Table 1 were sent by ranchers who had lost cattle from oat hay poisoning, several of them contain high concentrations of potassium nitrate.

As stated previously, other workers have reported cases of cattle poisoning which have resulted from the ingestion of pigweeds high in nitrate nitrogen. The analysis at this laboratory of a sample of pigweed hay which had caused the death of several cattle to which it had been fed showed it to contain 6.01% of KNO_3, which is well above the limit of toxicity.[4] Since then several samples of pigweed have been collected and analyzed for nitrates (see Table 2).

TABLE 2

The KNO_3 content of pigweeds (**Amaranthus retroflexus** L.)

Lab. No.	County in which sample was collected	% KNO_3
2683	Lyman	6.10
2684	Lyman	8.35
2685	Lyman	2.12
2689	Lyman	6.01
2690	Lyman	2.10
1939-250	Lyman	1.88
1939-251	Lyman	2.40
1939-252	Lyman	4.27
1939-258	Lyman	1.77
1939-260	Lyman	1.17
2686	Butte	0.96
2687	Mellette	3.53
2688	Brookings	4.24
1939-253	Brule	5.23
1939-257	Brule	4.67
1939-254	Aurora	1.41
1939-255	Davison	2.08
1939-259	Davison	2.23
1939-256	Sanborn	0.82
1939-261	Kingsbury	1.46
1939-262	Beadle	0.65
1939-265	Beadle	1.59
1939-263	Hand	0.20
1939-264	Hand	2.15

[4]Op. cit.

The samples as listed in Table 2 were collected at random within the state. On the basis of these results it appears that pigweeds often contain high concentrations of potassium nitrate. Their presence in pastures, especially during dry years may, therefore, result in cattle losses.

Occasionally a sample of sorghum which has killed cattle is found upon analysis to contain very little prussic acid, although the cattle that died showed typical symptons of prussic acid poisoning. Since the symptons of nitrate poisoning resemble those of prussic acid poisoning very closely[5] it seemed that possibly these deaths may have been caused by nitrate poisoning rather than by HCN poisoning. One case such as this is reported by Franzke, Puhr, and Hume.[6] It was therefore decided to study the nitrate content of sorghum. A few analyses are given in Table 3.

TABLE 3

The KNO_3 content of sorghum.

Lab. No.	County from which sample was obtained.	% KNO_3
2691	Butte	2.30
2692	Lyman	3.24
2697	Lyman	0.49
2698	Lyman	0.20
2693	Miner	0.78
2694	Miner	0.67
2695	Lake	0.43
2696	Lake	0.32
2699	Mellette	1.35
2700	Spink	1.10
2701	Custer	0.24

The data in Table 3 indicate that usually sorghums are low in nitrate nitrogen, but occasionally samples high in nitrate nitrogen may be found. Further work should be done

[5]Bradley, W. B., Beath, O. A., and Eppson, H. F. Oat hay poisoning. Science 89:365 (1939).

[6]Op. cit.

with sorghums in order to establish more definitely their importance from the standpoint of nitrate poisoning.

The work discussed in this paper was not started until late during the summer of 1939, but during that summer several samples of plants had been collected for selenium studies. These plants had been collected from fenced plots at various dates during the growing season and the stage of growth of the plants had been recorded at the time of sampling. Some of these samples were available for analysis in connection with this study. Table 4 contains data concerning four species of plants which were found to be relatively high in their content of nitrate nitrogen. As might be expected,

TABLE IV

The KNO_3 Content of Some Plants at Various Stages of Growth

Kind of Plant	Lab. No.	Date Collected	Stage of Growth	% KNO_3
Lamb's Quarter	1939-14	6-12-39	Early bud	3.24
(Chenopodium	1939-60	6-22-39	Bud	1.43
album L.)	1939-121	7- 6-39	Late bud	1.28
	1939-203	8-16-39	Early Maturity	0.92
	1939-236	9-19-39	Late Maturity	1.22
Sunflower	1939-8	6-12-39	Bud	4.75
(Helianthus	1939-111	7- 6-39	Blossom	1.77
sp?)	1939-165	7-22-39	Early maturity	2.95
	1939-192	8-16-39	Dry	2.81
	1939-233	9-19-39	Dry	0.531
Gum plant	1939-7	6-12-39	Prebud	1.76
(Grindelia	1939-46	6-22-39	Prebud to early bud	1.49
squarrosa	1939-110	7- 6-39	Early bud	0.48
(Pursh) (Dunal)	1939-166	8-16-39	Bud	0.48
	1939-191	9-19-39	Early blossom	0.36
Spiderwort	1939-11	6-12-39	Blossom	3.64
(Tradescantia	1939-50	6-22-39	Late blossom	1.28
bracteata)	1939-114	7- 6-39	Mature	1.66

these plants decrease steadily in nitrate nitrogen content during the growing season. Whether this holds true for oat hay and pigweeds is yet to be determined.

In Table 5 are listed a few miscellaneous samples that have been analyzed for nitrates at this laboratory.

TABLE V

The KNO_3 Content of Some Miscellaneous Samples

Lab. No.	Sample	% KNO_3	Remarks
2703	Alfalfa hay	0.51	
2704	Corn (stalk)	2.17	From same plant
2705	Corn (husk)	0.13	From same plant
2706	Corn (shanks)	1.21	From same plant
2707	Oat and barley hay (mixed)	5.43	
2708	Proso millet	3.66	
1939-9	Western wheat grass	0.46	Early stage
1939-1	Needle grass	0.77	Early stage
1939-31	Feather grass	0.22	Early stage
1939-6	Stickseed	0.51	Early stage
1939-83	Blue grama grass	0.12	Early stage
1939-207	Side-oat grama grass	0.02	Mature

The results of the analysis of the various parts of the corn plant agree well with the results of Gerdel[7] who found the stalk of corn to contain a much higher concentration of nitrate nitrogen than did the other parts of the plant. Grasses apparently do not contain very large quantities of nitrates, but a need for further work on the nitrate content of some of our common forage crops is indicated.

[7]Gerdel, R. W. Determination of the inorganic nitrogen in the corn plant by the expressed sap method. Plant Physiology 7:517-526 (1932).

Summary

The analyses of several samples of oat hay and pigweeds (**Amaranthus retroflexus** L.) are given. Several samples of each are found to contain toxic amounts of potassium nitrate.

The analyses of some samples of sorghum indicate that in some cases the toxicity of these plants may be the result of their high nitrate content rather than of their HCN content.

Stage studies on four plants (**Chenopodium album, Helianthus, Grindelia squarrosa,** and **Tradenscantia bracteata**) show a decrease in their content of nitrate nitrogen during the growing season.

Grasses were found to be generally low in nitrate nitrogen content.