Proceedings of the Iowa Academy of Science

Volume 7 | Annual Issue Article 16

1899

A Study of the Chemical Composition of Some of the Grasses of the State

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In the case of a strongly curved fold the pressure may be relieved locally by sliding along the bedding plains. In others the fault plane, instead of being almost vertical, may be nearly horizontal, which, in the near proximity to vertical faults, is apparently anomalous.

Both the normal compound and normal horizontal faults are readily reproduced experimentally. Two or three hundred sheets of paper are bent in the form of a pronounced fold, and clamped. The end of the fold is then covered with a colored paste, that becomes somewhat brittle when dry. When the clamps are slowly relieved the sheet of paste on the end indicates at once the movements of the strata of paper, and the directions and locations of the sudden movements and the production of the phenomena corresponding to the dislocations. On this transverse plate of paste the compound normal faulting and normal horizontal faulting is beautifully portrayed in miniature.

A STUDY OF THE CHEMICAL COMPOSITION OF SOME OF THE GRASSES OF THE STATE.

BY J. B. WEEMS.

One of the problems in connection with the work of the experiment station for the past two or three years has been an investigation of the native grasses of the state. The work has been carried on by the botanical and chemical sections of the station and the results which are presented here may be regarded as a part of this work. The analyses presented are of those grasses which have been most thoroughly investigated and are as follows: (1), Dactylis glomerata (orchard grass); (2), Muhlenbergia Mexicana (Mexican wood-grass); (3), Spartina cynosuroides (fresh water cord grass); (4), Poa pratensis (Kentucky blue grass).

The first of these to be considered is Dactylis glomerata or orchard grass. In the eastern states and the older settled countries this grass has been known for a long time and is considered one of the most valuable pasture grasses. The good properties of the grass consist in being an early and rapid grower and with strong resisting powers against drouth. If allowed to grow to extreme height it is said to become coarse

and hard. The grass is widely distributed in the state but is grown very little for forage purposes.

The following analyses of orchard grass were made in the laboratory of this station:

Sample 1. April 24, 1896, 7 to 16 inches high.
Sample 2. May 4, 1896, 14 to 18 inches high.
Sample 3. May 18, 1896, sample very wet
Sample 4. May 26, 1896, 38 to 42 inches high.
Sample 5. June 5, 1896, 28 to 30 inches high.
Sample 6. June 17, 1896, 40 to 45 inches high.

NATURAL CONDITION.

	Water.	Fat.	Protein.	Albumenoids.	Crude fiber.	Ash.	Nitrogen free extract.
Sample 1	85.52	.77	4.38	(3.39)	3.38	2.33	3.77
Sample 2	84.54	1.02	3.15	(2.14)	4.15	1.93	5.21
Sample 3	83.25	.86	2.51	(2.31)	5.80	1.77	5.81
Sample 4	78.18	1.35	2.95	(2.42)	7.17	2.36	7.99
Sample 5	78.74	1.00	3.38	(2.33)	8.63	2.68	5.57
Sample 6	69 78	1.22	2.75	(2.55)	11.71	2.58	11.96

WATE FREE SUBSTANCE.

	Fat.	Protein.	Albumenoids.	Crude fiber.	Ash.	Nitrogen free extract.
Sample 1	5.36	30.25	(23.45)	23.01	15.88	26.00
Sample 2	6.62	20.37	(13.83)	26.88	12 46	33.67
Sample 3	5.09	15.01	(13.80)	34 59	10.59	34.72
Sample 4	6.20	13.50	(11.09)	32.85	10.84	36.61
Sample 5	4.72	15.91	(10.98)	40.60	13.62	26.15
Sample 6	4.04	9 11	(8.44)	38.76	8.54	39.55

From these results it is readily seen that there is a decrease in the amount of water present in the samples as the growth increases. In the water free substance we find that the fat varies in the sample from 6.62 per cent to 4.04 per cent. There is not a regular decrease in this constituent, but it is somewhat irregular. Regarding the amount of protein we might say that there is a regular decrease with one exception from 30.25 per cent to 9.11 per cent. With the crude fiber there is a tendency for the amount to increase as the plant grows older as we have in the first sample 23.01 per cent and in samples five and six 40.60 per cent and 38.76 per cent respectively, and the same may be said regarding the amount of nitrogen free extract,

ncreasing from 26 per cent to 39.55 per cent, with one exception.

The following analyses of other states are added for comparison:

SAMPLE FROM—	Water.	Fat.	Protein.	Albumenoids.	Crude fiber.	Ash.	Nitrogen free extract.
U. S. Exp. Sta. Handbook (1)—Green fodder—in bloom	73.00	.90	2.60	.. ..	8.20	2.00	13.30
Iowa (2)—Cut June 9, just out of bloom	70.07	.71	2.31	.....	10.15	3.00	13.76
Cut April 29	*78.14	6.27	21.46	. ...	16.92	13.22	42.13
Cut May 10	*75.58	6.36	18.50	.....	19.76	12.27	43.11
Cut May 20	*72.43	4.62	12.34	.....	21.75	10.23	51.06
Cut May 30	*71.90	2.65	9.19	.....	29.48	10.00	48.68
Cut June 9	*70.07	2.36	7.71	.....	33.90	10.02	46.01
Louisiana (3)	*12.82	3.70	7.82	....	28.35	10.75	36.56
North Carolina (4)	5.25	2.60	6.69	.. ..	38.43	5.90	41.43
North Dakota (5)	15.35	3.53	8.12	.....	31.14	6.13	35.73
Oregon (6)	11.80	2.26	8.17	.....	38.33	5.90	33.54
Storrs (Conn.) (7), 16 analyses	68.60	1.30	3.00	.....	10.70	2.80	13.60
Utah (8), average of 3 analyses	14.82	2.62	3.52	.....	30.01	7.93	50.66

1. U. S. Dept. of Agriculture, Handbook Experiment Sta. Work, p. 386, 1893.
2. Bull. Iowa Agricultural Experiment Station 11, pp. 453, 476.
3. Bull. La. Agricultural Experiment Station 19, 2d series.
4. Bull. N. C. Agricultural Experiment Station 900.
5. Bull. N. D. Experiment Station 15.
6. Bull. Oregon Agricultural Exp. Sta. 39, 1895.
7. Ann. Report Storrs Agrl. Exp. Sta., Conn. 9, p. 280, 1896.
8. Rept. Experiment Station Utah, pp. 254-255, 1893.

Muhlenbergia Mexicana (Mexican wood-grass) is a grass which is said to be common in the state.

Seven samples of Muhlenbergia Mexicana were analyzed in the laboratory and the results are given below:

Sample 1. Collected April 29, 1896, height 4 to 12 inches.
Sample 2. Collected May 14, 1896, height 20 to 23 inches.
Sample 3. Collected May 28, 1896, height 26 to 29 inches.
Sample 4. Collected June 8, 1896, height 36 to 38 inches.
Sample 5. Collected June 18, 1896, height 38 to 39 inches.
Sample 6. Collected June 29, 1896, height 39 to 40 inches.
Sample 7. Collected July 20, 1896, height 48 to 49 inches.

NATURAL CONDITION.

	Water.	Fat.	Protein.	Albuminoid.	Fiber.	Ash.	Nitrogen free extract.
Sample 1	84.82	.88	3.51	(2.73)	3.70	2.04	5.05
Sample 2	73.28	1.21	5.12	(3.78)	7.72	2.77	9.90
Sample 3	82.95	.54	2.86	(1.96)	6.43	1.95	5.27
Sample 4	77.46	.79	2.41	(2.14)	8.10	2.08	9.16
Sample 5	73.37	.81	2.13	(2.10)	9.01	2.57	12.11
Sample 6	58.77	1.49	3.22	(2.60)	13.32	2.64	20.56
Sample 7	81.98	.53	1.48	(1.09)	5.82	1.10	9.09

***Per cents given are all for air-dry material except per cent of water.**

WATER FREE SUBSTANCE.

Sample 1	5.81	23.16	(17.99)	24.36	13.41	33.26
Sample 2	4.52	19.17	(14.17)	28.90	10.38	37.03
Sample 3	3.14	16.77	(11.46)	37.72	11.43	30.94
Sample 4	3.49	10.70	(9.52)	35.94	9.27	40.60
Sample 5	3.03	8.00	(7.88)	33.83	9.67	45.47
Sample 6	3.62	7.81	(6.30)	32.31	6.40	49.86
Sample 7	2.95	8.26	(6.11)	32.48	6.16	50.15

In the above results we find that the amount of water present varies from 84.82 per cent to 58.77 per cent, while it might be said that the amount tends to become less as the plant matures, yet there are exceptions, as it will be seen that the first sample collected in April having a height of four to twelve inches has only 2.84 per cent more of water than the sample taken on July 20th and having a height of forty-eight to forty-nine inches.

In considering the water free substance we find that the fat present varies from 5.81 per cent to 2.95 per cent, and that the change is not a constant one. The change in the amount of protein is constant for the first six samples and changes from 23.16 per cent to 7.81 per cent and in the seventh sample having this substance to the amount of 8.26 per cent; however, in the results for albuminoids we find that the decrease of this substance is constant, changing from 17.99 per cent to 6.11 per cent. The amount of fiber varies irregularly from 24.36 per cent in the youngest sample to 37.72 per cent in the third sample of May 28th. The ash constituent decreases with a regular change, while the nitrogen free extract increases constantly with one exception from 33.26 per cent to 50.15 per cent, the exception being the third sample with 30.94 per cent. The following analyses are added for comparison:

AIR DRY SUBSTANCE.

	Water.	Ash.	Fat.	Fiber.	Protein.	Nitrogen free extract.	Albuminoids.
South Dakota* Col. September 1, 1892	7 31	9.67	2.49	27.96	13.05	39.52	8.44
Tennessee† not yet in bloom	‡10.65	7.04	2.32	29.61	8.00	42.38	.....

WATER FREE SUBSTANCE.

South Dakota Col. September 1, 1892	10.43	2.69	30.17	14.08	42.64	9.06
Tennessee not yet in bloom	7.87	2.59	33 14	8.96	47.44	.....

* S. D. Bull. Agricultural Experiment Station 40, p. 64.

† Bull. Tenn. Agricultural Experiment Station, Vol. IX, No. 3, p. 90.

‡ Hay of grass.

Spartina cynosuroides, fresh water cord grass, grows from two to nine feet high and in this state is known by the name of slough grass, on account of occurring in low grounds. It is cut for hay along the Missouri and Mississippi rivers and is regarded very highly by many on account of the large growth produced by the grass, although it is not as valuable as some of the wild grasses.

The chemical composition of Spartina cynosuroides may be shown by the following analyses made in the laboratory:

Sample 1. Collected April 23, 1896, 6 inches to 1 foot high.
Sample 2. Collected May 7, 1896, 16 to 24 inches high.
Sample 3. Collected May 20, 1896, 36 to 38 inches high.
Sample 4. Collected June 1, 1896, 46 to 48 inches high.
Sample 5. Collected June 10, 1896, 50 to 56 inches high.
Sample 6. Collected June 20, 1896, 53 to 55 inches high.
Sample 7. Collected July 20, 1896, 62 to 63 inches high.

NATURAL CONDITION.

	Water.	Fat.	Protein.	Albuminoid.	Fiber.	Ash.	Nitrogen free extract.
Sample 1	71.81	1.49	4.23	(2.66)	9.19	1.89	11 29
Sample 2	69.84	.70	3.90	(3.07)	10.06	2.20	13.30
Sample 3	67.84	.70	3.74	(2.52)	11.66	2.06	14.00
Sample 4	63.32	.54	4.13	(2.90)	14.03	2.46	15.52
Sample 5	59.13	1.14	3.05	(2.10)	16.02	2.00	18.66
Sample 6	61.02	.89	2.15	(1.81)	15.44	2.07	18.43
Sample 7	56.74	1.21	3.15	(2.35)	17.19	2.87	18.84

WATER FREE SUBSTANCE.

Sample 1	5.30	15.34	(9.42)	32.61	6.71	40.02
Sample 2	2.32	12.92	(10.17)	33.38	7.29	44.09
Sample 3	2.18	11.61	(7.84)	36.24	6 40	43.54
Sample 4	1.46	11.27	(7.92)	38.24	6.70	42.33
Sample 5	2.79	7.57	(4.24)	39.21	4.90	45.53
Sample 6	2.27	5.52	(4.66)	39.62	5.32	47.17
Sample 7	2.79	7.29	(5 44)	39.73	6.62	43.57

It will be noticed that the above results show that the water content decreases gradually, with one exception, as the grass matures. The fat in the water free substance is largest in the youngest sample and varies in the others. The percentage of protein gradually decreases from 15.34 per cent to 5.52 per cent in the first six samples and then we find 7.29 per cent in the last sample. In the albuminoids we find that the amounts are not constant in their changes, the second sample having 10.17 per cent and the fifth sample 4.24 per cent. In the fiber there is a constant increase as the plant becomes matured. The nitrogen free extract increases from 40.02 per cent in the

young grass from six inches to one foot high, and increases to 47.17 per cent in the grass fifty-three to fifty-five inches high. The amount of ash varies from 6.71 per cent to 4.90 per cent and the changes are very irregular. The following analyses are added for comparison.

NATURAL CONDITION.

	Water.	Fat.	Protein.	Albuminoid.	Fiber.	Ash.	Nitrogen free extract.
Iowa,* cut Aug. 27th in full bloom, height sixty inches	53.53	.63	2.57	(2.27)	16.39	2.17	24.71
Cut June 1st, no head, sixty inches	‡65.36	1.63	8.41	(6.75)	38.32	6.75	44.89
Cut August 27th	‡53.53	1.35	5.53	(4.89)	35.27	4.66	53.19
South Dakota†, July 10, 1891	§6.45	1.21	5.29	.....	38.51	4.07	50.91

The other grass selected for presentation is Poa pratensis, or Kentucky blue grass. This grass is considered one of the best pasture grasses in the state, and it is said that the excellence of the Iowa stock is due largely to the pastures of this grass.

The samples analyzed in this station are given in the following table:

Sample 1. April 14, 1896, young, 1 to 4 inches high.
Sample 2. April 29, 1896, 3 to 10 inches high.
Sample 3. May 6, 1896, beginning to head out, 14 to 15 inches high.
Sample 4. May 18, 1896, very wet, headed, 14 to 15 inches high.
Sample 5. June 1, 1896, 31 to 32 inches high.

NATURAL CONDITION.

	Water.	Fat.	Protein.	Albuminoids.	Crude fiber.	Ash.	Nitrogen free extract.
Sample 1	77.78	1.36	8 66	(6.00)	3.61	2.91	5.68
Sample 2	78.96	1.03	4.42	(3.78)	5.22	3.06	7.31
Sample 3	76.18	1.04	4.79	(3.59)	5.49	2.65	9.85
Sample 4	78.50	.97	3.26	(3.14)	6.66	2.54	8.07
Sample 5	73.46	2.10	3.84	(2.35)	8.74	3.05	8.81

* Bull. Iowa Agricultural Experiment Station 11, pp. 456, 478.

† Bull. S. D. Agricultural Experiment Station 40, p. 94, 1894.

‡ These give the water which is found in the natural condition while the other percentages of these analyses are for the water free substance.

§ The amount of water is for the air dried substance while the other results are for water free substance.

WATER FREE SUBSTANCE.

Sample 1	6.13	38.98	(26.99)	16.23	13.10	25.56
Sample 2	4.90	21.02	(17.95)	24.71	14.53	34.84
Sample 3	4.25	20.11	(15.07)	23.06	11.11	41.47
Sample 4	4.51	15.18	(14.55)	30 96	11.80	37.55
Sample 5	7.91	14.46	(8.83)	32 92	11.48	33.23

In the above results we find that the amount of water present in the grass as received in the laboratory is very constant, the highest being 78.96 per cent and the lowest 73.46 per cent, a difference of only 5.5 per cent for a period of six weeks. In the comparison of the results of the analyses based on the water free substance in the fat content we find that the amount decreases comparatively little as the grass matures. However, with the amount of protein present there is a marked decrease from 38.98 per cent to 14.46 per cent and in the albuminoids from 26.99 per cent to 8.83 per cent. The crude fiber increases on the contrary from 16.23 per cent to 32.92 per cent. The amount of nitrogen free extract present varies greatly. There is no constant increase but it varies from 25.56 per cent to 41.47 per cent.

The constituents of an inorganic nature of ash remain quite constant. The following analyses have been selected for comparison with the work of this laboratory:

	Water.	Fat.	Protein.	Crude fiber.	Ash.	Nitrogen free extract
U. S. Exp. Sta. Rec. (1)—						
Aug. of 4 samples	.....	4.38	13.07	30.05	8.48	42.02
Northern grown	.....	3.60	10.50	26.10	7.90	51.90
Iowa (2)—						
Cut April 28th (3-6 in. high)	.....	5.55	18.03	22.19	11.49	42.74
Cut May 8th (8 in high)	.....	4.14	13.58	22.74	10.67	48 87
Cut May 18th (panicle spreading)	.....	3 89	11.11	24.36	8.75	51.89
Cut May 28th (early bloom)	.....	2.25	9 67	29.11	8.47	50.50
Cut June 7th (after bloom)	.....	2.75	7.88	29.92	8.66	51.79
Cut July 5th, in seed; brown	.....	3.05	7.89	30.55	9.98	48.53
Aug. of 3 analyses before blooming	.....	4.53	14.24	23.09	10.30	47.83
Louisiana (3)	*12.15	3.35	8.00	23.56	10.16	42.78
Mississippi (4)—						
Gathered March	.....	4.38	21.79	24.75	12.00	37.08
Gathered April	.....	4.13	9.04	34.64	5 34	46.85
Gathered May, just headed	.....	4.90	13.25	30.71	9.12	42.02
Gathered June, over-ripe	.....	4.13	8.21	30.12	7.45	50 09
North Dakota (5)	*15.35	3.03	6.53	27.29	4.16	43.64
Oregon (6)	*65 10	1.30	4.10	9.10	2 80	17.60

1. U. S. Dept. Agricultural Experiment Station Record VI, No. 2, p. 102, 1894.
2. Bull. Iowa Experiment Station 11, pp. 432, 434.
3. Bull. La. Agricultural Experiment Station 19, 2d series, pp. 536, 562.
4. Ann. Report Agricultural Experiment Station Miss. 8, p. 92, 1895.
5. Bull. Agricultural Experiment Station North Dakota, 15, 1894.
6. Bull. Oregon Agricultural Experiment Station 39, 1895.

* Analyses are for natural or air-dry condition; others are for water free substances

The results from the study of the grasses presented readily show that the chemical composition of a grass varies within wide limits, and that a knowledge of the composition of any grass can be made of great value in determining the time which is best adapted for cutting, for making hay, or for general feeding purposes.

A CHEMICAL STUDY OF BUTTER INCREASERS.

BY J. B. WEEMS AND F. W. BOUSKA.

In connection with the investigations in the chemical laborratory of the experiment station of problems connected with the amount of water present in butter, analyses were made of two samples of butter which appeared to contain a very large amount of water. The water present was apparently in large proportions and this condition gave a reason for the request for the analyses. In the attempt to mix the product in order to get an average sample it was found that the water readily separated from the other constitutents, and on analysis of the product the following results were obtained:

SAMPLE 1.	PER CENT.
Water	59.61
Fat	21.31
Casein	11.72
Ash	*7.36

SAMPLE 2.	PER CENT.
Water	42.76
Fat	44.92
Casein	5.10
Ash	†7.22

The above results were from samples of a product which has been sent to a commission firm with the object of selling it as butter. The large amount of water present with casein, etc., would naturally cause one to conclude that use was made of the so-called butter increasers in producing this product. It was a matter of interest in this connection to investigate some of these methods advertised in the past few years for the purpose of producing an abnormal amount of butter from cream and milk. In this relation it may be of interest to

* In sample one there was 6.48 per cent of salt in the ash.
† In sample two there was 6.60 per cent of salt in the ash.