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Bulletin No. 85.

March, 1905.

DEPARTMENT OF AGRICULTURE.

Oregon Agricultural Experiment Station.

CORVALLIS, OREGON.

Digestibility of Vetch Hay and Corn Silage.

By JAMES WITHYCOMBE AND A. L. KNISELY.

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1905

Oregon Agricultural College Press
Corvallis, Oregon

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BULLETIN NO. 85.

DIGESTIBILITY OF VETCH HAY AND CORN SILAGE.

JAMES WITHYCOMBE AND A. L. KNISELY.

SUMMARY.

Four feeding experiments were conducted with cattle from the Station herd. Each experiment extended over a period of seven days.

Two of the experiments were conducted with vetch hay (*Vicia sativa*) and two with corn silage.

The average results of these experiments are as follows:

DIGESTIBILITY OF VETCH HAY (*Vicia sativa*).

	Dry substance	Organic Matter	Ash	Protein	Crude Fiber	Nitrogen Free Extract	Ether Extract or Fat
Per cent digested -	66.05	67.35	52.23	69.91	57.56	71.59	71.21

DIGESTIBILITY OF CORN SILAGE.

	Dry substance	Organic Matter	Ash	Protein	Crude Fiber	Nitrogen Free Extract	Ether Extract or Fat
Per cent digested -	73.08	75.09	47.98	55.03	75.34	75.65	89.91

INTRODUCTION.

The common vetch (*Vicia sativa*) is becoming one of the most popular forage plants grown in Western Oregon. There are perhaps a thousand tons of vetch hay produced in this section now to one grown eight or ten years ago. This plant is hardy, enjoys a wide range of growth and is rich in protein. Its palatability is also a feature as all classes of stock are exceedingly fond of it, either in the form of hay or green forage.

When the virtues of this plant are more generally known to agriculturists the area of its culture will be appreciably extended. In addition to its value as a stock food, it is evidently an active nitrogen gatherer. Its roots are usually abundantly supplied with nodules and the generally increased crop production following its growth is good evidence of its value as a soil improver.

There seems to be a peculiarly wide variation in the protein content of individual plant. An investigation conducted by the Chemist of the Station in 1904 indicated that this variation in the water-free plant ranged from 12.19 per cent to 23.31 per cent total protein. Thus it would seem that this plant presents a very important field of work for the development of a race of vetch rich in protein.

The following table represents the results of analyses of portions of individual vetch plants at the proper stage of maturity for hay.

Per cent of Protein in Water-free Material.

No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.
5	12.19	9	16.38	77	17.37	24	18.13	36	18.75	22	19.63
2	14.69	12	16.38	66	17.37	1	18.13	61	18.88	18	19.69
64	14.94	63	16.38	30	17.44	67	18.19	40	18.94	70	20.00
42	15.00	64	16.63	33	17.44	69	18.19	3	18.99	29	20.06
20	15.29	78	16.75	46	17.56	16	18.25	63	19.06	21	20.19
72	15.38	66	16.81	65	17.66	17	18.25	6	19.13	28	20.25
51	15.69	74	16.81	43	17.69	19	18.25	18	19.13	32	20.44
75	15.81	10	17.00	58	17.69	50	18.31	44	19.18	47	20.50
7	15.94	79	17.00	14	17.75	49	18.38	39	19.19	84	20.75
35	15.94	41	17.19	76	17.75	73	18.38	62	19.19	48	20.75
62	16.00	65	17.19	15	18.00	38	18.50	60	19.44	28	21.13
31	16.06	60	17.25	26	18.00	45	18.55	4	19.50	27	21.69
8	16.25	37	17.37	71	18.00	68	18.69	11	19.63	59	22.13
										25	23.31

Seed from each plant showing a protein content of 20 per cent and above have been planted. A portion of individual plants of each generation will be analyzed and seed from those indicating a high protein content will be utilized for propagation. In this way it is hoped that in time a type of vetch can be produced having a large percentage of protein.

In view of the fact that vetch hay is destined to become an important factor in supplying nutrients to domestic live stock, the Station deemed it advisable to secure data as to its digestive coefficients.

The corn silage used in the test was steamed, although imperfectly done. This test was made with the express purpose of determining whether the steaming of silage decreased the percentage of its digestibility. Comparisons made with a number of other tests recorded, indicated that the heating of the silage did not have this effect, as its digestibility was found to be above the average given for corn silage.

The tests were made under as normal conditions as could be obtained. The cattle possessed a good constitutional vigor and the selection of the individuals was made to represent the average conditions usually found in herds. Golden Alice is a matured pure-bred Jersey cow well advanced in the period of lactation. Gladys A. is a two-year-old pure-bred Jersey heifer and was well advanced in the period of gestation at the time of the test. The other heifer, a yearling Shorthorn-Jersey cross, was not pregnant. Thus the three animals fairly represented average conditions found in dairy herds.

ANALYTICAL DATA AND RESULTS.

After the preliminary feeding each of the digestion experiments was continued for seven days. During the continuation of the feeding tests the cows were carefully watched day and night. A careful account was kept of the hay and water or corn silage and water consumed and of the feces produced. Composite samples of the hay and corn silage were taken daily and moisture determinations made each day. The feces were caught and weighed as soon as produced and samples placed in air-tight Mason jars. Composite samples of the feces were made each day during the digestion experiments. Determinations of moisture and total nitrogen in the feces were made daily.

EXPERIMENT I.—Digestibility of Vetch Hay.—Golden Alice at the beginning of the test weighed 970 pounds while at the end of the experiment she weighed 945 pounds, thus sustaining a loss of 25 pounds. During the feeding test she shrunk very little in milk production. A composite sample of the milk obtained during the feeding experiment contained 5.70 per cent of fat which was a trifle below the normal per cent.

Golden Alice.		Vetch Hay consumed. Lbs.	Water drunk. Lbs.	Feces produced. Lbs.	Milk produced. Lbs.
6 P. M. Nov. 20 to 6 P. M. Nov. 21	21 -----	20	20	21.06	8.00
"	" 22 -----	22	20	22.00	8.00
"	" 23 -----	20	38	30.00	10.50
"	" 24 -----	20	80	26.25	7.00
"	" 25 -----	20	90	34.50	8.00
"	" 26 -----	20	84	28.56	8.00
"	" 27 -----	20	42	28.75	7.00

EXPERIMENT II.—Digestibility of Vetch Hay.—Gladys A at the beginning of the feeding experiment weighed 740 pounds and at the end of the experiment she weighed 770 pounds, making a gain of 30 pounds during the seven days. The cow was dry during the experimental period.

Gladys A.		Vetch Hay consumed. Lbs.	Water drunk. Lbs.	Feces produced. Lbs.
6 P. M. Nov. 20 to 6 P. M. Nov. 21	21 -----	20	20	20.12
"	" 22 -----	21	20	23.75
"	" 23 -----	19	40	27.50
"	" 24 -----	18	60	27.50
"	" 25 -----	20	84	27.50
"	" 26 -----	20	76	28.50
"	" 27 -----	20	58	38.00

EXPERIMENT III.—Digestibility of Corn Silage.—Golden Alice at the beginning of the experiment weighed 940 pounds, at the end of the experiment she weighed 910 pounds, thus sustaining a loss of 30 pounds in seven days. During the feeding test she gave very nearly her average amount of milk. A composite sample of the milk extending over the experimental period contained 5.70 per cent of fat which was a trifle below the normal per cent.

Golden Alice.	Corn Silage consumed. Lbs.	Water drunk. Lbs.	Feces produced. Lbs.	Milk produced. Lbs.
6 P. M. Dec. 2 to 6 P. M. Dec. 3.....	38	0.00	26.75	7.00
" 3 " " 4.....	62	0.00	18.25	8.00
" 4 " " 5.....	66	0.00	20.12	7.00
" 5 " " 6.....	55	0.00	20.25	6.00
" 6 " " 7.....	72	0.00	18.25	7.00
" 7 " " 8.....	65	0.00	15.50	7.00
" 8 " " 9.....	45	0.00	20.88	8.00

EXPERIMENT IV.—Digestibility of Corn Silage.—Cross-bred heifer at the beginning of the feeding experiment weighed 530 pounds. At the end of the experimental period she weighed 530 pounds, having undergone no change in weight. The heifer was dry during the feeding test.

Cross-bred heifer.	Corn Silage consumed. Lbs.	Water drunk. Lbs.	Feces produced. Lbs.
6 P. M. Dec. 2 to 6 P. M. Dec. 3.....	37	0.00	18.25
" 3 " " 4.....	62	0.00	14.88
" 4 " " 5.....	60	0.00	18.88
" 5 " " 6.....	50	0.00	21.75
" 6 " " 7.....	72	0.00	22.25
" 7 " " 8.....	70	0.00	23.00
" 8 " " 9.....	42	0.00	19.12

In each of the feeding tests with corn silage the cows drank no water. It was offered them daily but they refused to drink.

EXPERIMENT I.—Golden Alice.—The analytical data obtained are as follows:

		Vetch hay consumed		Moisture in vetch hay		Water-free vetch hay consumed		Water contained in hay consumed		Water consumed in hay and drink		Fresh feces produced		Weight feces when dry		Moisture in feces		Nitrogen in fresh feces	
		Lbs	Per ct	Lbs	Per ct	Lbs	Per ct	Lbs	Per ct	Lbs	Per ct	Lbs	Per ct	Lbs	Per ct	Lbs	Per ct	Lbs	Per ct
6 P. M. Nov. 20 to 6 P. M. Nov. 21	21	20	17.39	16.52	3.48	23.48	20.12	4.235	78.95	.451	.0907								
" 21	22	22	19.71	16.86	4.14	24.14	23.75	5.007	78.92	.596	.1273								
" 22	23	20	17.93	16.41	3.41	43.41	27.50	5.415	80.31	.452	.1248								
" 23	24	20	18.13	14.74	3.26	63.26	27.50	5.228	80.99	.419	.1162								
" 24	25	20	18.66	16.27	3.73	87.73	27.50	5.002	81.81	.334	.0919								
" 25	26	20	17.61	16.48	3.52	79.52	28.50	5.164	81.88	.355	.1012								
" 26	27	20	19.39	16.12	3.88	61.88	33.00	6.039	81.70	.372	.1228								

EXPERIMENT II.—Gladys A.—The analytical data obtained are as follows:

		Vetch hay consumed		Moisture in vetch hay		Water-free vetch hay consumed		Water contained in vetch hay consumed		Water consumed in hay and drink		Fresh feces produced		Weight feces when dry		Moisture in feces		Nitrogen in fresh feces	
		Lbs	Per ct	Lbs	Per ct	Lbs	Per ct	Lbs	Per ct	Lbs	Per ct	Lbs	Per ct	Lbs	Per ct	Lbs	Per ct	Lbs	Per ct
6 P. M. Nov. 20 to 6 P. M. Nov. 21	21	20	17.39	16.52	3.48	23.48	20.12	4.235	78.95	.451	.0907								
" 21	22	22	19.71	16.86	4.14	24.14	23.75	5.007	78.92	.596	.1273								
" 22	23	20	17.93	15.59	3.41	43.41	27.50	5.415	80.31	.452	.1248								
" 23	24	20	18.13	14.74	3.26	63.26	27.50	5.228	80.99	.419	.1162								
" 24	25	20	18.66	16.27	3.73	87.73	27.50	5.002	81.81	.334	.0919								
" 25	26	20	17.61	16.48	3.52	79.52	28.50	5.164	81.88	.355	.1012								
" 26	27	20	19.39	16.12	3.88	61.88	33.00	6.039	81.70	.372	.1228								

EXPERIMENT III.—Golden Alice.—The analytical data obtained are as follows:

		Corn silage consumed		Moisture in corn silage		Water-free corn silage consumed		Water contained in silage consumed		Water consumed in silage and drink		Fresh feces produced		Weight feces when dry		Moisture in feces		Nitrogen in fresh feces	
		Lbs	Per ct	Lbs	Per ct	Lbs	Per ct	Lbs	Per ct	Lbs	Per ct	Lbs	Per ct	Lbs	Per ct	Lbs	Per ct	Lbs	Per ct
6 P. M. Dec. 2 to 6 P. M. Dec. 3	3	45	82.28	8.73	31.27	26.75	4.312	83.83	.317	.0842									
" 3	4	62	88.45	10.26	51.74	61.74	13.25	1.968	85.15	.940	.0451								
" 4	5	66	81.61	12.14	53.86	53.86	20.12	3.211	84.04	.400	.0805								
" 5	6	55	83.43	9.11	45.89	45.89	20.26	8.141	84.49	.385	.0780								
" 6	7	72	84.20	11.88	60.62	60.62	13.25	3.015	83.48	.381	.0665								
" 7	8	65	83.14	10.96	54.04	54.04	15.60	2.478	84.01	.376	.0583								
" 8	9	45	82.76	7.76	37.24	37.24	20.88	3.397	83.73	.359	.0741								

EXPERIMENT IV.—Cross-bred Heifer.—The analytical data obtained are as follows:

	Corn silage consumed		Moisture in corn silage		Water-free corn silage consumed		Water contained in silage consumed		Water consumed in silage and drink		Fresh feces produced		Weight feces when dry		Moisture in feces		Nitrogen in fresh feces		Nitrogen in fresh feces	
	Lbs	Per ct	Lbs	Per ct	Lbs	Per ct	Lbs	Per ct	Lbs	Per ct	Lbs	Per ct	Lbs	Per ct	Per ct	Lbs	Per ct	Lbs	Per ct	
6 P. M. Dec. 2 to 6 P. M. Dec. 3	37	82.28	6.56	30.44	30.44	18.25	2.730	85.04	.324	.0591										
.. 3	62	83.45	10.26	51.74	51.74	14.38	2.082	85.52	.314	.0452										
.. 4	60	81.61	11.03	48.97	48.97	18.88	2.681	85.80	.850	.0661										
.. 5	50	83.43	8.28	41.72	41.72	21.75	2.843	86.93	.296	.0644										
.. 6	72	84.20	11.38	60.62	60.62	22.25	2.821	87.32	.319	.0710										
.. 7	70	83.14	11.80	58.20	58.20	23.00	2.859	87.57	.318	.0731										
.. 8	42	82.75	7.24	34.76	34.76	19.12	2.388	87.77	.269	.0514										

Analysis of	Fresh material						Water-free material				
	Water	Ash	Protein	Crude fiber	Nitrogen free extract	Fat	Ash	Protein	Crude fiber	Nitrogen free extract	Fat
	Per ct	Per ct	Per ct	Per ct	Per ct	Per ct	Per ct	Per ct	Per ct	Per ct	Per ct
Composite vetch hay	18.24	7.01	12.71	21.59	37.86	2.59	8.58	15.54	26.40	46.31	3.17
Composite corn silage	83.02	1.27	1.52	4.02	8.94	1.23	7.49	8.92	23.69	52.66	7.24
Composite sample of feces from Golden Alice when fed vetch hay	79.49	2.37	2.87	7.08	7.67	0.52	11.54	13.99	34.52	37.42	2.53
Composite sample of feces from Gladys A when fed vetch hay	80.94	2.39	2.57	5.95	7.61	0.54	12.56	13.48	31.20	39.92	2.84
Composite sample of feces from Golden Alice when fed corn silage	84.15	2.29	2.84	3.32	7.48	0.42	14.46	14.76	20.91	47.20	2.67
Composite sample of feces from cross-bred heifer when fed corn silage	86.82	1.85	1.94	2.88	6.15	0.86	14.05	14.72	21.83	46.70	2.70

Determinations of total nitrogen were made daily in fresh samples of the feces. Later the total nitrogen was determined a second time in the feces after drying with the following results calculated to water-free feces:

	Protein (N x 6.25)
Golden Alice—vetch hay feces in fresh sample	13.99 per cent
in dried sample	12.00 per cent
Gladys A.—vetch hay feces in fresh sample	13.48 per cent
in dried sample	12.93 per cent
Golden Alice—corn silage feces in fresh sample	14.76 per cent
in dried sample	13.00 per cent
Cross-bred heifer—corn silage feces in fresh sample	14.72 per cent
in dried sample	13.16 per cent

From these figures we see that if the feces are dried before the determination of nitrogen is made that the results will be erroneous and misleading. It is necessary to make nitrogen determinations in the fresh feces as soon as they come to the laboratory in order to obtain correct results.

The record kept in each of the four digestion experiments extended over seven days. The digestibility of the vetch hay and corn silage was arrived at by comparing what was eaten during the first six days with what was excreted during the last six days.

Experiment I (Concluded).—Golden Alice fed vetch hay.

	Dry sub- stance	Organic matter	Ash	Protein	Crude fiber	Nitrogen free ex- tract	Ether ex- tract or fat
	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs
Golden Alice consumed from 6 P. M. Nov. 20 to 6 P. M. Nov. 26, 122 lbs. vetch hay which contained	99.71	91.16	8.55	15.51	26.34	46.19	8.16
Golden Alice produced from 6 P. M. Nov. 21 to 6 P. M. Nov. 27, 170.06 lbs. feces which contained...	34.776	30.746	4.03	4.88	12.04	13.04	0.88
Digested	64.934	60.414	4.52	10.63	14.30	33.15	2.28
Per cent undigested	34.88	33.73	47.13	31.46	45.71	23.23	27.85
Per cent digested	65.12	66.27	52.87	68.54	54.29	71.77	72.15

Experiment II (Concluded).—Gladys A fed vetch hay.

	Dry sub- stance	Organic matter	Ash	Protein	Crude fiber	Nitrogen free ex- tract	Ether ex- tract or fat
	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs
Gladys A consumed from 6 P. M. Nov. 20 to 6 P. M. Nov. 26, 118 lbs. vetch hay which contained....	96.46	88.19	8.27	15.00	25.48	44.67	3.16
Gladys A produced from 6 P. M. Nov. 21 to 6 P. M. Nov. 27, 167.75 lbs. feces which contained..	31.855	27.846	4.01	4.31	9.98	12.77	.91
Digested	64.605	60.345	4.26	10.69	15.50	31.90	2.15
Per cent undigested	33.02	31.57	48.49	28.73	39.17	28.59	29.74
Per cent digested	66.98	68.43	51.58	71.27	60.83	71.41	70.26

The results derived from experiments I and II, indicating the digestibility of the food nutrients of vetch hay, are as follows:

	Dry sub- stance	Organic matter	Ash	Protein	Crude fiber	Nitrogen- free ex- tract	Ether ex- tract or fat
Experiment I—Per cent digested.....	65.12	66.27	52.87	68.54	54.29	71.77	72.15
Experiment II—Per cent digested....	66.98	68.43	51.58	71.27	60.83	71.41	70.26
Average digestibility of vetch hay— Per cent.....	66.05	67.35	52.23	69.91	57.56	71.59	71.21

The digestibility of the food nutrients in the vetch hay seems to be higher than the average which is usually given for forage plants. Nevertheless, it would seem that the digestibility of the protein was somewhat lower than it would have been had the vetch been cut earlier. The vetch, when cut was slightly overripe, consequently the hay contained many matured seed rich in protein which the cattle were unable to digest. When the cattle were fed this vetch hay, their feces contained many undigested seed. Had the vetch been cut a few days earlier, namely, when the pods were only partially filled, then its digestibility would have doubtless been higher than these feeding trials indicate.

These results show the very great value of vetch as a forage plant where it can be successfully grown.

Experiment III (Concluded).—Golden Alice fed corn silage.

	Dry substance	Organic matter	Ash	Protein	Crude fiber	Nitrogen-free extract	Ether extract or fat
	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs
Golden Alice consumed from 6 P. M. Dec. 2 to 6 P. M. Dec. 8, 358 lbs. corn silage which contained	62.58	58.03	4.55	5.44	14.39	32.00	4.40
Golden Alice produced from 6 P. M. Dec. 3 to 6 P. M. Dec. 9, 108.25 lbs. feces which contained	17.21	14.73	2.48	2.53	3.59	8.10	1.45
Digested	45.37	43.30	2.07	2.91	10.80	23.90	3.95
Per cent undigested	27.50	25.38	54.50	46.51	24.95	25.31	10.23
Per cent digested	72.50	74.62	45.50	53.49	75.05	74.69	89.77

Experiment IV (Concluded).—Cross-bred heifer fed corn silage.

	Dry substance	Organic matter	Ash	Protein	Crude fiber	Nitrogen-free extract	Ether extract or fat
	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs
Cross-bred heifer consumed from 6 P. M. Dec. 2 to 6 P. M. Dec. 8, 351 lbs. corn silage which contained	59.31	54.85	4.46	5.34	14.11	31.38	4.32
Cross-bred heifer produced from 6 P. M. Dec. 3 to 6 P. M. Dec. 9, 119.38 lbs. feces which contained	15.624	13.414	2.21	2.32	3.44	7.34	0.43
Digested	43.686	41.436	2.25	3.02	10.67	24.04	3.89
Per cent undigested	26.34	24.45	49.55	43.44	24.38	23.39	9.95
Per cent digested	73.66	75.55	50.45	56.56	75.62	76.61	90.05

The results derived from experiments III and IV indicating the digestibility of the food nutrients of steamed corn silage are as follows:

	Dry substance	Organic matter	Ash	Protein	Crude fiber	Nitrogen-free extract	Ether extract or fat
Experiment III—Per cent digested.	72.50	74.62	45.50	53.49	75.05	74.69	89.77
Experiment IV—Per cent digested.	78.66	75.55	50.45	56.56	75.62	76.61	90.06
Average digestibility of corn silage, per cent.....	73.08	75.09	47.98	55.03	75.34	75.65	89.91

These results show that in the feeding trials here recorded, considerably more of the carbohydrates and ether extract or fat is digestible than is usually given by authorities. This may be due to the fact that the corn fodder was steamed.

LIST OF BULLETINS

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