

Major Thesis in Analytical Chemistry.

A Digestion Trial with Two Holstein Cows.

Respectfully submitted

to

Prof. J. B. McBride.

by

for

The M. S. Degree in Chemistry.

Approved:

A DIGESTION TRIAL WITH TWO HOLSTEIN COWS.

In the course of an investigation carried on by the Virginia Experiment Station, a digestion trial was conducted with two Holstein cows covering a period of ten days when one was on maintenance ration plus carbohydrate and **THESIS** maintenance ration plus protein.

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William G. Harris
W. G. Harris

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Table 1 gives the ration received daily by the two animals.

A DIGESTION TRIAL WITH TWO HOLSTEIN COWS.

	Wagon		Wagon	
	I		II	
O.S. Meal	1 lb. 42 oz.	588.3 gms	1.6 lbs	725.7 gms.
L.D. Grain	1 " 15 oz.	578.8 "	2.4 "	1088.6 "
Coro Meal	4 " 15 oz.	2239.6 "	7.2 "	3265.8 "
Silage	42 1/2 "	19277.6 "	5.4 "	24495.9 "
Hay	6 " 90	1814.4 "	4.8 "	2177.2 "
B-Albumen	1 "	433.6 "	0.0	0000.0 "
Water	0	000.0	1.15.6.5oz	637.9

In the course of an investigation carried on by the Virginia Experiment Station, a digestion trial was conducted with two Holstein cows covering a period of ten days when one was on maintenance ration plus carbohydrate and the other on maintenance ration plus protein. These cows were registered animals selected from the V. P. I. Dairy Herd.

The first digestion trial covered ten days beginning April 21st, 1912. The chemical work was done under the direction of Dr. W. B. Ellett. The digestion trial was carried out in the usual manner. The grain and hay ration for each day for each animal for the entire period was weighed out every morning. The food was taken from a large tin, the contents of which had been sampled and analyzed. Not being able to keep the silage outside of silo, it was necessary to take silage from the silo at each feeding and at the same time take a sample for analysis and placing it in a tight glass jar in which sufficient chloroform had been placed to prevent spoiling. The cows were kept in the barn and watered in the manner to be followed during the digestion trial for a week preceding, in order that they might be accustomed to the routine.

Three attendants were provided for each cow, working in 8 hour shifts to collect the dung and urine. A common grain shovel was used for the former and a tin vessel about the size of an ordinary milk pail with a wooden handle was used for collecting the urine. None of the excreta was lost during the ten days covered by the digestion trial.

Table 1 gives the ration received daily by the two animals.

Percentage composition of Daily Ration Feed No. I.

	Fione I		Veeman II				
	Amt. Fed	in gms.	Ash	Protein	Crude Fiber	N. Free Extract	Fat.
C.S. Meal	1 lb. 4 $\frac{3}{4}$ oz.		588.3 gms		1.6 lbs		725.7 gms.
D.D. Grain	1 " 15 oz.		878.8 "		2.4 "		1088.6 "
Corn Meal	4 " 15 oz.		2239.6 "		7.2 "		3265.9 "
Silage	42 $\frac{1}{2}$ " 00		19277.6 "		5.4 " v		24493.9 "
Hay	4 " 00		1814.4 "		4.8 "		2177.2 "
B.Albumen	1 "		453.6 "		0.0		0000.0
Starch	0		000.0		1 lb. 6.5oz		637.9 "

This was the same ration as used throughout the entire investigation of which the digestion trial was one part. The ration of both animals were made up in the same proportion with the only difference being in the quantity given which had been adjusted during the several weeks preceeding to maintain the cows at uniform weight. It will be noted that No. II received more than No. I which is accounted for by her larger production of milk and her greater weight.

Table 2, gives the chemical analysis and table 3 and 4 give the amounts of the several constituents in the ration received by the two cows.

Table II.

Percentage composition of Daily Ration.

No. I and No. II.

	Dry Matter	Ash	Protein	Crude Fiber	N. Free extract	Fat.
C. S. Meal	93.25	5.70	39.44	11.57	29.37	7.17
D. D. Grain	88.06	1.68	30.88	13.40	31.29	10.81
C. Meal	92.06	1.45	8.21	2.045	76.025	4.33
Silage	34.77	1.81	2.88	9.33	19.81	.94
Hay	89.17	3.99	5.63	29.92	46.97	2.66
B Albumen	92.51	3.64	83.11	.11	.139	4.26
Starch	89.88	.19	.60	.00	88.91	.81

Table III.

Percentage composition of Daily Ration Feed No. I.

	Amt. Fed in gms.	Moist	Ash	Protein	Crude Fiber	N. Free Extract	Fat.
C.S.Meal	588.3	39.7	33.5	232.0	68.1	172.8	42.2
D.D.Grain	878.8	104.9	14.8	271.4	117.8	274.9	95.0
C.Meal	2239.6	177.9	32.4	183.8	45.9	1702.7	97.0
Silage	19277.6	13733.3	244.8	374.0	1276.2	3497.0	152.3
Hay	1814.4	196.5	72.4	102.2	542.9	852.2	48.2
B.Albumen	453.6	34.0	16.5	377.0	.5	6.3	19.3
Total	25252.3	14286.2	414.4	1540.4	2051.4	6505.9	454.0

Table IV.

Composition of Daily Ration fed No. 2

	Amt. Fed in gms.	Moist.	Ash	Protein	Crude Fiber	N. Free extract	Fat
C.S.Meal	725.7	49.0	41.4	286.2	84.0	213.1	52.0
D.D.Grain	1088.6	130.0	18.3	336.2	145.9	340.6	117.6
C.Meal	3265.9	259.2	47.3	268.1	66.9	2483.0	141.4
Silage	24493.9	17449.4	311.1	475.2	1621.5	4443.2	193.5
Hay	2177.2	235.8	86.9	122.6	651.4	1022.6	57.9
Starch	637.9	64.6	1.2	3.8	0.0	567.2	1.1
Total	32389.2	18188.0	506.2	1492.1	2569.7	9069.7	563.5

Table V.

Actual amount of food eaten by I. & II during the ten days.

	Amt. fed in gms.	Moisture	Ash	Protein	Crude Fiber	N. Free extract	Fat,
No. I.	243,564.4	138143.3	3934.2	15095	18,981.4	62,933.2	4477.3
No. II.	277,852.4	156,245.1	4155.2	13521.4	18,763.4	79,854.7	5312.6

Table VI.

	No. I.		No. II.			
	Lbs. Milk	% Fat	Lbs. Fat	Lbs. Milk	% Fat	Lbs. Fat.
4/21/12	20.1	3.1	.62	31.7	3.0	.95
4/22/12	20.4	3.1	.63	30.0	3.0	.90
4/23/12	18.9	3.1	.59	38.9	3.0	.87
4/24/12	20.3	3.1	.63	30.7	3.0	.92
4/25/12	20.5	3.1	.64	29.0	3.0	.89
4/26/12	19.6	3.1	.61	28.1	3.0	.84
4/27/12	17.5	3.1	.54	27.9	3.0	.84
4/28/12	18.9	3.1	.59	26.9	3.0	.81
4/29/12	20.4	3.1	.63	28.7	3.0	.86
4/30/12	20.9	3.1	.65	27.8	3.0	.84
<hr/>						
Total	197.5		6.13	289.7		8.80

Table VII.

Composition of Milk.

	% Composition		Constituents in Lbs. & Kilos.			
	I.	II.	I.		II.	
			Lbs.	Kilos	Lbs.	Kilos
Total Milk			197.5	89.58	289.7	131.41
% Nitrogen	.41	.40	.811	.367	1.17	.53
% Protein	2.56	2.50	5.06	2.29	7.25	3.29
% Fat	3.1	3.0	6.13	2.78	8.80	3.94
Sugar	4.75	4.5	9.37	4.25	12.94	5.91
Ash	.66	.70	1.31	.59	2.03	.92

Table 8
weight of Dung and Urine

Veeman II

Date	Dung.			Urine		
	lbs.	oz.	gms.	lbs.	oz.	gms.
4-22-12	66	1	29965.3	4	15	2239.6
4-23-12	61	9	27924.1	5	7	2466.4
4-23-21	58	8	26535.0	15	15	7229.1
4-24-12	67		30390.5	8	3	3713.7
4-25-12	52		23586.7	8	15	4054.0
4-26-12	52-1/2		23813.5	8	15	4054.0
4-27-12	51		23133.1	8	15	4054.0
4-28-12	51	12	23473.3	9	15	4707.6
4-29-12	52		23586.7	15	15	7229.1
4-30-12	58	8	26535.0	12	7	5641.5
Total	570	14	258943.2	99	10	45189.0

Fione. I

Date	Dung		Urine	
	lbs.	gms.	lbs.	gms.
4-22-12	46-1/2	21091.9	10	4649.3
4-23-12	43-1/2	19731.2	7	3515.3
4-23-12	47	21318.7	26	12133.5
4-24-12	51	23133.1	10	4876.1
4-25-12	43	19504.4	9	4195.7
4-26-12	45-1/2	20638.4	11	5329.7
4-27-12	44	19958.0	9-1/2	4309.1
4-28-12	50	22679.5	17	8051.2
4-29-12	63	28576.2	13	6236.0
4-30-12	51-1/2	23359.9	29	13267.5
Total	485	219991.3	146	66563.9

Table 9

Analysis of Dung and Urine

Composition of Dung & Urine Digestion Trial.

	II	I	
Dung	Veeman	Fione.	
Dry Matter	16.12	16.00	
Moisture	83.88	84.00	
Ash	1.13	1.18	
N.	.365	.375	
Protein	2.28	2.32	
Crude Fibre	4.61	4.66	
N. Free Extract	7.75	7.43	
Fat	.35	.41	
Urine	<u>.97</u>	<u>1.55</u>	<i>Nitrogen in urine</i>

	Veeman	Nitrogen Balance.	Fione
	Wt. in gms.		Wt. in gms.
Dung	945.1		825.0
Urine	438.3		1031.7
Milk	521.6		347.4
Total	1905.0		2204.1

Comparison of Average and actual Digestion Coefficients.

	No. I.		No. II.	
Consumed in feed	2159.0		2442.7	
Protein	Average	Actual	Average	Actual
Crude Fiber	Average	Actual	Average	Actual
N. Free Ext.	Average	Actual	Average	Actual
Fat	Average	Actual	Average	Actual
No. I.	70.8	66.14	63.9	66.92
No. II.	70.8	66.34	63.9	66.50

Table X.
Summary of Digestion Trial

No. I.

	Consumed	Weight in gms. Excreted in Dung wt. in gms.	Per Cent Digested.
Protein	15,095.0	5103.8	66.16
Fat	4,477.3	901.9	79.86
Crude Fiber	18,981.4	10251.6	45.99
N. Free Extract	62,933.4	16345.4	74.03
Total	101,487.1	32,602.7	67.87

Table XI.

No. II.

	Consumed	Weight in gms. Excreted in Dung	Per cent Digested.
Protein	13,521.4	5903.9	56.34
Fat	5,312.6	906.3	82.94
Crude Fiber	18,763.4	11,937.3	36.38
N. Free Ext.	79,854.7	20,068.1	74.82
Total	117,452.1	38,815.6	66.10

Table XII.

Comparison of Average and actual Digestion Coefficients.

No. I.

When cow was fed maintenance ration plus B. Albumen.

No. I	Protein		Crude Fiber		N. Free Ext.		Fat	
	Average	Actual	Average	Actual	Average	Actual	Average	Actual
No. I	70.2	66.16	53.9	45.99	76.6	74.03	78.0	79.86

No. II.

When cow was fed maintenance ration plus Carbohydrate.

No. II.	Protein		Crude Fiber		N. Free Ext.		Fat.	
	Average	Actual	Average	Actual	Average	Actual	Average	Actual
No. II.	70.2	56.34	53.9	36.38	76.6	74.82	78.0	82.94

Table 13
Energy value in food, milk and dung.

Results - Cals.	Fione		Food.	
Date	4-21-12	4-22-12	4-23-12	4-24-12
Protein 1016	3423.92	3332.48	3362.96	3423.92
Carbo x 1071	15165.36	14533.47	14779.80	15165.36
Fat x 2273	2250.27	2227.54	2227.54	2250.27
Total	20839.55	20093.49	20370.30	20839.55
Cr. Fiberx 617	2708.63	2449.49	2544.21	2708.63
Act. E. Value	18130.92	17644.00	17826.09	18130.92
Total for 10 days	178,985.37	<i>milk</i>		
Protein 2660	1369.00	1388.52	1287.44	1383.20
Carbo x 1795.3	1703.64	1739.50	1613.97	1721.57
Fat X 4190.3	2598.05	2639.95	2473.34	2639.95
Total	5670.69	5767.97	5373.75	5744.72
Total for 10 days	55,941.11	<i>Dung</i>		
Protein x 1015	1097.28	1026.16	1107.44	1198.88
Carbo x 1071	3694.95	3459.33	3737.79	4059.09
Fat x 2273	431.87	409.14	431.87	477.33
Total	5224.10	4894.63	5277.10	5735.30
Cr. Fiber x 617	1338.89	1252.51	1351.23	1468.46
Act. E. Value	3885.21	3642.12	3925.87	4266.84
Total for 10 days	40,603.05			

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Results - Gain Energy Value.

4-25-12	4-26-12	4-27-12	4-28-12	4-29-12	4-30-12
3444.24	3403.60	3373.12	3362.96	3302.00	3373.12
15358.14	14844.06	14790.51	14779.80	14340.69	14790.51
22273.00	2250.27	2227.54	2250.27	2204.81	2250.27
21075.38	20497.93	20391.17	20393.03	19847.50	20413.90
2788.84	2579.06	2542.04	2544.21	2369.28	2542.04
18286.54	17918.87	17849.13	17848.82	17478.22	17871.86

Total for the 10 days = 119,513.77 Cals.

milk

1396.50	1335.32	1191.68	1287.44	1388.52	1423.10
1739.50	1667.77	1488.44	1613.97	1739.50	1775.37
2681.86	2556.14	2262.82	2472.34	2639.95	2723.76
5817.86	5559.23	4942.94	5373.75	5767.97	5922.23

Dung

1016.00	1076.96	1036.32	1178.56	1483.36	1209.04
3416.49	3619.98	3502.17	3984.12	5012.28	4091.22
409.14	431.87	409.14	477.33	590.98	477.33
4841.63	5128.81	4947.63	5640.01	7085.62	5777.59
1234.00	1308.04	1264.85	1437.61	1813.98	1480.80
3607.63	3820.77	3682.78	4202.40	5272.64	4296.79

Carbo x 1071	5463.52	5103.67	4851.63	5558.49
Fat x 2273	522.79	500.06	454.60	522.79
Total	7540.47	7031.13	6657.51	7635.76
Cr. Fiber x 617	1881.85	1752.28	1665.90	1906.53
Total	5658.62	5278.65	4991.61	5729.23

Total for 10 days = 48,947.41

Table 13

Results - Cals.

Food --- Veeman.

Date	4-21-12	4-22-12	4-23-12	4-24-12	4-25-12
Protein x 1016	3210.56	3210.56	3281.68	3129.28	2685.41
Carbo x 1071	20402.55	20402.55	20970.18	19717.11	17757.15
Fat x 2273	2750.33	2750.33	2795.79	2704.87	2591.12
Total	26363.44	26363.44	27047.65	25551.26	23233.68
Cr. Fiber x 617	3122.02	3122.02	3331.80	2862.88	2147.16
Act. E. Value.	23241.42	23241.42	23715.85	22688.38	21086.52

Total for the 10 days = 219,816.77 Cals

	4-26-12	4-27-12	Milk.	4-28-12	4-29-12	4-30-12
Protein x 2660	2101.40	1995.00		1915.20	2048.20	2241.83
Carbo x 1793.3	2564.42	2420.96		2151.96	2474.54	3319.94
Fat x 4190.4	3980.88	3771.36		3645.65	3855.17	7623.57
Total	8646.70	8187.32		7712.81	8377.91	

Total for 10 days = 78946.59 Cals.

	4-26-12	4-27-12	Dung.	4-28-12	4-29-12	4-30-12
Pr						
Protein x 1016	1534.16	1422.40		1351.28	1554.48	1857.51
Carbo x 1071	5483.52	5108.67		4851.63	5558.49	6685.90
Fat x 2273	522.79	500.06		454.60	522.79	991.61
Total	7540.47	7031.13		6657.51	7635.76	
Cr. Fiber x 617	1881.85	1752.28		1665.90	1906.53	
Total	5658.62	5278.85		4991.61	5729.23	

Total for 10 days = 48,847.41

4-25-12	4-26-12	4-27-12	4-28-12	4-29-12	4-30-12
3058.16	3149.60	2875.28	2621.28	2804.16	2885.44
19149.48	19888.47	17628.66	15550.92	17061.03	17757.18
2682.14	2727.60	2591.22	2454.84	2545.76	2591.22
24889.78	25765.67	23095.16	20627.04	22410.95	23233.84
2653.10	2936.92	2134.82	1332.72	1888.02	2147.16
22256.68	22828.75	20960.34	19294.32	20522.93	21086.68

		B.V. in Milk		Amount of milk.	
		55 Therms.		197.5 pounds	
4-25-12	4-26-12	4-27-12	4-28-12	4-29-12	4-30-12
1941.80	1862.00	1862.00	1782.20	1915.20	1852.00
2349.22	2259.56	2259.56	2169.89	2313.36	2241.63
3645.65	3519.94	3519.94	3394.22	3603.74	3519.94
7936.67	7641.50	7641.50	7346.31	7832.30	7623.57

4-25-12	4-26-12	4-27-12	4-28-12	4-29-12	4-30-12
1209.04	1219.20	1178.56	1198.88	1209.04	1351.28
4316.13	4358.97	4230.45	4294.71	4316.13	4851.63
409.14	409.14	409.14	409.14	409.14	454.60
5934.31	5987.31	5818.15	5902.73	5934.31	6657.51
1480.80	1493.14	1449.95	1474.63	1480.80	1665.90
4453.51	4494.17	4368.20	4428.10	4453.51	4991.61

carbohydrate digested 66.1% of whole ration. Both of which is a little lower than the theoretical.

The following authorities have been consulted:
 Lusk's Nutrient System, Bulletin Research 2 and 3.
 Lusk's Nutrient System, Dairy's, and Farmers Bulletin 316.
 Bulletin 27 revised Department of Agriculture.

The first half of the table gives the comparison of the average digestive co-efficients with the actual co-efficients and it indicates that the excess protein does effect the digestibility of the ration to any material change. The same is the case in the second part of the table, though there seems to be a slightly greater change in the digestibility of the protein and the crude fiber.

In table IX the nitrogen balance does not agree quite as closely as it might.

Table XIII. Continued.

	E.V. Consumed	E.V. in Milk	Amount of milk.
No. I.	17.8 Therms.	55 Therms.	197.5 pounds
No. II.	21.9 "	78 "	289.7 pounds
No. I.	Amount of energy used by cow	83.65 Therms	X
No. II.	" " " " " "	92.03 "	X

2--3% this energy may have escaped through hair or in the gases.

Summary--

Complete data is given of a digestion trial made with two Holstein cows, one being feed maintenance ration plus protein, the other maintenance ration plus carbohydrate.

The digestive co-efficient of both cows were about normal. The cow which received the maintenance ration plus B. Albumen digested 67.87% of whole ration and the one which received maintenance ration plus carbohydrate digested 66.10% of whole ration. Both of which is a little lower than the theoretical.

The following authorities have been consulted:

- Echol's Missouri Station Bulletin Research 2 and 5.
- Henry's, Shermans, Armsby's, and Farmers Bulletin 346.
- Bulletin 22 Revised Department of Agriculture.