SOME EFFECTS OF THE QUANTITY AND PHYSICAL CONDITION OF THE ROUGHAGE FED DAIRY COWS ON THE COMPOSITION OF THE MILK OKLAHOMA AGRICULTURAL & MECHANICAL COLLEGE SOME EFFECTS OF THE QUANTITY AND LIBRARY PHYSICAL CONDITION OF THE ROUGHAGE FED OCT 27 1939 DAIRY COWS ON THE COMPOSITION

OF THE MILK

By

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INTRODUCTION

The composition of milk has long been an object of scientific investigation. As milk is evaluated largely on the basis of its composition, investigators have given considerable study to the factors causing variations in the amounts of its various constituents.

Although many scientific discoveries have been made relative to the mode of milk secretion, much yet remains to be done to satisfactorily explain this phenomenon. Early workers were of the opinion that while the composition of milk of individual cows varied within certain limits, the composition was determined by heredity and could not be affected appreciably by feeding. Present day evidence indicates that this early hypothesis is only partially true. It still appears to be a fact, however, that the normal composition of a cow's milk is largely fixed by heredity and cannot be changed beyond certain more or less fixed limits.

THE PROBLEM

There are two fundamental causes of variations in the composition of milk--heredity and environment. The variation in the composition of milk of animals of different breeds is largely due to hereditary differences between the breeds. The composition of milk of animals of any breed may, however, change considerably under different conditions of environment.

Furthermore, there are a number of factors that operate during the dry period and throughout the lactation period that tend to alter the composition of milk. Some of these factors tend to lower the percentages of some of the constituents, while others tend to increase them. Some of these factors may be classed under management and nutrition and may be under the control of the feeder and milker, while others may be classed as physiological factors and are due to changes in the internal condition of the cow.

Extensive research has been conducted by experiment stations in the United States and in Europe, and this evidence indicates conclusively that the composition of milk cannot be appreciably changed permanently by any method of feeding. Experiments have shown that certain feeds and galactagogues may effect a slight change in the composition of milk for only a short period of time.

Recent research work has been presented that shows that the composition of milk might be materially changed for periods as long as several lactations by changing the physical condition and/or the quantity of roughage consumed.

The object of this investigation is to study some effects of the quantity and physical conditions of the roughages fed dairy cows on the composition of the milk.

REVIEW OF LITERATURE

A study of the literature relative to investigations of the composition of milk as affected by the physical condition and/or the quantity of roughage consumed reveals a very small amount of data, all of which are the results of comparatively recent work.

Studies by Powell (8) show conclusively that the physical character of the ration and the quantity of roughage consumed will significantly affect the composition of milk in both butterfat and solids-not-fat percentages. His studies include thirty-one cows for seventy-nine lactations. The cows received ample nutrients according to accepted standards and a later check-up on carotene content of the ration made up of the same formula as those that were used during the experiment, showed a daily intake up to 560,000 micrograms of carotene per cow.

Data presented on results from eight individual cows, which were said to be typical of all results secured under like circumstances, show a range of decrease in butterfat percent of 0.6 to 1.3 percent for lactations on a checkered ration $\frac{1}{2}$ as compared with a regular ration where natural roughage was fed ad libitum.

In two cases reported when the entire ration was fed in the meal form for the entire lactation, the average butterfat tests were 2.9 percent and 2.6 percent as compared to butterfat tests of 3.4 percent and 3.3 percent, respectively, for succeeding lactations on the regular ration.

Two other animals received checkered rations plus five pounds of alfalfa hay daily in rations that contained 21.9 and 14.7 pounds of roughage, respectively. The butterfat test was 2.9 percent as compared with 3.8 percent

A checkered ration is made by grinding the ingredients, mixing them, and running the mixture through a machine that compresses it into checkers or cubes.

during the succeeding lactation on the regular ration, and 2.5 percent in the sixth lactation as compared with 3.3 percent on a regular ration in the third lactation. When another individual received 15.0 pounds of silage daily with a checkered ration which included 22.3 pounds of roughage, the butterfat test was 2.7 percent for that lactation as compared with butterfat tests of 3.1 and 2.9 percent for the two succeeding lactations.

Studies with twelve Holsteins averaging more than sixty pounds of milk daily showed a decline in butterfat tests from approximately 4.0 percent while receiving 25.0 pounds of hay daily to approximately 2.1 percent when placed on a ration including 6.0 pounds of hay daily. When the cows were returned to 25.0 pounds of long hay daily, the butterfat test increased to approximately 3.2 percent. Graphic illustrations show that the trends of changes in the butterfat test closely paralleled trends of changes in hay consumption.

Powell (9) reports that the reaction of the cows in respect to butterfat content of milk was similar when the roughage allowance was kept the same but ground relatively fine, or when the total roughage allowed was reduced and the total digestible nutrients of the roughage deducted was replaced by increased concentrate allowances.

By regulating the physical characteristics and the total intake of the roughage part of the ration, Powell (10), in a series of tests involving thirty-seven cows, mostly Holsteins, for a total of eighty-five lactations, varied the fat content of the milk at will as much as 60.0 percent without materially changing the quantity of milk produced. He reported that a low fat test could be maintained for at least three complete lactations without apparent physical injury to the cow, and then restored to the normal fat percentage permanently by changing the physical characters of the roughage

received and/or the amount of roughage consumed. The solids-not-fat also varied in the same general manner as the butterfat.

Ingham and Meade (4) fed ground and unground soybean hay to dairy cattle in a roughage ration of 1.0 pound of hay and 3.0 pounds of silage per one hundred pounds live weight. The cows were allowed all the concentrates they would consume. For grinding the soybean hay, a hammer type mill with a 5/16 inch screen was used. The average butterfat test was 0.15 percent to 1.0 percent higher on ground than on unground soybean hay.

Olson (7) conducted four ninety-day feeding trials comparing the value of ground and unground alfalfa hay, sweet clover hay, and alfalfa hay and corn fodder. The animals were fed 30.0 pounds of silage daily and the additional quantity of dry roughage they would consume. Concentrates were fed according to milk production.

The butterfat test was 0.042 percent higher on whole alfalfa than on ground alfalfa; 0.175 percent higher on ground sweet clover hay than on whole sweet clover hay; 0.073 percent higher on ground alfalfa and corn fodder than on whole alfalfa and corn fodder in the first trial, and 0.021 percent higher on ground alfalfa and fodder in the second trial.

Morrow and LaMaster (5) studied the value of ground and unground alfalfa hay, soybean hay, and oats and wetch hay for milk production. Two lots of five cows each were allowed all the dry roughage they would consume after they were fed 3.0 pounds of corn silage per one hundred pounds live weight. The concentrate mix was fed in proportion to production using the Henry and Morrison Feeding Standard for computing the feed requirements.

The butterfat itests were 0.107 percent higher on ground alfalfa hay than on unground alfalfa hay; 0.004 percent higher on ground soybean hay than on unground soybean hay; and 0.024 percent higher on ground oats and vetch hay than on unground oats and vetch hay. They concluded that the

physical preparation of hay had no effect upon the quantity or quality of milk produced.

Reed and Burnett (11) fed ground and unground alfalfa hay in comparative rations to two groups of six cows each for a period of ninety days. The rations consisted of 1.0 pound of hay and 3.0 pounds of silage per one hundred pounds live weight, and 1.0 pound of concentrate per 3.5 pounds of milk produced by Holsteins, and 1.0 pound concentrate per 3.0 pounds of milk produced by Ayrshires. Samples for Babcock analyses were taken at each milking. The results show a 0.017 percent higher butterfat test for the ground hay periods than for the unground hay periods.

Hayden and co-workers (2) reported work in which ground and unground roughages consisting of two parts alfalfa and one part corn stover were fed to two groups of six cows each for one hundred and seventy-four days. The hay and stover were run through a hammer mill with a 7/16 inch screen. The butterfat test was 0.017 percent higher on the ground hay than on the unground hay.

In one feeding trial, Williams (12) compared the value of a ground and an unground roughage ration consisting of two parts alfalfa and one part corn stover for milk production. Two lots of six cows each were fed for about six months. The cows were given all the feed they would consume. Results show a butterfat test 0.059 percent higher for the ground roughage period than for the whole roughage period.

PLAN OF INVESTIGATION

Experimental Setup

Fourteen cows in the dairy herd of the Oklahoma Agricultural and Mechanical College were used in this study to obtain additional information of the effects of the quantity and physical condition of the roughage fed dairy cattle on the butterfat percent and solids-not-fat percent of milk. These studies include three experiments: (1) in which different levels of prairie hay were fed in the ground and the unground conditions, (2) in which alfalfa hay was fed in the ground and the unground forms, and (3) in which the roughage consisted of a limited amount of alfalfa hay.

In all experiments the single reversal plan of experimentation was used. The ordinary single reversal plan was used when a comparison between whole and ground hay was made and when a comparison was made between a full roughage ration and a limited roughage ration. The modified single reversal plan was used in Experiment 2 in which the relative effects of a full roughage ration of ground hay and limited roughage rations of ground and long hays were compared with a full roughage ration of long hay. The idea of an ordinary single reversal plan and the modified single reversal plan can easily be described diagrammatically.

Ordinary single reversal plan:

Long hay	1000	0	fround hay	10000	Long hay	29
1	1	2	2	3	3	1

Modified single reversal plan:



The ordinary single reversal plan permits a comparison of the first and third experimental periods with the second experimental period, and the modified form of the single reversal plan affords a comparison of the first and last experimental periods on the basal ration with each of the intermediate periods. It also permits a comparison between the intermediate periods. The merits and disadvantages of these plans will not be discussed here.

Cows Used in Experiments

Eight grade Jersey cows that were being used in a prairie hay and cottonseed meal investigation were available for studying some of the effects of feeding prairie hay in the ground and in the unground conditions on the composition of milk. Three of these animals received 4.0 pounds of hay daily, one 8.0 pounds of hay daily, and four approximately as much hay as they would consume.

Two Ayrshires and two Holsteins were used to study the influence on the butterfat and solids-not-fat content of the milk of a full roughage ration of long alfalfa as compared with a full roughage ration of ground alfalfa hay and with a limited roughage ration of ground and long alfalfa.

Two Holsteins that were finishing an experiment in which mungbean silage was compared with alfalfa hay for milk production offered an opportunity to compare the butterfat and solids-not-fat content of the milk produced on a full and on a limited roughage ration of alfalfa hay.

There were considerable variations in daily milk production, butterfat tests, stages of lactation, stages of gestation, live weights, and levels of feed intake among the fourteen animals used in the experiments. A description of these factors is given in Table 1.

			Age		Body	Stage of	Stage	Daily Milk	Butterfat	
Cow No.	Type of Hay Ration 2/	Breed	Yrs.	Mos.	Weight Lbs.	Lactation Days	Gestation Days	Yield Lbs.	Test Percent	
36	Full prairie hay	Grade Jersey	8	4	970	247	127	7.14	5.8501	
38	Full prairie hay	Grade Jersey	8	3	1016	29	0	21.98	4.3731	
13	Full prairie hay	Grade Jersey	10	9	1000	84	3	17.12	4.5724	
404	Full prairie hay	Grade Jersey	5	0	961	221	24	15.82	5.9147	
331	8 lbs. prairie hay	Grade Jersey	4	5	860	40	0	28.28	4.7546	
604	4 lbs. prairie hay	Grade Jersey	2	11	949	296	157	10.08	6.7935	
431	4 lbs. prairie hay	Grade Jersey	3	3	927	149	44	12.22	5.8219	
338	4 lbs. prairie hay	Grade Jersey	4	3	871	134	0	22.56	4.5468	
1	Full alfalfa hay	Holstein	3	11	1404	69	0	41.59	3.5779	
2	Full alfalfa hay	Holstein	5	4	1602	47	0	56.19	3.4166	
3	Full alfalfa hay	Ayrshire	6	3	1289	43	0	41.41	3.6491	
4	Full alfalfa hay	Ayrshire	4	11	1149	130	41	23.49	3.7027	
5	Full alfalfa hay	Holstein	6	6	1431	162	39	37.48	3.4308	
6	Full alfalfa hay	Holstein	9	5	1524	115	29	60.41	3.4367	

Table 1. Description of Animals at the Beginning of Experiments

2/ A full hay ration is the quantity of hay a cow will consume when dry hay constitutes the entire roughage. This is usually about 2.0 pounds of hay daily for each 100 pounds body weight.

Feeds Used

The feeds used in Experiment 1 were good quality Oklahoma prairie hay grown locally, molasses beet pulp, and cottonseed meal, 45 percent protein grade. In Experiment 2 good quality brown alfalfa hay was used. The concentrate mixture fed from February 20 to February 28 consisted of four parts corn, three parts wheat bran, two parts cats, and two parts cottonseed meal. The concentrate mixture fed from March 1 to May 25 consisted of four parts corn, three parts wheat bran, two parts cats, and one part cottonseed meal. In Experiment 3, No. 2 grade alfalfa hay was fed. The concentrate mixture consisted of four parts corn, three parts wheat bran, two parts cats, and one part cottonseed meal. In all cases the cows were fed ample protein and total digestible nutrients to meet their requirements for maintenance and milk production as required by the Morrison Feeding Standards.

Preparation of Hays

The alfalfa and prairie hays fed in the ground condition from March 8 to April 1 were ground with a Jay Bee hammer type mill, size 2 U, using a 2/32 inch screen. A thirty horse-power electric motor was the source of power.

The ground alfalfa hay fed from April 2 to May 25 was ground with a John Deere hammer type mill, 10-inch size, using a 3/32 inch screen. A 15-30 horse-power McCormick Deering tractor was the scarce of power.

A sample was taken from each bag of ground hay fed in the experiments for the purpose of determining the modulus of fineness. All samples of ground prairie hay were combined and thoroughly mixed by placing the samples of hay on a large paper and alternately pulling the opposite corners of the paper across each other. Two representative samples were taken from the composite batch for determining the modulus of fineness by the method described by Bohstedt (1).

The same procedure was followed for mixing samples and determining the modulus of fineness of the alfalfa hay ground by the Jay Bee hammer type mill, size 2 U, using the 2/32 inch screen and that ground with the John Deere hammer type mill, 10-inch size, using the 3/32 inch screen.

Modulus of Fineness of Ground Hays

Table 2 shows the average percent of hays retained on the different Tyler standard screen scale sieves and the modulus of fineness of the hays fed in the experiment.

The prairie hay ground with the Jay Bee harmer type mill, size 2 U, using a 2/32 inch screen had an average modulus of fineness of 1.4587, while the alfalfa hay ground with the same equipment had an average modulus of fineness of 1.3009. The alfalfa hay ground with the John Deere harmer type mill, 10-inch size, using the 3/32 inch screen had an average modulus of fineness of 2.1923.

Powell (9) stated that part of the hay used in his experimental work was No. 2 grade, submitted to a 1/4 inch grind. Eighty percent of this material would pass through a 10 mesh screen. In other parts of his investigation, No. 1 grade hay ground fine enough for ninety percent to pass through a 24 mesh screen was fed.

Analysis of the ground hays used in Experiments 1 and 2 shows that the prairie hay was ground fine enough for ninety percent to pass through a 28 mesh screen. The alfalfa hay ground with the Jay Bee hammer type mill, Size 2 U, using the 2/32 inch screen was fine enough for ninety-five percent to pass through the 28 mesh. The alfalfa ground with the John Deere hammer type mill, 10-inch size, using a 3/32 inch screen was fine enough for seventythree percent to pass through the 28 mesh screen.

Thus it appears that the ground prairie hay used in Experiment 1 and the more finely ground alfalfa hay used in Experiment 2 were of finer grind

	Average Percent of Hay Retained on Screens										
	Screen Size:										
	3/8 mesh	4 mesh	8 mesh	14 mesh	28 mesh	48 mesh	100 mesh	Bottom	Total	Modulus	
Prairie 3/	0.00	0.07	0.12	0.47	9.19	42.97	29.46	17.75	100.00		
Added totals	0.00	0.07	0.19	0.66	9.85	52.82	82.28		145.87	1.4587	
Alfalfa 3/	0.00	0.00	0.00	0.27	4.78	48.09	18.49	28.38	100.00		
Added totals	0.00	0.00	0.00	0.27	5.05	53.14	71.63	25 21 1	130.09	1.3009	
Alfalfa 4/	0.00	0.00	0.02	9.85	26.74	41.26	16.99	14.03	100.00	1.28	
Added totals	0.00	0.00	0.02	9.87	36.61	77.87	94.86	Sec. 1	219.23	2.1923	

Table 2. Modulus of Fineness of Ground Hays Consumed in Experiments

3/ Jay Bee, Size 2 U, hammer type mill, 2/32 screen.

4/ John Deere hammer type mill, 10-inch size, 3/32 screen.

than that used in Powell's investigation. One would estimate that the more coarsely ground alfalfa hay used in Experiment 2 was coarser than the finer ground hay used by Powell.

Management of the Cows

The cows were stanchioned in individual stalls with special box-mangers designed to eliminate wasting of feeds and to prevent the exchange of feeds between mangers. Water bowls were located at each stall to provide water. Water was also available in the outdoor lot.

The feed allowances were weighed out each afternoon for the evening feeding and for the following morning feeding. Orts were removed and weights recorded each afternoon before the evening feed allowances were placed in the mangers. The cows were kept outdoors in dry lot all days when weather was favorable.

All cows in the experiments were milked twice daily and the weights of milk were recorded at each milking.

Sampling and Analyses of Milk Samples

A representative sample of milk was taken from each cow immediately after each milking for analysis of butterfat percent and for making lactometer readings.

Duplicate butterfat determinations by the Babcock method were made on all samples. The test bottles used were calibrated and all duplicate analyses checked within 0.1 percent. The daily butterfat production and daily butterfat tests were calculated using the average results of the duplicate determinations for each milking.

Lactometer readings were made on all samples of milk with a Quevenne lactometer calibrated to be read at the level of the surface of the milk according to Hereford (3). Lactometer readings were taken at the top of the meniscus and recorded. The temperature of the milk was also recorded. Corrections for temperature and reading at the top of the meniscus were made as described by Newlander (6). The Babcock Formula, Sclids-Not-Fat Percent = $\frac{\text{Lactometer Reading}}{4}$ + 0.2 x Butterfat Percent, was used for calculating percent of solids-not-fat.

Live Weights

Live weights of individual cows were taken at the beginning and at the end of each preliminary and experimental period. The plan was to have the second of the three weighing days fall on the first or last day of each preliminary or experimental period as the case might be. The animals were woighed on successive days until three weights within a range of twenty pounds were obtained. The average of these three weights was used as the average body weight.

PRESENTATION AND DISCUSSION OF EXPERIMENTAL DATA

Feed Records

The average daily ration offered each cow, the feeds refused, and the feeds consumed are summarized in Table 3.

In Experiment 1, Cow No. 604 received 4.0 pounds of hay daily. From the beginning of Period 3 on January 11 to January 20, cottons eed meal was fod mixed with ground hay. During the remaining portion of the experimental period, each feed was fed separately. During the entire experimental period portions of the ground hay were refused whether fed mixed with the cottonseed meal or fed alone. Average daily hay refusal for Period 1 on long hay was 0.24 pounds; for Period 3 on ground hay, 2.33 pounds; and for Period 5 on long hay there were no hay refusals (Table 3).

On the other hand, Cow No. 36 refused an average of only 0.09 pounds of ground hay daily during Period 3 as compared with average daily refusals of 2.38 pounds of long hay in Period 1 and 1.49 pounds of long hay in Period 5.

Cow No. 13 refused no hay during Period 3 on the ground hay ration. During Period 1 on long hay there was an average daily refusal of 2.10 pounds of hay and during Period 5 on long hay there was an average daily refusal of 3.73 pounds of hay (Table 3).

With the exception of an average daily hay refusal of 3.30 pounds of long hay for Cow No. 404 during Period 1, there were no appreciable daily hay refusals during any periods for the other cows on the experiment.

Difficulty was encountered in getting Cow No. 3 in Experiment 2 to consume the hay in the ground condition. During Period 3 in which 8.0 pounds of long hay and 18.0 pounds of ground hay were fed, she refused an average of 2.38 pounds of ground hay daily. For Period 4 in which 18.0 pounds of ground hay were fed, the average daily refusal was 4.06 pounds, and for Period 5 in which 4.0 pounds of ground hay were fed daily, the

		Length	Prairie Hay				Beet Pu	lp	Cottonseed Meal		
Feeding Period	Ration	Period Days	Offered Lbs.	Refused Lbs.	Consumed Lbs.	Offered Lbs.	Refused Lbs.	Consumed Lbs.	Offered Lbs.	Refused Lbs.	Consumed Lbs.
Cow No. 36 1 3 5	Full long hay Full ground hay Full long hay	5 26 12	15.00 12.46 13.00	2.38 0.09 1.49	12.62 12.37 11.51				8.00 6.46 6.00	0.00 0.00 0.00	8.00 6.46 6.00
Cow No. 38 1 3 5	Full long hay Full ground hay Full long hay	5 24 18	23.00 20.00 22.00	0.10 0.00 0.43	22.90 20.00 21.57				8.24 10.00 10.00	0.00 0.00 0.00	8.24 10.00 10.00
Cow No. 13 1 3 5	Full long hay Full ground hay Full long hay	5 50 11	20.00 18.00 18.00	2.10 0.00 3.73	17.90 18.00 14.27				9.76 10.00 10.00	0.00 0.00 0.00	9.76 10.00 10.00
Cow No. 404 1	Full long hay and best pulp	5	19.00	3.30	15.70	4.40	0.00	4.40	6.60	0.00	6.60
3	Full ground hay and beet pulp	25	17.88	0.26	17.62	4.00	0.00	4.00	6.08	0.00	6.08
4 6	Full ground hay Full long hay	18 25	17.50 18.00	0.58 0.32	16.92 17.68				7.58 7.00	0.00	7.58 7.00
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Table 3. Average Dai ly Ration Offered, Feeds Refused, and Feeds Consumed by Individuals

		Length	Prairie Hay				Beet Pul	lp	Cottonseed Meal		
Feeding Period	Ration	Period Days	l Offered Lbs.	Refused Lbs.	Lbs.	Offered Lbs.	Refused Lbs.	Consumed Lbs.	Offered Lbs.	Refused Lbs.	Consumed Lbs.
Cow No. 331 1 3 5 7 9	8 lbs. long hay 8 lbs. ground hay 8 lbs. long hay 8 lbs. ground hay 8 lbs. long hay	8 35 15 14 10	8.20 8.17 8.19 8.04 8.00	0.00 0.20 0.00 0.00 0.10	8.20 7.97 8.19 8.04 7.90	15.75 14.00 14.00 14.00 14.00	0.00 0.00 0.00 0.00 0.00	15.75 14.00 14.00 14.00 14.00	9.00 8.00 8.00 8.00 8.00 8.00	0.00 0.00 0.00 0.00 0.00	9.00 8.00 8.00 8.00 8.00 8.00
Cow No. 604 1 3 5	4 lbs. long hay 4 lbs. ground hay 4 lbs. long hay	5 30 16	4.00 4.00 4.00	0.24 2.33 0.00	3.76 1.67 4.00	9.00 8.50 8.00	0.00 0.00 0.00	9.00 8.50 8.00	6.40 6.20 6.00	0.00 1.03 0.00	6.40 5117 6.00
Cow No. 431 1 3 5	4 lbs. long hay 4 lbs. ground hay 4 lbs. long hay	5 49 18	4.00 4.00 4.00	0.00 0.04 0.09	4.00 3.96 4.00	12.00 11.15 11.00	0.00 0.00 0.00	12.00 11.15 11.00	5.00 5.00 5.00	0.00 0.02 0.00	5.00 4.98 5.00
Cow No. 338 1 3 5	4 lbs. long hay 4 lbs. ground hay 4 lbs. long hay	5 49 18	4.00 4.00 4.00	0.00 0.02 0.00	4.00 3.98 4.00	12.00 12.00 12.00	0.00 0.00 0.00	12.00 12.00 12.00	5.00 5.00 5.00	0.00 0.00 0.00	5.00 5.00 5.00

Table 3 (Continued). Average Daily Ration Offered, Feeds Refused, and Feeds Consumed by Individuals

		Length	Prairie Hay			-	Beet Pul	.p	Concentrate		
Feeding Period	Ration	Period Days	Offered Lbs.	Refused Lbs.	Consumed Lbs.	Offered Lbs.	Refused Lbs.	Consumed Lbs.	Offered Lbs.	Refused Lbs.	Consumed Lbs.
Cow No. 1 1 5 6 8	Full long hay Full ground hay Limited ground hay Limited long hay Full long hay	8 30 10 10 10	28.00 28.00 4.00 4.00 28.00	0.00 0.13 0.00 0.00 4.50	28.00 27.87 4.00 4.00 23.50	16.20 16.20	0.00 0.00	16.20 16.20	12.00 12.00 12.00 12.00 12.00 12.00	0.00 0.07 0.00 0.00 0.00	12.00 11.93 12.00 12.00 12.00
Cow No. 2 1 3 5 6 8	Full long hay Full ground hay Limited ground hay Limited long hay Full long hay	8 30 10 10 10	32.00 32.00 4.00 4.00 32.00	0.12 2.02 0.00 0.00 7.84	31.88 29.98 4.00 4.00 24.16	19.00 19.00	0.00 0.00	19.00 19.00	16.00 16.00 16.00 16.00 16.00	0.00 1.01 0.00 0.00 0.00	16.00 14.99 16.00 16.00 16.00
Cow No. 3 1 3 4 6 7 9	Full long hay 8 lbs. long hay 18 lbs. ground hay 18 lbs. ground hay Limited ground hay Limited long hay 18 lbs. long hay	8 20 10 10 10 10	26.00 8.00 18.00 18.00 4.00 4.00 18.00	0.25 0.00 2.38 4.06 2.63 0.00 3.69	25.75 8.00 15.62 13.94 1.37 4.00 14.31	9.40 9.40	0.20 0.00	9.20 9.40	13.00 13.00 24.00 23.32 20.60 20.60	0.00 1.19 5.40 7.89 7.83 0.42	13.00 11.81 18.60 15.43 12.77 20.18
Cow No. 4 1 3 5 6 8	Full long hay Full ground hay Limited ground hay Limited long hay Full long hay	8 30 10 10 10	24.00 24.00 4.00 4.00 24.00	0.24 0.04 0.00 0.00 4.31	23.76 23.96 4.00 4.00 19.69	13.60 13.60	0.00	13.60 13.60	4.00 6.00 6.00 6.00 6.00	0.00 0.03 0.00 0.20 0.10	4.00 5.97 6.00 5.80 5.90

Table 3 (Continued). Average Daily Ration Offered, Feeds Refused, and Feeds Consumed by Individuals

Feeding Period	Ration	Length of Period Days	Prairie Hay				Beet Pul	p	Co	oncentra	te
			Offered Lbs.	Refused Lbs.	Consumed Lbs.	Offered Lbs.	Refused Lbs.	Consumed Lbs.	Offered Lbs.	Refused Lbs.	Consumed Lbs.
Cow No. 5 1 3 5	Full long hay Limited long hay Full long hay	20 10 10	29.00 8.00 29.00	0.15 0.00 0.13	28.85 8.00 28.87	14.00	0.00	14.00	14.00 14.00 14.00	0.00 0.00 0.00	14.00 14.00 14.00
Cow No. 6 1 5 3 5	Long hay plus silage Limited long hay Full long hay	20 10 10	15.00 8.00 30.00	0.49 0.00 3.09	14.51 8.00 26.91	15.40	0.00	15.40	20.00 20.00 20.00	0.00 0.00 0.15	20.00 20.00 19.85

Table 3 (Continued). Average Daily Ration Offered, Feeds Refused, and Feeds Consumed by Individuals

5/ 44.97 pounds of mungbean silage consumed daily.

average daily refusal was 2.63 pounds of ground hay (Table 3).

Cow No. 2 refused portions of the mixed ground hay and concentrate occasionally during Period 3 on ground hay. Cows Nos. 1 and 4 refused no appreciable quantities of hay during the ground hay period (Table 3).

During the initial ground hay periods every animal in the experiment consumed practically all the alfalfa hay offered. The quality of hay offered during the final long hay period appeared to be somewhat more coarse than that fed during the initial long hay period. There were average daily hay refusals for Cows Nos. 1, 2, 3, and 4 of 4.50, 7.84, 3.69, and 4.31 pounds of long hay, respectively, for Period 8 (Table 3).

Animal No. 6 in Experiment 3 went off feed and refused large quantities of hay during the last few days of Period 5 on long hay. With this exception there were no appreciable quantities of hay refused during any of the feeding periods in Experiment 3.

With a few exceptions, the cows consumed most of the roughages offered during the different feeding periods. There was little difference in the palatibility of the hays whether fed in the ground or unground condition. With the exception of Cow No. 604 in Experiment 1 and Cow No. 3 in Experiment 2, little difficulty was experienced in getting the cows to consume hay in the ground condition.

Changes in Live Weights

The changes in live weight of individual cows on the different roughage rations during the experiments are recorded in Table 4.

Animals Nos. 36, 13, and 404, receiving the full ration of prairie hay showed small daily losses during Period 1 on long hay. Cow No. 38 made an avorage gain of 1.0 pound daily during the period. While on ground hay (Period 3) all three animals showed small avorage daily losses, and during Period 5 on long hay all animals made small daily gains.

Fèeding Period	Ration	Length of Period Days	Ave. Initial Weight Lbs.	Ave. Final Weight Lbs.	Gain or Loss Lbs.	Ave. Daily Gain or Loss Lbs.
Cow No. 36 1 3 5	Full long hay Full ground hay Full long hay	5 26 12	970 967 949	968 956 956	- 2 -11 + 7	-0.40 -0.42 +0.58
Cow No. 38 1 3 5	Full long hay Full ground hay Full long hay	5 24 18	1016 993 967	1021 971 970	+ 5 -22 + 3	+1.00 -0.92 +0.17
Cow No. 13 1 3 5	Full long hay Full ground hay Full long hay	5 50 11	1000 966 930	990 935 945	-10 -31 +15	-2.00 -0.62 +1.36
Cow No. 404 1 3 and 4 6	Full long hay Full ground hay Full long hay	5 43 25	961 956 909	953 940 937	- 8 -16 +28	-1.60 -0.37 +1.12
Cow No. 331 1 3 5 7 9	8 lbs. long hay 8 lbs. ground hay 8 lbs. long hay 8 lbs. ground hay 8 lbs. long hay	8 35 15 14 10	860 866 864 889 902	866 850 889 902 886	+ 6 -16 +25 +13 -16	+0.75 -0.46 +1.67 +0.93 -1.60
Cow No. 604 1 3 5	4 lbs. long hay 4 lbs. ground hay 4 lbs. long hay	5 30 16	949 955 942	955 941 946	+ 6 -14 + 4	+1.20 -0.47 +0.25
Cow No. 431 1 3 5	4 lbs. long hay 4 lbs. ground hay 4 lbs. long hay	5 49 18	927 939 931	939 925 961	+12 -14 +30	+2.40 -0.29 +1.67
Cow No. 338 1 3 5	4 lbs. long hay 4 lbs. ground hay 4 lbs. long hay	5 49 18	871 897 859	897 859 834	+26 -38 -25	+5.20 -0.78 -1.39

Table 4. Changes in Live Weights of Cows on Different Roughage Rations

Feeding Poriod	Ration	Length of Period Days	Ave. Initial Weight Lbs.	Ave. Final Weight Lbs.	Gain or Loss Lbs.	Ave. Daily Gain or Loss Lbs.
Cow Ho. 1 1 3 5 6 8	Full long hay Full ground hay Limited ground hay Limited long hay Full long hay	8 30 10 10 10	1602 1448 1486 1498 1481	1500 1448 1498 1480 1463	-102 \pm 0 + 12 - 18 - 18	-12.75 ± 0.00 + 1.20 - 1.80 - 1.80
Gow No. 2 1 3 5 6 8	Full long hay Full ground hay Limited ground hay Limited long hay Full long hay	8 30 10 10 10	1404 1237 1214 1200 1257	1262 1230 1200 1232 1262	-142 - 7 - 14 + 32 + 5	-17.75 - 0.23 - 1.40 + 3.20 + 0.50
Cow No. 3 1 3 and 4 6 7 9	Full long hay 18.0 lbs. ground hay Limited ground hay Limited long hay 18.0 lbs. long hay	8 30 10 10 10	1289 1161 1155 1125 1183	1180 1149 1125 1190 1194	-109 - 12 - 30 + 65 + 11	-13.63 - 0.40 - 3.00 + 6.50 + 1.10
Cow No. 4 1 3 5 6 8	Full long hay Full ground hay Limited ground hay Limited long hay Full long hay	8 30 10 10 10	1149 1078 1100 1117 1130	1149 1162 1117 1132 1119	* 0 + 84 + 17 + 15 - 11	+ 0.00 + 2.80 + 1.70 + 1.50 - 1.10
Cow Ho. 5 1 3 5	Full long hay Limited long hay Full long hay	20 10 10	1431 1431 1457	1446 1445 146 2	+ 15 + 14 + 5	+ 0.75 + 1.40 + 0.50
Cow No. 6 1 3 5	Long hay plus silage Limited long hay Full long hay	20 10 10	1524 1466 1472	1526 1457 1472	+ 2 - 9 - 0	+ 0.10 - 0.90 ± 0.00

Table 4 (Continued). Changes in Live Weights of Cows on Different Roughage Rations

Cow No. 331 fed 8.0 pounds of hay and Cows Nos. 604, 431, and 336 fed 4.0 pounds of hay showed small daily gains during Period 1 on long hay; small daily losses during Period 3 on ground hay; while all made slight daily gains during Period 5 on long hay with the exception of Cow No. 338. Cow No. 338 showed an average daily loss of 1.39 pounds during Period 5. Cow No. 331 showed an average daily gain of 0.93 pound during Period 7 on ground hay and an average daily loss of 1.60 pounds during Period 9 on long hay.

Animals Nos. 1, 2, 3, and 4 in Experiment 2 showed wider variations in live weight than did the animals in the other experiments, as revealed by Table 4. Some individuals gained weight while others lost weight during most of the feeding periods. The changes in live weights were not accompanied by corresponding changes in condition, but perhaps represent a difference in fill of the animals. Milk production was not appreciably affected by the changes in live weights of the animals.

Cows Nos. 5 and 6 showed small daily gains during Period 1 on the full roughage ration and small daily losses during Period 3 on the reduced hay ration. During Period 5 on the full long hay ration, Cow No. 5 showed small gains and Cow No. 6 maintained the same live weight.

With few exceptions, there were no significant daily variations in live weight during the different fooding periods in Experiments 1, 2, and 3. The low live weights of Cows Nos. 1, 2, and 3 in Experiment 2 during Period 1 might be accounted for, at least partially, by the fact that they had been receiving an allowance of Sargo silage in the ration prior to the beginning of this period.

Production of Cows

Records of milk yield, butterfat production, and solids-not-fat production for the individual cows are summarized by five-day periods in Table 5

			Cow Nc.	36		Cow No. 38					
Five- Day Period	Milk Yield Lbs.	Fat Porcent	Butterfat Production Lbs.	Solids- Not-Fat Percent	Solids- Not-Fat Production Lbs.	Milk Yield Lbs.	Fat Percent	Butterfat Production Lbs.	Solids- Not-Fat Percent	Solids- Not-Fat Production Lbs.	
1 2 <u>6</u> / 3 4 5 6 7 8 9 10	35.7 25.6 31.8 30.9 31.1 30.1 29.8 28.2 24.7 23.3 21.6	5.850 5.716 5.196 5.772 5.465 5.394 5.602 5.987 5.901 5.790 5.780	2.0885 1.4633 1.9702 1.7837 1.6096 1.6237 1.6695 1.6884 1.4576 1.3490 1.2601	10.141 10.033 9.876 9.498 8.970 9.395 9.534 9.328 9.354 9.354 9.547 9.576	3.6202 2.5685 3.1406 2.9350 2.7897 2.8280 2.8411 2.6304 2.3104 2.2245 2.0876	109.9 89.6 112.1 107.9 106.2 107.2 104.0 101.6 95.7 98.7 99.1	4.373 4.919 4.643 4.380 4.413 4.476 4.477 4.846 4.782 4.910 4.758	4.8060 4.4078 5.2053 4.7262 4.6862 4.7986 4.6565 4.9234 4.5766 4.8462 4.7151	9.585 9.627 9.410 9.204 8.719 8.909 9.293 8.999 8.968 8.883 8.577	10.5342 8.6253 10.5491 9.9315 9.2592 9.5507 9.6648 9.1432 8.5829 8.7671 8.4995	
12	~L•O	5.700	1.007	3.010		100.2	4.649	4.6585	8.511	8.5278	

Table 5. Milk, Butterfat, and Solids-Not-Fat Production by Five-Day Periods

6/ Only four days' data collected during period.

A States			Cow No.	13		Cow No. 404						
Five- Day Period	Milk Yield Lbs.	Fat Percent	Butterfat Production Lbs.	Solids- Not-Fat Percent	Solids- Not-Fat Production Lbs.	Milk Yield Lbs.	Fat Percent	Butterfat Production Lbs.	Solids- Not-Fat Percent	Solids- Not-Fat Production Lbs.		
1	85.6	4.573	3.9141	9.388	8.0364	79.1	5.914	4.6783	9.739	7.7036		
2	87.1	4.837	4.2127	9.227	8.0369	83.5	5.097	4.2558	9.681	8.0838		
3	81.8	4.758	3.8923	9.103	7.4466	82.5	5.255	4.3355	9.585	7.9075		
4	83.2	4.421	3.6781	9.023	7.5069	82.3	5.046	4.1531	9,369	7.7109		
5	81.7	4.336	3.5425	8.665	7.0796	80.3	5.080	4.0795	9.085	7.2953		
6	82.4	4.361	3.5938	8.646	7.1239	80.7	4.982	4.0207	8.854	7.1455		
7	81.0	4.352	3.5253	8.884	7.1960	83.3	5.028	4.1885	9.165	7.6344		
8	77.9	4.756	3.7051	8.933	6.9587	78.9	5.358	4.2276	9.238	7.2890		
9	79.0	4.503	3.5575	8.899	7.0303	75.8	5.257	3.9845	8.984	6.8101		
10	73.9	4.922	3.6372	8.858	6.5458	69.5	5.153	3.5811	8.950	6.2199		
11	75.7	4.570	3.4592	8.699	6.5853	72.9	5.160	3.7615	8.551	6.2333		
12	75.6	4.671	3.5316	8.131	6.1471	77.3	5.056	3.9082	8.422	6.5098		
13	75.9	4.471	3.3938	8.152	6.1874	77.8	4.740	3.6878	8.213	6.3900		
14	75.1	4.643	3.4870	8.297	6.2310	76.8	4.855	3.7286	8.379	6.4353		
15	70.2	4.895	3.4361	8.348	5.8603	74.2	4.820	3.5761	8.553	6.3462		
16	66.7	4.496	2.9990	8.624	5.7522	75.7	4.512	3.4155	8.494	6.4300		
17		129 6023				68.8	4.879	3.3568	8.671	5.9655		
18 6/	Sector	100				58.8	4.912	2.8884	8.758	5.1497		

6/ Only four days' data collected during period.

			Cow No. 3	31				Cow No. 6	04	
Five- Day Period	Milk Yield Lbs.	Fat Percent	Butterfat Production Lbs.	Solids- Not-Fat Percent	Solids- Not-Fat Production Lbs.	Milk Yield Lbs.	Fat Percent	Butterfat Production Lbs.	Solids- Not-Fat Percent	Solids- Not-Fat Production Lbs.
1	142.3	4.738	6.7422	9.021	12.8369	50.4	6.793	3.4239	10.640	5.3626
2	139.0	4.722	6.5637	8.778	12.2020	48.3	6.841	3.3044	10.472	5.0580
3	141.2	4.612	6.5124	8.566	12.0949	38.9	7.138	2.7765	10.106	3.9313
4	137.6	4.559	6.2737	8.566	11.7861	37.4	6.711	2.5100	9.900	3.7025
5	141.7	4.427	6.2729	8.610	12.2002	35.9	6.411	2.3017	9.504	3.4118
6	143.4	4.439	6.3653	8.769	12.5740	33.6	6.594	2.2155	9.587	3.2212
7	135.6	4.357	5.9076	8.790	11.9190	32.8	6.932	2.2737	9.720	3.1982
8	134.4	4.391	5.9015	8.980	12.0690	27.7	7.180	1.9889	9.524	2.6380
9	131.4	4.468	5.8710	9.127	11.9932	28.9	6.954	2.0097	9.614	2.7783
10 6/	109.2	4.468	4.8792	9.071	9.9059	26.1	6.763	1.7652	9.918	2.5886
11	132.5	4.944	6.5510	9.213	12.2072	24.3	6.925	1.6827	9.713	2.3603
12	130.5	4.849	6.3279	9.305	12.1428		1. 1. 1. 1.	1.1.1.1.1.1.1.1		
13 6/	104.0	4.896	5.0915	9.287	9.6587		1999	and the second	2	
14	128.1	4.904	6.2816	9.436	12.0875			1 1 1 1	Same .	1.2.3.5. 30
15	124.9	4.627	5.7787	9.485	11.8463					1.1.1
16 6/	99.4	4.545	4.5173	9.543	9.4858	1.1.1.2		a start and		
17 6/	101.3	4.767	4.8288	9.830	9.9576	1200	1	CC-32	R. C.	No. of Contraction
18	126.7	4.857	6.1532	9.585	12,1440	1993	and the second	1.1.1.1.1.1.1.1.1		
19	126.0	4.897	6.1698	9.356	11.7884					

6/ Only four days' data collected during period. (Cow No. 331, Periods 10, 13, 16, and 17)

	1.2.5.5		Cow No. 4	31		Cow No. 338				
Five- Day Period	Milk Yield Lbs.	Fat Percent	Butterfat Production Lbs.	Solids- Not-Fat Percent	Solids- Not-Fat Production Lbs.	Milk Yield Lbs.	Fat Percent	Butterfat Production Lbs.	Solids- Not-Fat Percent	Solids- Not-Fat Production Lbs.
1	61.1	5.822	3.5572	10.504	6.4180	112.8	4.547	5.1288	9.297	10.4872
2	59.0	5.722	3.3759	10.153	5.9904	115.8	4.227	4.8951	9.283	10.7491
3	57.4	6.036	3.4646	10.167	5.8359	115.2	4.537	5.2271	9.247	10.6527
4	58.5	5.441	3.1831	9.702	5.6759	109.9	4.078	4.4820	8.822	9.6957
5	57.5	5.374	3.0902	9.457	5.4375	110.3	3.935	4.3403	8.705	9.6015
6	59.5	5.245	3.1210	9.276	5.5191	106.1	3.932	4.1721	8.820	9.3579
7	59.0	5.377	3.1727	9.666	5.7027	102.6	4.033	4.1382	8.820	9.0491
8	55.0	5.552	3.0537	9.540	5.2469	102.9	4.044	4.1617	8.695	8.9467
9	56.4	5.549	3.1297	9.646	5.4346	103.5	3.960	4.0989	8.799	9.1065
10	53.2	5.614	2.9868	9.443	5.0239	102.7	4.113	4.2239	8.765	9.0018
11	54.9	5.427	2.9793	9.320	5.1166	103.2	4.163	4.2962	8.467	8.7378
12	56.1	5.405	3.0321	8.945	5.0179	103.4	4.118	4.2581	8.331	8.6142
13	57.8	5.279	3.0515	8.759	5.0625	111.4	4.025	4.4844	8.315	9.2624
14	57.9	5.152	2.9831	8.989	5.2046	112.2	3.834	4.3018	8.400	9.4245
15	57.6	5.234	3.0147	9.248	5.3271	112.3	4.028	4.5236	8.720	9.7928

Table 5 (Continued). Milk, Butterfat, and Solids-Not-Fat Production by Five-Day Periods

		S. C	Cow No.	1				Cow No.	2	
Five- Day Period	Milk Yield Lbs.	Fat Percent	Butterfat Production Lbs.	Solids- Not-Fat Percent	Solids- Not-Fat Production Lbs.	Milk Yield Lbs.	Fat Percent	Butterfat Production Lbs.	Solids- Not-Fat Percent	Solids- Not-Fat Production Lbs.
1	210.6	3.562	7.5014	8.652	18.2216	285.2	3.407	9.7164	7.706	21.9772
2	203.4	3.603	7.3293	8.594	17.4792	268.5	3.495	9.3844	7.903	21.2195
3 6/	163.3	3.768	6.1535	8.227	13.4353	217.1	3.438	7.4646	7.546	16.3814
4	201.3	3.477	6.9989	8.492	17.0948	265.0	3.374	8.9412	7.662	20.3046
5	201.8	3.401	6.8637	8.591	17.3364	259.2	3.014	7.8135	8.006	20.7526
6	192.4	3.249	6.2520	8.480	16.3157	242.7	3.054	7.4125	8.026	19.4799
7	186.4	3.368	6.2779	8.605	16.0395	243.1	2.964	7.2051	8.045	19.5570
8	176.9	3.257	5.7610	9.148	16.1737	224.2	2.966	6.6506	7.989	17.9118
9	184.8	3.275	6.0523	8.752	16.1738	201.8	3.086	6.2281	8.117	16.3806
10	186.3	3.393	6.3208	8.656	16.1260	207.9	3.289	6.8388	7.924	16.4741
11	181.3	3.359	6.0894	8.748	15.8597	216.2	2.822	6.1020	7.899	17.0779
12	177.7	3.314	5.8888	8.905	15.8241	219.3	2.055	4.5072	7.942	17.4167
13	186.3	3.418	6.3677	8.949	16.6727	209.9	1.895	3.9774	7.971	16.7308
14	165.0	3.349	5.5252	8.846	14.5966	201.2	1.532	3.0818	8.099	16.2994
15	168.4	3.426	5.7697	8.683	14.6222	206.5	1.849	3.8192	8.115	16.7583
16 2	130.9	3.213	4.2062	8.860	11.5975	157.3	2.438	3.8350	8.156	12.8292
17	159.7	3.605	5.7564	8.835	14.1093	191.5	2.904	5.5609	8.234	15.7684
18	160.4	3.702	5.9388	8.836	14.1732	187.4	3.084	5.7789	8.197	15.3611
19	145.9	3.403	4.9651	8.408	12.2678	185.8	3.093	5.7473	7.899	14.6763
			And the second second second	1		11	1	1		1

6/ Only four days' data collected during period.

			Cow No.	3		Cow No. 4				
Five- Day Period	Milk Yield Lbs.	Fat Percont	Butterfat Production Lbs.	Solids- Not-Fat Percent	Solids- Not-Fat Production Lbs.	Milk Yield Lbs.	Fat Percent	Butterfat Production Lbs.	Solids- Not-Fat Percent	Solids- Not-Fat Production Lbs.
$ \begin{array}{c} 1 & 6 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 & 6 \\ 7 \\ 8 \\ 9 \\ 10 \\ 11 \\ 12 \\ 13 \\ 14 \\ 15 \\ \end{array} $	206.7 207.4 209.0 190.9 195.1 188.7 191.0 188.6 181.7 171.6 169.9 160.0 151.5 145.7 157.1	3.546 3.723 3.689 3.439 3.610 3.617 3.499 3.077 3.184 3.427 3.184 3.427 3.378 3.194 2.958 3.167 3.143	7.3297 7.7206 7.7108 6.5641 7.0438 6.8260 6.6838 5.8036 5.7845 5.8803 5.7392 5.1102 4.4815 4.6137 4.9378	8.734 8.628 8.517 8.509 8.509 8.614 8.835 8.814 8.835 8.817 8.694 8.819 8.796 8.696 8.696 8.805 8.747	18.0526 17.8951 17.8003 16.2433 16.6009 16.6327 16.8745 16.7572 16.0208 14.9192 14.9827 14.9827 14.0733 13.1747 12.8293 13.7421	93.8 116.9 122.7 121.4 123.5 98.4 117.4 107.4 112.8 115.6 114.8 110.8 111.3 106.1 89.2	3.645 3.849 3.651 3.656 3.611 3.464 3.612 3.679 3.588 3.485 3.485 3.485 3.457 3.382 3.368 3.463 3.463 3.633	3.4194 4.4992 4.4798 4.4378 4.4601 3.4085 4.2410 3.9517 4.0469 4.0283 3.9682 3.7476 3.7491 3.6743 3.2403	8.804 8.573 8.414 9.220 8.644 8.872 8.761 8.986 8.925 8.826 8.826 8.800 8.965 9.010 9.141 8.379	8.2584 10.0218 10.3238 11.1931 10.6755 8.7299 10.2849 9.6508 10.0670 10.2024 10.1027 9.9332 10.0276 9.6990 7.9201
16 <u>6</u> / 17 18 19	131.0 159.2 154.9 146.9	2.867 3.087 3.060 3.032	3.7560 4.9145 4.7394 4.4536	8.863 8.897 8.807 8.648	11.6101 14.1647 13.6420 12.7045	76.7 87.7 86.2 81.6	3.864 3.869 4.003 3.806	2.9634 3.3934 3.4509 3.1061	9.103 9.154 8.964 8.658	6.9820 3.0281 7.7269 7.0649

<u>6</u>/

Only four days' data collected during period (Periods 1 and 6 for Cow No. 4; Period 16 for Cows 3 and 4)

Sector Sector			Cow No.	5		Cow No. 6				
Five- Day Period	Milk Yield Lbs.	Fat Percent	Butterfat Production Lbs.	Solids- Not-Fat Percent	Solids- Not-Fat Production Lbs.	Milk Yield Lbs.	Fat Percent	Butterfat Production Lbs.	Solids- Not-Fat Percent	Solids- Not-Fat Production Lbs.
1	188.0	3.307	6.2176			295.7	3.527	10.4296		AL US
2	189.3	3.480	6.5875		Contraction of	301.7	3.475	10.4849		
3	187.7	3.562	6.6850	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	1. 1. 1. 1. 1. 1.	304.9	3.469	10.5775		
4 6/	147.2	3.357	4.9419	1. 1. 1.		245.5	3.240	7.9547		AND STARLES
5	180.7	3.123	5.6427	18.24 8.1	S. S. Disselfs	305.4	3.093	9.4454	1.5.873	CONTRACTOR NO
6	196.2	3.273	6.4208	8.478	17.0580	310.5	3.046	9.4569	8.771	27.2338
7	204.2	3.044	6.2168	8.416	17.1855	299.4	2.940	8.8025	8.567	25.6500
8	177.7	2.960	5.2608	8.272	14.6987	272.7	3.082	8.4039	8.745	23.8465
9	160.0	3.126	5.0017	8.298	13.2764	257.6	3.121	8.0387	8.611	22.1807
10 6/	123.5	3.403	4.2026	8.518	10.5203	201.2	3.439	6.9188	8.635	17.3738
11	153.8	3.356	5.1621	8.437	12.9758	235.9	3.347	7.8952	8.754	20.6513

6/ Only four days ! data collected during period.

and in Figures 1 to 14, inclusive. Table 6 presents the average daily milk yield, butterfat percent, butterfat production, solids-not-fat percent, and solids-not-fat production for the individual animals by feeding periods.

Experiment 1, Long Vs. Ground Prairie Hay

Cows Nos. 36, 38, and 13 showed reductions of 0.1446, 0.1069, and 0.0922 percent butterfat, respectively, and reductions of 0.4251, 0.0680, and 0.2156 percent solids-not-fat, respectively, on ground hay (Period 3) as compared with the averages of Periods 1 and 5 on long hay. During the experiment these cows maintained fairly uniform levels of milk production as shown by Table 5. Trends of changes in butterfat tests, solids-not-fat percentages, and milk yields for each cow are shown in Figures 1, 2, and 3.

The milk of Cow No. 404 tested 0.3589 percent lower in butterfat and 0.5894 percent lower in solids-not-fat when ground hay replaced the long hay and approximately the same allowance of beet pulp was fed (Periods 1 and 3). For Period 4 in which the ground hay was fed without the beet pulp allowance, the butterfat test increased 0.1694 percent while the solids-notfat percent decreased 0.2138 percent. When the ground hay was replaced by long hay, the butterfat and solids-not-fat were lowered 0.4428 and 0.3994 percent, respectively. Milk production during the experiment was very uniform as shown in Table 5. Trends in butterfat tests, solids-not-fat percentages, and milk yields are shown in Figure 4.

Cow No. 331 received approximately 8.0 pounds of prairie hay daily during the entire experiment. During the initial long hay period she consumed 15.75 pounds of beet pulp and 9.0 pounds of cottonsoed meal daily. During the succeeding periods she consumed 14.0 pounds of molasses beet pulp and 3.0 pounds of cottonseed meal daily (Table 3). The butterfut and selids-not-fat were 0.3576 percent and 0.3096 percent lower, respectively.

Period	Ration	Length of Period Days	Milk Yield Lbs.	Fat Percent	Butterfat Production Lbs.	Solids- Not-Fat Percent	Solids- Not-Fat Production Lbs.
Cow No. 36 1 3 5	Full long hay Full ground hay Full long hay Average Periods 1 and 5 Difference due to grinding	5 26 12	7.14 6.11 4.54 5.84	5.8501 5.6902 5.8194 5.8348 -0.1446	0.4177 0.3478 0.2642 0.3410	10.1401 9.4042 9.5184 9.8293 - 0.4251	0.7240 0.5746 0.4323 0.5782
Cow No. 38 1 3 5	Full long hay Full ground hay Full long hay Average Periods 1 and 5 Differencendue to grinding	5 24 18	21.98 21.28 19.84 20.91	4.3731 4.4629 4.7665 4.5698 -0.1069	0.9612 0.9497 0.9456 0.9534	9.5853 9.0291 8.6088 9.0971 - 0.0680	2.1068 1.9214 1.7080 1.9074
Cow No. 13 1 3 5	Full long hay Full ground hay Full long hay Average Periods 1 and 5 Difference due to grinding	5 50 11	17.12 15.78 13.53 15.33	4.5725 4.5355 4.6829 4.6277 -0.0922	0.7828 0.7157 0.6336 0.7082	9.3884 8.7288 8.5004 8.9444 - 0.2156	1.6073 1.3774 1.1501 1.3787
Cow No. 404 1 3 4 6	Full long hay plus heet pulp Full ground hay plus beet pulp Full ground hay Full long hay	5 23 20 25	15.82 16.30 14.83 14.80	5.9147 5.0558 5.2252 4.7824	0.9357 0.8241 0.7749 0.7078	9.7391 9.1497 8.9359 8.5365	1.5407 1.4914 1.3252 1.2634

Table 6. Average Daily Production of Cows During Experimental Periods

Feeding Period	Ration	Length of Period Days	Milk Yield Lbs.	Fat Percent	Butterfat Production Lbs.	Solids- Not-Fat Percent	Solids- Not-Fat Production Lbs.
Cow No. 331 1 3 5 7 9	8 lbs. long hay 8 lbs. ground hay 8 lbs. long hay 8 lbs. long hay 8 lbs. long hay 8 lbs. long hay Average Periods 1 and 5 Difference due to grinding Average Periods 5 and 9 Difference due to grinding	8 35 15 14 10	28.28 27.54 26.29 25.10 25.27 27.29 25.78	4.7546 4.4597 4.8764 4.7303 4.8730 4.8155 -0.3576 4.8747 -0.1444	1.3446 1.2282 1.2820 1.1873 1.2314 1.3133 1.2567	8.9413 8.7727 9.2233 9.4341 9.4769 9.0823 -0.3096 9.3501 7+0.0840	2.5286 2.4160 2.4248 2.3680 2.3948 2.4767 2.4098
Cow No. 604 1 3 5	4 lbs. long hay 4 lbs. ground hay 4 lbs. long hay Average Periods 1 and 5 Difference due to grinding	5 30 16	10.08 7.30 5.31 7.70	6.7935 6.7890 6.8832 6.3384 -0.0494	0.6848 0.4956 0.3655 0.5252	10.6401 9.8523 9.7232 10.1817 -0.3294	1.0725 0.7192 0.5163 0.7944
Cow No. 431 1 3 5	4 lbs. long hay 4 lbs. ground hay 4 lbs. long hay Average Periods 1 and 5 Difference due to grinding	5 49 17	12.22 11.35 12.26 12.24	5.8219 5.5286 5.2423 5.5321 -0.0035	0.7114 0.6275 0.6427 0.6771	10.0621 9.6282 8.9641 9.5131 +0.1151	12296 12928 110990 110990 111643 1118 M
Cow No. 338 1 3 5	4 lbs. long hay 4 lbs. ground hay 4 lbs. long hay 4 lbs. long hay Average Periods 1 and 5 Difference due to grinding	5 49 17	22.56 21.37 23.56 23.06	4.5468 4.1042 3.9813 4.2641 -0.1599	11.0258 0.8771 0.9380 0.9819	9.2971 8.8401 8.4244 8.8608 -0.0207	A .0974 -1.8893 1.9847 2.0424

Table 6 (Continued). Average Daily Production of Cows During Experimental Periods

Feeding Period	Ration	Length of Period Days	Milk Yield Lbs.	Fat Percent	Butterfat Production Lbs.	Solids- Not-Fat Percent	Solids- Not-Fat Production Lbs.
Cow No. 1 1 5 6 8	Full long hay Full ground hay Limited ground hay Limited long hay Full long hay Average Periods 1 and 8 Difference due to grinding (Period 3 and Periods 1, 8) Difference due to grinding and limit- ing hay (Period 5 and Periods 1,8) Difference due to limiting hay (Period 6 and Periods 1,8)	8 30 10 10 10	41.59 38.06 36.40 33.34 31.03 36.31	3.5779 3.3418 3.3672 3.3878 3.5442 3.5611 -0.2193 -0.1939 -0.1733	1.4880 1.2719 1.2257 1.1295 1.0998 1.2939	8.6804 8.5959 8.9277 8.7639 8.6336 8.6570 -0.0641 +0.2707 +0.1069	3.6100 3.2704 3.2497 2.9219 2.6790 3.1445
Cow No. 2 1 3 5 6 8	Full long hay Full ground hay Limited ground hay Limited long hay Full long hay Average Periods 1 and 8 Difference due to grinding (Period 3 and Periods 1, 8) Difference due to grinding and limit- ing hay (Period 5 and Periods 1,8) Difference due to limiting hay (Period 6 and Periods 1,8)	8 30 10 10 10	56.19 47.53 42.92 40.77 37.50 46.85	3.4166 3.0880 1.9768 1.6927 3.0569 3.2368 -0.1488 -1.2600 -1.5441	1.9197 1.4676 0.8485 0.6901 1.1463 1.5330	7.8037 7.9709 7.9561 8.1071 8.0481 7.9259 +0.0450 +0.0302 +0.1812	4.3849 3.7886 3.4148 3.3053 3.0180 3.7015

Table 6 (Continued). Average Daily Production of Cows During Experimental Periods

Feeding		longth of Period	Milk Yield	Fat	Butterfat Production	Solids- Not-Fat	Solids- Not-Fat Production
Period	Ration	Da y s	Lbs.	Percent	Lbs.	Percent	Lbs.
Cow Mc. 3 1 3 4 6 7 9	Full long hay 18 lbs. ground hay and 8 lbs. long hay 18 lbs. ground hay Limited ground hay Limited long hay 18 lbs. long hay	8 20 10 10 10 10	41.41 38.27 36.55 31.15 30.28 30.37	3.6491 3.5246 3.1861 3.0793 3.1545 3.0641	1.5111 1.3489 1.1645 0.9592 0.9552 0.9306	8.7304 8.6370 8.8554 8.7474 8.7752 8.7597	3.6155 3.3245 3.2367 2.7248 2.6571 2.6603
Cow No. 4 1 3 5 6 8	Full long hay Full ground hay Limited ground hay Limited long hay Full long hay Average Periods 1 and 6 Difference due to grinding (Period 3 and Periods 1,8) Difference due to grinding and limit- ing hay (Period 5 and Periods 1, 8) Difference due to limiting hay (Period 6 and Periods 1, 8)	8 30 10 10 10	23.49 23.33 22.21 19.53 16.95 20.22	3.7027 3.5869 3.3755 3.5407 3.8932 3.7980 -0.2111 -0.4225 -0.2573	0.8696 0.8367 0.7497 0.6915 0.6599 0.7648	8.7237 8.7768 6.9874 9.0216 8.8360 8.7799 -0.0011 +0.2075 +0.2417	2.0492 2.0481 1.9961 1.7619 1.4977 1.7735

Table 3 (Continued). Average Daily Production of Cows Juring Experimental Periods

Feeding Period	Ration	Length of Period Days	Milk Yield Lbs.	Fat Percent	Butterfat Production Lbs.	Solids- Not-Fat Percent	Solids- Not-Fat Production Lbs.
Cow No. 5 1 3 5	Full long hay Limited long hay Full long hay Average Periods 1 and 5 Difference due to limiting hay	20 10 10	37.48 39.04 31.37 34.43	3.4308 3.0305 3.3461 3.3885 -0.3580	1.2859 1.1831 1.0497 1.1678	8.3856 8.4680 -0.0824	3.2737 2.6564
Cow No. 6 1 3 5	Long hay plus silage Limited long hay Full long hay Average Periods 1 and 5 Difference due to limiting hay	20 10 10	60.41 58.01 46.06 53.24	3.4367 2.9697 3.3607 3.3987 -0.4290	2.0761 1.7228 1.5480 1.8121	8.6423 8.7568 -0.1145	5.0134 4.0334

Table 6 (Continued). Average Daily Production of Cows During Experimental Periods



Average Butterfat Percent, Solids-Not-Fat Percent, and Milk Yield by Five-Day Periods



Feeding Period	Cow No. 36	Cow No. 38
1	12.62 lbs. long hay	22.90 lbs. long hay
2	Change to ground hay	Change to ground hay
3	12.37 lbs. ground hay	20.00 lbs. ground hay
4	Change to long hay	Change to long hay
5	11.51 lbs. long hav	21.57 lbs. long hay

Amount and Condition of Prairie Hay Consumed Daily



Legend: _____ Butterfat Percent _____ Solids-Not-Fat Percent _____ Average Daily Milk Yield Pounds

Feeding Period	Cow No. 13	Cow No. 404
1	17.90 lbs. long hay	15.70 lbs. long hay, 4.00 lbs. beet pulp
2	Change to ground hay	Change to ground hay
3	18.00 lbs. ground hay	17.62 lbs. ground hay, 4.00 lbs. beet pulp
4	Change to long hay	16.92 lbs. ground hay
5	14.27 lbs. long hay	Change to long hay
6		17.68 lbs. long hay

Amount and Condition of Prairie Hay Consumed Daily



Legend: _____ Butterfat Percent _____ Solids-Not-Fat Percent _____ Average Daily Milk Yield Pounds

Feeding Period	Cow No. 331	Cow No. 604		
123456780	8.20 lbs. long hay Change to ground hay- 7.97 lbs. ground hay Change to long hay 8.19 lbs. long hay Change to ground hay 8.04 lbs. ground hay Change to long hay	3.76 lbs. long hay Change to ground hay 1.67 lbs. ground hay Change to long hay 4.00 lbs. long hay		

Amount and Condition of Prairie Hay Consumed Daily



Average Butterfat Percent, Solids-Not-Fat Percent, and Milk Yield by Five-Day Periods



Feeding Period	Cow No. 431	Cow No. 338
1	4.00 lbs. long hay	4.00 lbs. long hay
2	Change to ground hay	Change to ground hay
3	3.96 lbs. ground hay	3.98 lbs. ground hay
4	Change to long hay	Change to long hay
5	4.00 lbs. long hay	4.00 lbs. long hay

Amount and Condition of Prairie Hay Consumed Daily



Legend: _____ Butterfat Percent _____ Solids-Not-Fat Percent _____ Average Daily Milk Yield Pounds

Amount and Condition of Alfalfa Hay Consumed Daily				
Feeding Period	Cow No. 1	Cow No. 2		
1	28.00 lbs. long hay	31.88 lbs. long hay		
2	Change to ground hay	Change to ground hay		
3	27.87 lbs. ground hay	29.98 lbs. ground hay		
4	Change to 4.00 lbs. ground hay	Change to 4.00 lbs. ground hay		
5	4.00 lbs. ground hay	4.00 lbs. ground hay		
6	4.00 lbs. long hay	4.00 lbs. long hay		
7	Change to 28.00 lbs. long hay	Change to 32.00 lbs. long hay		
8	23.50 lbs. long hay	24.16 lbs. long hay		



Legend: _____ Butterfat Percent _____ Solids-Not-Fat Percent _____ Average Daily Milk Yield Pounds

Feeding Period	Cow No. 3	Cow No. 4
1	25.72 lbs. long hay	23.76 lbs. long hay
2	Change to 16.00 lbs. ground hay	Change to ground hay
3	15.62 lbs. ground hay, 8.00 lbs. long hay	23.96 lbs. ground hay
4	13.94 lbs. ground hay	Change to 4.00 lbs. ground hay
5	Change to 4.00 lbs. ground hay	4.00 lbs. ground hay
6	1.37 lbs. ground hay	4.00 lbs. long hay
7	4.00 lbs. long hay	Change to 24.00 lbs. long hay
8	Change to 18.00 lbs. long hay	19.69 lbs. long hay
9	1433 lbs. long hay	

Amount and Condition of Alfalfa Hay Consumed Daily



Legend: _____ Butterfat Percent _____ Solids-Not-Fat Percent _____ Average Daily Milk Yield Pounds

Amount	and	Condition	of	Alfalfa	Hay	Consumed	Daily	r

Feeding Period	Cow No. 5	Cow No. 6
1	28.85 lbs. long hay	14.51 lbs. long hay, 44.97 lbs. mungbean silage
2	Change to 8.00 lbs. long hay	Change to 8.00 lbs. long hay
3	8.00 lbs. long hay	8.00 lbs. long hay
4	Change to 29.00 lbs. long hay	Change to 30.00 lbs. long hay
5	28.87 lbs. long hay	26.91 lbs. long hay

for Period 3 on the ground hay ration than the averages of Periods 1 and 5 on the long hay ration; and 0.1444 and 0.0840 percent lower for Period 7 on ground hay as compared with the averages of Periods 5 and 9 on long hay (Table 6). Hilk production showed a slow, uniform decline during the experimont as shown in Table 5. The course of changes in butterfat tests, solidsnot-fat percentages, and milk yields are shown in Figure 5.

Animals Nos. 604, 431, and 338 which received roughage rations consisting of 4.0 pounds of prairie hay daily showed reductions in butterfat tests of 0.0494, 0.0035, and 0.1599 percent, respectively, on ground hay (Period 3) as compared with the averages of Periods 1 and 5 on long hay. Cows Nos. 604 and 338 declined 0.3294 and 0.0207 percent, respectively, in solids-not-fat, while Cow No. 431 increased 0.1151 percent on ground hay (Period 3) as compared with the average of Periods 1 and 5 on long hay. The animals maintained rather uniform levels of milk production during the experiment (Table 5). Courses of changes in butterfat and solids-not-fat percentages and in milk yields are shown in Figures 6, 7, and 8.

Experiment 2, Full Vs. Ground Vs. Limited Alfalfa Hay Rations

Animals Nos. 1 and 4 showed reductions of 0.2193 and 0.2111 percent butterfat, and 0.0641 and 0.0011 percent solids-not-fat when the full long hay allowances were replaced by the same amounts of ground hay (Periods 1 and 3). When the full ground hay allowances were reduced to 4.0 pounds of ground hay daily (Period 5), the milk of Cow No. 1 increased 0.0254 percent in butterfat and 0.3348 percent in solids-not-fat while that of Cow No. 4 decreased 0.2114 percent in butterfat and increased 0.2086 percent in solidsnot-fat. When the 4.0 pounds of ground hay were replaced by 4.0 pounds of long hay (Period 6), the butterfat tests increased 0.0206 and 0.1652 percent, respectively, while the solids-not-fat decreased 0.1638 percent for Cow No. 1

and increased 0.0342 percent for Cow No. 4. When the cows were returned to full roughage rations of long hay, the butterfat tests increased 0.1564 and 0.3525 percent, respectively, and the solids-not-fat decreased 0.1303 and 0.1856 percent, respectively.

Due to the striking manner in which the butterfat content of the milk was lowered by limiting the roughage intake of Cow No. 2, a more detailed discussion of this case is offered. During Period 1 in which 32.0 pounds of long hay were fed and during the transition period when this amount of long hay was gradually changed to 32.0 pounds of ground hay, Cow No. 2 tested about 3.4 percent butterfat. In the early part of Period 3 when fed 32.0 pounds of ground hay there was a gradual reduction in butterfat test to about 3.0 percent which was maintained somewhat uniformly to the end of the period. Early in the next transition period in which Cow No. 2 was changed from 32.0 pounds of ground hay to 4.0 pounds of ground hay, the butterfat test began to decline. This decline continued schewhat uniformly to the end of the transition period and through Period 5 in which she was continued on 4.0 pounds of ground hay. Her lowest test of 1.3 percent butterfat occurred on the fourthday of Period 6 in which 4.0 pounds of long hay were fed. During the remaining portion of Poriod 6 and during the period in which she was changed to 32.0 pounds of long hay, the butterfat test increased steadily. During Period 8 in which 32.0 pounds of long hay were fed daily, the milk tested about 3.05 percent butterfet. There was a slight gradual increase in solids-not-fat percent from the beginning of the experiment through Period 6 in which 4.0 pounds of long hay were fed. The solids-notfat percent for Period 8 on 32.0 pounds of long hay was slightly lower than for Period 6 on the limited hay ration.

During Period 3 in which Cow No. 3 received 18.0 pounds of ground and 3.0 pounds of long hay daily, the butterfat and solids-not-fat percentages were 0.1245 and 0.0604 percent lower than during Period 1 on 26.0 pounds of long hay. During Period 4 in which the total digestible nutrients supplied by the 8.0 pounds of long hay wore replaced by increasing the quantity of concentrate mixture fed, the butterfat test was lowered 0.3385 percent and the solids-not-fat content was increased 0.1684 percent. When the roughage was reduced to 4.0 pounds of ground hay daily (Period 6) the butterfat and solids-not-fat percentages were lowered 0.1068 percent and 0.1080 percent respectively. When 4.0 pounds of long hay replaced the ground hay (Period 7) the butterfat and solids-not-fat percentages were increased 0.0752 and 0.0278 percent, respectively. For Period 9 in which 18.0 pounds of long hay were fed, the butterfat test was 0.0904 percent lower and the solids-notfat content was 0.0155 percent higher than during Period 7 on 4.0 pounds of long hay.

The declines in milk yields for Cows Nos. 1, 3, and 4 were gradual and somewhat uniform during the experiment (Table 5). Milk production for Cow No. 2 declined rather rapidly during the first half and more slowly during the last half of the experiment (Table 5). Trends of changes in butterfat tests, solids-not-fat percentages, and milk yields for Cows 1, 2, 3, and 4 are shown in Figures 9, 10, 11, and 12.

Experiment 3, Full Vs. Limited Alfalfa Hay Rations

Cows Nos. 5 and 6 in Experiment 3 showed reductions in butterfat percent of about the same range on the limited hay ration (Period 3) as compared with the full hay rations $\frac{7}{2}$ (Periods 1 and 5). The average difference in butterfat tests represents a decline of 0.3935 percent for the

During Feriod 1, Cow No. 6 received 1.0 pound of alfalfa hay and 3.0 pounds of mungbean silage for each one hundred pounds live weight.

period on the limited roughage ration as compared with the averages of the full roughage periods. On the limited roughage ration (Period 3) the milk of Cows Nos. 5 and 6 was 0.0824 and 0.1145 percent lower in solids-not-fat than during Period 5, the final full roughage ration. The levels of milk production of the cows in this group were quite uniform during the first part of the experiment but manifested a rathor sharp decline during the last part. Trends of butterfat tests, solids-not-fat percentages, and milk yields for the experiment are shown in Figures 13 and 14.

SURMARY

With the exception of two animals, little difficulty was experienced in getting the cows to consume the allowances of hays offered in the ground condition. There was little difference in the palatibility of the hays whether fed in the ground or unground condition.

Except for Cows Nos. 1, 2, and 3 during Period 1, there were no appreclable changes in the live weights of the cows on the ground and unground, and/or on the full and limited hay rations.

In Experiment 1, Cows Nos. 36, 38, and 13, which were fed from 12.4 to 23.0 pounds of prairie hay daily, showed an average butterfat test of 4.93 percent for the initial long hay periods, 4.90 percent for the ground hay periods, and 5.09 percent for the final long hay periods. The average solidsnot-fat tests for the respective periods were 9.70, 9.05, and 8.88 percent. These results indicate that there was a slight reduction in butterfat test caused by feeding the hay in the ground condition. The physical condition of the hay apparently was not the cause of the variations in the solids-notfat content of the milk.

A similar comparison for Cow No. 331 which received an 3.0 pound hay ration shows average butterfat tests of 4.32, 4.60, and 4.37 percent and solids-not-fat content of 9.08, 9.10, and 9.35 percent, respectively, for the initial long hay periods, the ground hay periods, and the final long hay periods. The average of the two trials with this animal indicates that grinding the hay caused a small reduction in the butterfat test, but did not cause any marked changes in the solids-not-fat content.

Cows Nos. 604, 431, and 338 which were fod 4.0 pounds hay daily showed average buttorfat tosts of 5.72 percent for the initial long hay periods, 5.47 percent for the periods on ground hay, and 5.37 percent for the final periods on long hay. The average solids-not-fat percentages for these respective periods were 10.00, 9.44, and 9.19. These results indicate that grinding the 4.0 pounds daily hay allowance effected no appreciable reduction in butterfat test. The solids-not-fat content was not affected by the physical condition of the roughage.

In Experiment 2, Cows Nos. 1, 2, and 4 which received from 24.0 to 32.0 pounds of alfalfa hay daily showed an average butterfat test of 3.57 percent on the initial full long hay ration (Period 1), 3.34 percent on the full ground hay ration (Period 3), 2.89 percent on the limited roughage rations (Periods 5 and 6), and 3.50 percent on the final long hay ration (Period 8). The solids-not-fat content of the milk was 8.40 percent for the initial full long hay periods, 8.45 percent for the full ground hay periods, 8.63 percent for the limited hay periods, and 8.51 percent for the final full long hay periods. Due to the short duration of the limited hay periods, a comparison was not made of the effect on the butterfat and solidsnot-fat content of the milk caused by feeding the 4.0 pounds hay ration in the ground condition. These results indicate that feeding a full roughage ration in the ground condition and/or limiting the mughage ration effected a reduction in the butterfat test, but did not appreciably affect the solids-not-fat percent of the milk produced.

In Experiment 3, Cow No. 5 received 29.0 pounds of alfalfa hay during the full roughage periods. Cow No. 6 received 15.0 pounds of alfalfa hay and 45.0 pounds of mungbean silage during the initial full roughage period and 50.0 pounds of alfalfa hay during the final full roughage period. Cows Nos. 5 and 6 had an average butterfat test of 3.43 percent for the initial full roughage periods, 3.00 percent for the limited roughage periods, and 3.55 percent for the final full roughage periods. The average solidsnot-fat content for the limited roughage periods was 8.51 percent as compared with 8.61 percent for the final full roughage periods. Limiting the quantity of roughage fed caused a small reduction in butterfat test. Feeding a full roughage ration caused a slight increase in the solids-notfat content over that produced on a limited roughage ration.

Of the twelve cows fed hay in the ground condition in this investigation, no individual responded with changes in butterfat test to the extent of those described by Powell (8). Of the six animals fed limited roughage rations, only one responded to the reduced hay ration with a reduction in butterfat test similar to decreases reported by Powell (8). In the investigation herein reported, molasses beet pulp was fed during the limited roughage period to replace the total digestible nutrients of the deducted quantity of hay. In Powell's investigations, increased quantities of concentrate were fed during the limited roughage period to supply ample total digestible nutrients.

CONCLUSIONS

The physical proparation of the roughage fed dairy cows effected a small reduction in the butterfat content of the milk produced. The degree of reduction in butterfat caused by the physical proparation of the roughage varies inversely with the level of roughage intake. The physical condition of the roughage fed did not significantly affect the solids-not-fat content of the milk.

Limiting the quantity of roughage fed dairy cows caused a reduction in butterfattest. Individual cows responded to limited roughage allowances with varying degrees of reduction in butterfat percent. Limiting the quantity of roughage fed has no significant effect on the solids-notfat content of the milk.

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