

UNIVERSITY OF IDAHO
AGRICULTURAL EXPERIMENT STATION

Department of Dairy Husbandry

APPLE POMACE SILAGE

for

MILK PRODUCTION

by

F. W. ATKESON and G. C. ANDERSON

BULLETIN NO. 150

MAY, 1927

Published by the University of Idaho, Moscow, Idaho.

UNIVERSITY OF IDAHO AGRICULTURAL EXPERIMENT STATION

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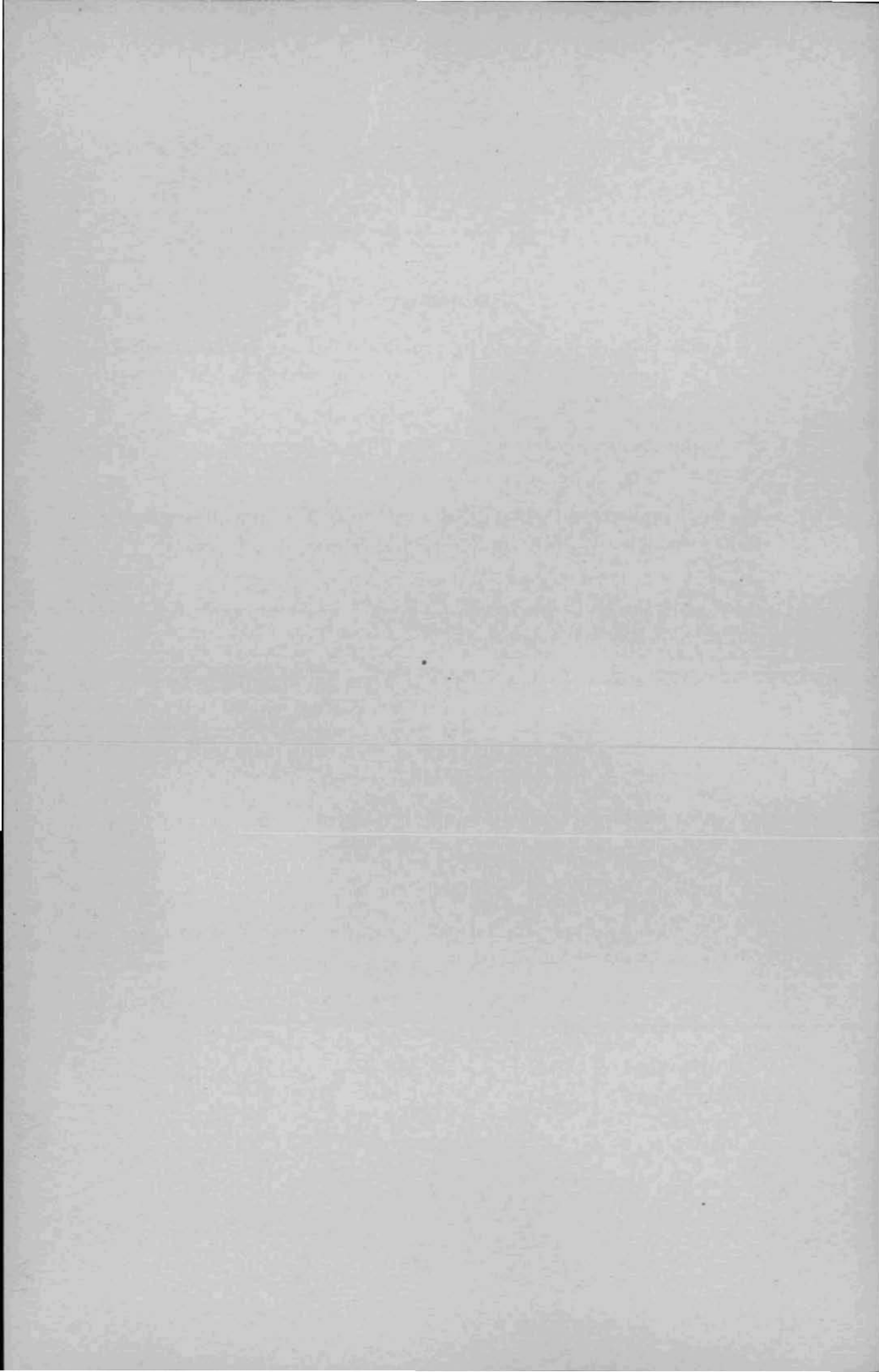
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SUMMARY

1. Apple pomace is a waste by-product produced in the manufacture of cider or vinegar from apples. The amount produced in the western states runs into thousands of tons.
2. Many factory owners report difficulty in disposing of the product to livestock feeders.
3. Apple pomace is similar in analysis to corn silage and since it is a waste by-product, livestock feeders should utilize it for feed if it is of value.
4. Results of two trials comparing apple pomace to corn silage seemed to justify the following conclusions:
 - a. The cows produced milk and butterfat equally as well on the apple pomace ration as on the corn silage ration.
 - b. The cows approximately maintained their body weights on both rations during the experimental periods.
 - c. Apple pomace seemed equal, pound for pound, to corn silage in feeding dairy cows.
5. Apple pomace is very palatable and is relished by cows.
6. Apple pomace may be fed in the same manner as corn silage but care should be taken not to overfeed.
7. Apple pomace should be fed after milking in order to avoid abnormal flavors in the milk.
8. Apple pomace is easily stored and keeps well with little spoilage for several months.

APPLE POMACE SILAGE FOR MILK PRODUCTION

by

F. W. Atkeson and G. C. Anderson

INTRODUCTION

Apple pomace is the solid residue left after the juice is pressed from apples.

The apparent lack of appreciation by livestock owners of the feeding value of apple pomace, together with the importance to the manufacturer of finding a market, seemed to justify experimental work along this line, especially in view of the paucity of experimental data on the subject.

It is true that the problem is not general, but the number of communities where it is acute justifies its consideration. Apple pomace is a waste product and its profitable use is in harmony with conservation. Certainly an income of from \$1,000 to \$3,000 annually from a by-product which at present is almost a liability should be welcomed by any manufacturer.

One of the chief functions of the dairy cow is to convert bulky, relatively unsaleable products into valuable human food. Profitable production often is the result of the best utilization of waste by-products. Therefore, the dairyman so fortunate as to be located near a cider or vinegar factory is very much interested in the food value of apple pomace.

APPLE POMACE IN THE UNITED STATES

In the pressing of apples the proportion of juice to pomace will vary with the variety of apples and the efficiency of the pressing. Walton and Bidwell (1) report that in United States mills the yield of pomace is about 30 percent of the original weight of the apples.

The New England states produce the largest quantity of apple pomace altho a considerable amount is made in most sections where commercial apple orchards are extensive. Walton and Bidwell (1) estimate that the annual production of apple pomace in the United States is about 162,000 tons. This figure does not include pomace from farm cider mills.

The writers were not able to obtain any estimates of the production of apple pomace in the western states but by correspondence with manufacturers obtained some data on certain communities in the various states. The amount produced varies from as low as 20 tons to as high as 3,000 tons in different localities. Quite a number of communities have an annual production of from 800 to 1,000 tons of pomace.

Most of the pomace produced in the western states is disposed of in wet form just as it comes from the press. Economical disposition of pomace is quite a factor in the success of a vinegar plant. The writers

found great variation in the methods of different companies in solving this problem. Usually, pomace is either sold as stock feed or as fertilizer, or it is hauled to a dump as waste. By far the greater quantity is handled under the last two methods.

Several large producers in California report that they have been unable to find a market for pomace and that at present they are getting it removed from the factory premises free of charge, but without revenue. A common use of pomace is as fertilizer for orange groves. A plant in Oregon reports: "—we will run about a thousand tons of pomace. This costs us about \$1.00 a ton to have hauled away and dumped on waste land." Other operators report that they give pomace to local dairymen in order to get rid of it.

A number of plants seem to have been more fortunate. They are selling pomace to dairymen at from \$1.00 to \$3.00 per ton at the factory, and have a good demand.

APPLE POMACE IN IDAHO

About 1,500 tons of apple pomace was made in Idaho last year, representing the output from companies located at Moscow, Lewiston, Payette, Ustick, and Twin Falls. In addition, there are several other localities equipped to manufacture pomace under favorable conditions. Spokane has four manufacturers of pomace and this is of interest to Idaho since the output from the Spokane plants is easily accessible to Idaho feeders.

About half the Idaho manufacturers have a profitable outlet for this waste product, selling to livestock owners at one or two dollars per ton. The others, however, have been unable to create a market.

PREVIOUS INVESTIGATIONS

The first investigator in the United States to report studies of apple pomace as feed for livestock was Cooke (2) of Vermont, who reported the percentage of total digestible nutrients in fresh pomace and in apple pomace silage. In 1888 (3) he reports that he had successfully stored pomace in 6 foot silos by covering it and weighting it down with stones. He reports that the cows ate this silage with relish and that 10 pounds per day gave good results.

Hills (4) of Vermont reports that he fed 10 pounds of pomace to two cows along with what silage they cared for and their regular hay and grain. This ration was fed in alternate periods with a full ration of silage, hay and grain. One cow increased her production on pomace while the other decreased. In 1901 (5) he reports that he fed seven cows a ration of one-fourth corn silage and three-fourths apple pomace along with hay

and grain in alternating periods with a ration consisting of corn silage, hay and grain. The cows produced slightly less milk but with higher test when on pomace. He concluded that one ton of corn silage was equal to one and one-fifth tons of pomace. In 1902 (6) he reports feeding 12 cows, four of which were too low in production to give serviceable results. The eight cows used in the summary gave slightly more milk with higher test when on pomace than when on corn silage. The increased production was estimated at 7 percent. No harmful effects were noted on the cows. In 1903 Hills (8) reports that he fed from 24 to 35 pounds of pomace to each of five cows in alternate periods with an equal amount of corn silage. The pomace made more milk and butter than the silage. No injurious effects were noted on either the cows or their products. He concludes that one pound of pomace is equal to from three-fourths to one pound of good corn silage.

In the Vermont Agricultural Experiment Station bulletin No. 96, Hills summarizes the work done at Vermont and emphasizes the importance of utilizing apple pomace in feeding livestock rather than letting it go to waste.

Lindsey (9) of Massachusetts reports the use of apple pomace in feeding the station herd for several years prior to 1910. To check on his general observations he ran two cows on apple pomace in an experiment using a ration of hay, grain, and 15 to 30 pounds of apple pomace in alternate periods of four weeks each against a ration of hay and grain. The cows produced more milk and butter when fed apple pomace. He concludes that five pounds of pomace is worth more than one pound of hay and that possibly four pounds of pomace would equal one pound of hay.

Shutt (10) of the Canadian Experimental Farms reports that a farmer who wrote to him regarding the value of apple pomace claimed to have secured higher production from four cows when from one-fourth to one-half bushel of pomace was fed along with grain and fodder than when pomace was dropped from the ration.

The United States Department of Agriculture (11) summarized the work done on apple pomace at various experiment stations in the United States in Farmers' Bulletin No. 186 in 1904.

Walton and Bidwell (1) gave a complete summary and bibliography of the work published on the value of apple by-products as a feed for all kinds of livestock.

FIRST FEEDING TRIAL
1924-1925

The plan consisted of a comparison of apple pomace with corn silage as succulent feed for dairy cows under conditions otherwise as nearly standardized as possible. Ten cows were divided into two groups of five each, designated as Group I and Group II. An effort was made to balance the groups with respect to breed, weight, age, production, period of lactation, and gestation.

The experiment covered a period of 96 days, consisting of three experimental periods of 25 days each, preceded in each case by a preliminary period of seven days. The reversal system of feeding was used, the two groups being started on different feeds indicated as follows:

	GROUP I	GROUP II
First period.....	Grain, hay, and corn silage	Grain, hay, and apple pomace
Second period.....	Grain, hay, and apple pomace	Grain, hay, and corn silage
Third period.....	Grain, hay, and corn silage	Grain, hay, and apple pomace

The milk was weighed and tested for butterfat each milking thruout all experimental periods. Each cow was weighed three consecutive days previous to the preliminary periods, the experimental periods, and at the close of the trial, the average of the three weights in each case being taken as the true weight. All feed was weighed to the cows individually and the refused feed weighed back. Composite samples of feeds offered and all feed refused was taken for chemical analysis.

A brief description of the cows used, both as individuals and as groups, is given in Table I.

TABLE I.

Group I.

E. T. No.	Breed	Age Yrs. Mo.	Weight	Days in lactation	Days in gestation	Approximate production per day
11	Holstein	8-5	1636	244	0	42.0
21	"	6-4	1499	104	57	47.0
28	"	4-4	1469	72	0	58.0
31	"	3-11	1460	408	63	32.0
129	Jersey	2-11	949	170	87	26.0
Average....		5-2	1402.6	200	42	41.0

Group II.

E. T. No.	Breed	Age Yrs. Mo.	Weight	Days in lactation	Days in gestation	Approximate production per day
7	Holstein	9-9	1384	161	112	47.0
16	"	7-0	1600	236	97	42.0
23	"	5-4	1357	160	98	42.0
32	"	3-8	1536	53	0	58.0
130	Jersey	3-2	770	291	16	15.0
Average....		5-9	1329.4	180	65	41.0

It would seem that the groups were fairly well balanced, and in all cases except possibly cow No. 130, the cows were producing a sufficient quantity of milk to be sensitive to feed changes.

FEEDING METHODS AND RATIONS

During the preliminary period each cow was fed all the alfalfa hay she would consume and grain in proportion to the milk. During the experimental period the hay and the succulent feed were standardized to the quantity the cows would readily consume, as indicated by the preliminary period, and were kept as nearly as possible constant for both the individual and the group thruout the experiment. The grain was fed at the rate of 1 pound to each 3 pounds of milk produced per day in the case of Holsteins and 1 pound to 2½ pounds of milk per day in the case of Jerseys. The amount of grain was determined by determining the average production per day for each five days and feeding proportionate amount of grain the next five days. The grain mixture used was the standard herd ration:

350 lbs. wheat bran
 200 lbs. barley (ground)
 200 lbs. oats (ground)
 100 lbs. linseed oil meal
 100 lbs. cotton seed meal
 36 lbs. mineral mixture

The analysis of feeds used, as represented by composite samples, is given in Table II.

TABLE II.
 ANALYSIS OF FEEDS FED DURING EXPERIMENT

FEED	Percent Water	Percent dry matter	Percent ash	Percent crude protein	Carbohydrates		Percent fat	*Carbo- hydrate equivalent	Nutritive ratio
					Percent fiber	Percent N.F.E.			
Grain	7.04	92.96	5.24	15.81	10.50	56.86	4.55	77.60	1 : 4.9
Alfalfa	16.37	83.63	6.10	9.61	31.03	35.45	1.44	69.72	1 : 7.3
Corn silage	71.0	29.00	2.09	2.29	5.90	17.85	.87	25.71	1 : 11.2
Apple pomace	77.1	22.90	.79	1.42	4.66	14.80	1.23	22.23	1 : 15.7

* (Carbohydrates) plus (Fat times 2.25) equals carbohydrate equivalent.

From the foregoing table we note that both corn silage and apple pomace are high in carbohydrates and moisture. However, corn silage contains 6.1 percent more dry matter than apple pomace. If adjustment were made for moisture content we would find the feeds very similar in

composition. The pomace is lower in ash and protein and higher in fat, and has a wider nutritive ratio. Compared with the analyses given by Henry and Morrison the alfalfa hay used in this experiment was very high in moisture and consequently low in other nutrients except crude fiber. The hay analyzed at this station for the past several years seems very high in crude fiber.

RESULTS

A summary of the feeds consumed and the milk and butterfat produced per cow per 25-day period for each group is presented in Table III. The comparisons are based on the assumption that by averaging the figures from the first and third periods the normal decline in production would be counteracted and the average thus obtained would be comparable to the second period.

In Group I the production of milk and butterfat was almost exactly the same. Group II gave 12.5 pounds of milk and .623 pounds of fat per cow more on apple pomace than on corn silage. However, when this is reduced to a daily basis per cow the result is only 0.5 of a pound of milk and 0.025 of a pound of fat, which is so negligible that the two feeds may be considered as giving equal production with each group. The average percent of fat also checked closer than in most feeding trials of this kind.

Figuring the difference in feed consumption for Group I on a daily basis per cow the results show 0.06 of a pound of hay more, 0.12 of a pound of grain less, and 0.2 of a pound of succulent feed more while on apple pomace than while on corn silage. These differences are so slight that the feed consumption may be considered the same in Group I. In Group II the feed consumption was slightly greater in all instances when the cows were on apple pomace. The daily surplus of feed per cow was 1.1 pounds of hay, 0.16 of a pound of grain, and 1.1 pounds of succulent feed. Even these differences are very small and about equal to the very slight increase in production of Group II while on apple pomace.

Nutrients Consumed—The comparison of feeds consumed on the two rations may be further studied by comparing the nutrients consumed. This is shown in Table IV.

TABLE III

SUMMARY OF MILK AND BUTTERFAT PRODUCTION AND FEEDS CONSUMED

GROUP I							GROUP II						
Experimental feeds	Average production per cow per 25-day period			Average feed consumed per cow per 25-day period			Experimental feeds	Average production per cow per 25-day period			Average feed consumed per cow per 25-day period		
	Milk pounds	Percent fat	Fat pounds	Alfalfa hay pounds	Grain pounds	Silage pounds		Milk pounds	Percent fat	Fat pounds	Alfalfa hay pounds	Grain pounds	Silage pounds
While on corn silage. (Ave. 1st and 3rd periods)	881.2	3.45	30.431	445.7	308.1	783.9	While on corn silage (2nd period)	830.8	3.11	25.851	415.2	277.2	751.9
While on apple pomace (2nd period)	880.3	3.52	30.964	447.1	305.1	789.1	While on apple pomace (Ave. 1st and 3rd periods)	843.3	3.14	26.474	443.1	281.3	778.8
Difference per cow per 25 day period compared with corn silage	-.9		+ .533	+1.4	-3.0	+5.2		+12.5		+ .623	+27.9	+4.1	+26.9

TABLE IV
 NUTRIENTS CONSUMED PER COW FOR EACH GROUP ON BOTH RATINGS
 (In pounds)

GROUP I

Experimental feed	Water	Matter	Ash	Protein	Carbohydrates		Fat	*Carbohydrate equivalent	**Total nutrients	Nutritive Ratio
					Fiber	N. F. E.				
While on corn silage	651.21	886.48	59.71	109.49	216.90	473.11	27.26	751.59	861.08	1 : 6.8
While on apple pomace	703.07	838.23	49.49	102.42	207.55	448.77	30.03	723.90	826.32	1 : 7.06
Difference compared with corn silage	+51.86	-48.25	-10.22	-7.07	-9.35	-24.34	+2.77	-27.69	-34.66	

GROUP II

While on corn silage	621.33	822.97	55.57	100.95	202.31	439.02	25.13	697.90	798.85	1 : 6.9
While on apple pomace	692.79	810.41	47.92	98.11	203.32	432.29	28.76	700.35	798.46	1 : 7.1
Difference compared with corn silage	+71.46	-12.56	-7.65	-2.84	+1.01	-6.73	+3.63	+2.45	-.39	

* (Carbohydrates) plus (fat times 2.25) equals carbohydrate equivalent.

** (Carbohydrate equivalent) plus (proteins) equals total nutrients.

The nutritive ratios of the two rations was very similar for both groups, the corn silage ration being slightly higher in protein in both cases, since the corn silage is higher in protein than the apple pomace. The total amount of nutrients consumed by Group II was exactly the same for both rations. In Group I the cows averaged about 1 pound less per day of total nutrients on apple pomace than on corn silage. The groups ranked about the same on dry matter consumed. It is evident from this table that the two rations fed were almost equal; where any difference existed it was in favor of the corn silage ration rather than the apple pomace.



Fig. I. Group of cows on corn silage vs. apple pomace.

Daily Production and Feed Consumption Per Cow—The comparative feed consumption and milk and fat production may possibly be better visualized if presented on the daily per-cow basis. This method also shows how comparatively similar the conditions and results were when measured in this manner.

TABLE V
DAILY PRODUCTION AND FEED CONSUMPTION PER COW

Kind of silage	Feed consumed per cow daily while on each silage crop			Dairy products produced per day		Feed required					
	Alfalfa Hay pounds	Grain pounds	Silage pounds	Milk pounds	Fat pounds	Per cwt. milk			Per pound fat		
						Hay pounds	Grain pounds	Silage pounds	Hay pounds	Grain pounds	Silage pounds
GROUP I											
Corn silage (Ave. 1st and 3rd periods).....	17.83	12.32	31.36	35.25	1.217	50.6	35.0	89.0	14.7	10.1	25.8
Apple pomace (2nd period)	17.88	12.20	31.56	35.21	1.239	50.8	34.6	89.6	14.4	9.8	25.5
Difference compared with corn silage	+.05	-.12	+.20	-.04	+.022	+.2	-.4	+.6	-.3	-.3	-.3
GROUP II											
Corn silage (2nd period)	16.61	11.09	30.08	33.23	1.034	50.0	33.4	90.5	16.1	10.7	29.1
Apple pomace (Ave. 1st and 3rd periods)	17.72	11.25	31.15	33.73	1.059	52.5	33.4	92.4	16.7	10.6	29.4
Difference compared with corn silage	+1.11	+.16	+1.07	+.50	+.025	+2.5	.0	+1.9	+.6	-.1	+.3

Table V shows very little difference in the daily feed consumption or in production whether on corn silage or apple pomace. The amount of the various feeds necessary to produce a hundred pounds of milk was practically the same within a group for both corn silage and apple pomace rations. The same was true in the production of a pound of butterfat.

Weight of Cows—One of the factors to consider in comparing the efficiency of two feeds for milk production is the body weights of the cows. A cow may continue to produce well for a short period of time by drawing on her own body for nutrients. In Table VI the effect of the two rations on the weights of the cows is shown.

TABLE VI
AVERAGE WEIGHT PER COW BY GROUPS
(In pounds)

Experimental feed	Group	Weight at Beginning of period	Weight at close of period	Gain or loss in weight
Corn silage (Ave. 1st and 3rd periods)...	I	1419.1	1429.7	10.6
Apple pomace (2nd period).....	I	1415.6	1413.4	-2.2
Corn silage (2nd period).....	II	1338.6	1345.0	6.4
Apple pomace (Ave. 1st and 3rd periods)...	II	1335.8	1348.2	12.4

The variation in body weight is no greater in any case than would be experienced in daily fluctuations on individual cows. The body weights would seem to indicate that the cows were fed about what they required.

SUMMARY OF FIRST FEEDING TRIAL

Considering the feeds consumed, the milk and butterfat production obtained and the body weights of the cows, apple pomace seems to be equal, pound for pound, to corn silage as a succulent feed for dairy cows altho chemical analyses show corn silage to be higher in dry matter and in total nutrients.

SECOND FEEDING TRIAL

1925-1926

Such good results were obtained with apple pomace in the initial experiment that it was deemed advisable to check these results by another trial.

The same general plan was continued, the experiment again covering 96 days and Group I being started on corn silage and Group II on apple pomace as before. The experiment started with eight cows divided into groups of four each. However, one of the cows in Group II became sick during the trial and was dropped from the experiment.

Table VII presents a brief description of the cows used, as individuals and as groups.

TABLE VII
DESCRIPTION OF COWS

GROUP I							
E. T. No.	Breed	Age		Weight	Days in lactation	Days in gestation	Approximate production per day-lbs. milk
		Yrs.	Mo.				
13	Holstein	8-9-27		1472	69	0	58.2
23	"	6-3-4		1396	155	5	49.3
40	"	3-8-7		1048	20	0	42.1
125	Jersey	2-10-1		849	224	0	26.3
Average		5-4-25		1191.2	117	1.2	44.0

GROUP II							
E. T. No.	Breed	Age		Weight	Days in lactation	Days in gestation	Approximate production per day-lbs. milk
		Yrs.	Mo.				
12	Holstein	8-11-0		1416	175	0	40.3
43	"	3-5-21		1378	16	0	48.5
132	Jersey	2-11-2		793	188	0	20.9
Average		5-1-8		1195.7	99	0	36.6

FEEDING METHODS AND RATIONS

The same feeding methods were used as in the previous trial. In fact, the same grain mixture was used, altho from a new supply of grains.

Analyses of feeds, as represented by composite samples, is given in Table VIII.

TABLE VIII
ANALYSES OF FEEDS FED DURING EXPERIMENT

FEED	Percent Water	Percent Dry matter	Percent ash	Percent Crude protein	Carbohydrates		Percent fat	*Carbohy- drate equiv- alent	Nutritive ratio
					Percent fiber	Percent N. F. E.			
Grain	9.0	91.0	6.03	19.05	9.05	52.05	4.82	71.95	1 : 3.77
Alfalfa	8.6	91.4	6.10	10.66	33.75	38.84	2.05	77.20	1 : 7.2
Corn silage..	72.2	27.8	2.80	2.06	6.22	16.07	.65	23.75	1 : 11.5
Apple pomace	73.1	26.9	.94	1.56	5.08	18.15	1.17	25.86	1 : 16.5

* (Carbohydrates) plus (fat times 2.25) equals carbohydrate equivalent.

The feeds used all show a little variation in composition from similar feeds used in the previous trial. The hay in general is about the same except that it is much lower in moisture. The grain mixture has a more narrow nutritive ratio. The silage and apple pomace compare about as before except that, due to a difference in moisture content, the apple pomace contains slightly more total nutrients per hundred pounds than the corn silage.

RESULTS

Table IX presents a summary of feeds consumed and of milk and butterfat produced per cow per 25-day period for each group. The same method of comparison is used as described preceding Table III.

TABLE IX

SUMMARY OF MILK AND BUTTERFAT PRODUCTION, AND FEEDS CONSUMED

Experimental feed	GROUP I						Experimental feeds	GROUP II					
	Average production per cow per 25-day period			Average feed consumed per cow per 25-day period				Average production per cow per 25-day period			Average feed consumed per cow per 25-day period		
	Milk pounds	Per-cent fat	Fat pounds	Alfalfa Hay pounds	Grain pounds	Silage pounds		Milk pounds	Per-cent fat	Fat pounds	Alfalfa Hay pounds	Grain pounds	Silage pounds
While on corn silage (Ave. 1st and 3rd periods)	953.0	3.372	32.139	371.7	334.9	727.9	While on corn silage (2nd period)	712.0	3.796	27.026	357.4	252.6	716.9
While on apple pomace (2nd period)	947.6	3.654	34.622	371.7	333.7	705.2	While on apple pomace (Ave. 1st and 3rd periods)	725.8	4.108	29.814	344.3	259.3	714.5
Difference per cow per 25-day period compared with corn silage	-5.4		+2.483	.0	-1.2	-22.7		+13.8		+2.788	-13.1	+6.7	-2.4

The only deviation from the experimental methods of the trial of the previous year was made in testing the milk. Instead of testing all milkings, tests were made on each milking only during two consecutive days in the middle of each period, and the average percent of fat obtained was used as the butterfat test for the period.

The cows in Group I averaged 5.4 pounds less milk and 2.483 pounds more fat while on apple pomace than they did while on the corn silage ration. However, figured on a daily basis this difference is very slight and the production may be considered equal on the two feeds. Likewise in Group II the difference is negligible. In both groups the percent of fat is considerably higher when the cows are on the apple pomace ration. This, no doubt, is due to experimental error as this condition did not exist the previous year with more exact methods of testing. Milk production is probably a truer indicator than butterfat production. The results indicate that in both groups production on the apple pomace ration was equal to the production obtained from the corn silage ration.

Group I consumed practically the same amount of hay and grain on the two rations but averaged almost a pound less succulent feed per day. Group II consumed the same amount of succulent feed on the two rations but consumed 0.27 pound of grain more per day and 0.52 pound of hay less per day while on apple pomace than on corn silage. In general, the rations may be considered fairly equal.

Nutrients Consumed—The comparison of feeds consumed per cow in each group while on the two rations may be further studied in the following table.

TABLE X
 NUTRIENTS CONSUMED PER COW FOR EACH GROUP ON BOTH RATIIONS
 (In pounds)

GROUP I

Experimental Feed	Water	Dry Matter	Ash	Protein	Carbohydrates		Fat	Carbohydrate equivalent	Total nutrients	Nutritive ratio
					Fiber	N. F. E				
While on corn silage (Ave. 1st and 3rd periods) .	587.65	846.72	63.24	118.39	201.02	435.58	28.49	700.69	819.08	1 : 5.9
While on apple pomace (2nd period)	577.49	833.03	49.42	114.18	191.45	431.36	31.00	709.37	823.55	1 : 6.2
Difference compared with corn silage	-10.16	-13.69	-13.82	-4.21	-9.57	-4.22	+2.51	+8.68	+4.47	

GROUP II

While on corn silage (2nd period).....	571.09	730.21	57.19	100.98	188.06	385.48	24.16	627.90	728.88	1 : 6.2
While on apple pomace (Ave. 1st and 3rd periods) .	575.22	742.84	43.35	97.24	175.96	398.13	27.91	637.12	734.36	1 : 6.5
Difference compared with corn silage	+4.13	+12.63	-13.84	-3.74	-12.10	+12.65	+3.75	+9.22	+5.48	

Table X shows that the nutrients consumed on the two different rations were very similar for each group. Group I consumed 0.55 pound of dry matter more per cow daily while on corn silage than on apple pomace. However, the total nutrients consumed daily by the apple pomace group amounted to 0.32 pound per cow more than the total consumed by the cow fed corn silage. The nutritive ratios of the two rations consumed by Group I were very close. The two rations checked even more closely in Group II except that the nutritive ratios differed more. The rations compared as closely as could be expected considering the opportunity for experimental error.



Fig. II Group of cows used in second feeding experiment.

For further study the average daily consumption per cow of each feed and the average daily production per cow for both groups is presented in Table XI.

TABLE XI
AVERAGE DAILY PRODUCTION AND FEED CONSUMPTION PER COW

Kind of silage	Feed consumed per cow daily while on each silage crop			Dairy products produced per day		Feed required					
	Alfalfa Hay pounds	Grain pounds	Silage pounds	Milk pounds	Fat pounds	Per cwt. milk			Per pound fat		
						Hay pounds	Grain pounds	Silage pounds	Hay pounds	Grain pounds	Silage pounds
GROUP I											
Corn silage (Ave. 1st and 3rd periods).....	14.87	13.40	29.12	38.12	1.286	39.01	35.15	76.39	11.56	10.42	22.64
Apple pomace (2nd period)	14.87	13.35	28.21	37.90	1.385	39.23	35.22	74.30	10.74	9.64	20.37
Difference compared with corn silage00	+.05	-.91	-.22	+.099	+.22	+.07	-2.09	-.82	-.78	-2.37
GROUP II											
Corn silage (2nd period)	14.30	10.10	28.68	28.48	1.081	50.21	35.46	100.70	13.23	9.34	26.53
Apple pomace (Ave. 1st and 3rd periods)	13.77	10.37	28.58	29.03	1.193	47.43	35.72	98.45	11.54	8.69	23.95
Difference compared with corn silage	-.53	+.27	-.10	+.55	+.112	-2.78	+.26	-2.25	-1.69	-.65	-2.58

Table XI shows that the cows averaged more than a pound of fat a day, a production which should make them sensitive to differences in feeds. The daily basis shows how nearly equal the production and the feed consumption were for each group on the different rations.

Weights of Cows—The effect of the two rations on body weights of the cows is shown in Table XII.

TABLE XII
AVERAGE WEIGHT PER COW BY GROUPS
(In pounds)

Experimental feed	Group	Weight at beginning of period	Weight at close of period	Gain or loss in weight
Corn silage (Ave. 1st and 3rd periods)	I	1188.8	1162.8	-26.0
Apple pomace (2nd period)	I	1159.2	1176.0	16.8
Corn silage (2nd period)	II	1209.3	1204.7	-4.6
Apple pomace (Ave. 1st and 3rd periods)	II	1204.2	1195.2	-9.0

Group I registered an average loss per cow while on the corn silage ration and made a gain while on the apple pomace rations. This would seem to indicate that with this group the apple pomace ration was somewhat superior. However, the variation is not great when we consider that the time covered was 25 days and, also, bear in mind the fact that cows often vary 15 pounds from day to day. Group II lost weight on both rations but the average loss per cow was no greater during the 25-day period than the daily fluctuations found in weighing cows on consecutive days under standard conditions. Therefore, the results on both groups indicate that the cows maintained body weight almost equally well on both rations and that the feeds consumed apparently about met the cow's requirements for reproduction and body maintenance.

PALATABILITY OF APPLE POMACE

No tests were made on the palatability of apple pomace as it was obviously just as palatable as corn silage and possibly more so. Cows that had never received it before took to it readily and there were many cases in which the cow exhibited a ravenous appetite for it. This was true with some of the cows on official test that were being heavily fed.

METHODS OF FEEDING

Apple pomace should be fed the same as silage, but care should be exercised not to overfeed with it at the beginning. It is very palatable and the cows will eat large quantities, but due to the fact that it packs together much more than silage, far more will be fed than expected if the pomace is not weighed to begin with. A bushel of apple pomace silage weighs nearly twice as much as a bushel of corn silage. Cows should be started

on about 20 pounds a day, divided in equal feeds. The pomace may be increased gradually up to 30 or 35 pounds for Holsteins and 25 or 30 pounds for Jerseys, with safety. The physiological effect on the cows seems good. The solid manure became colored slightly red but is of desirable consistency. If, however, through lack of knowledge of the weight of apple pomace excessive amounts are fed, the cows will go off feed and may scour.

STORAGE AND KEEPING QUALITIES

The apple pomace was stored in a concrete root cellar, being dumped in from the top. The pomace is so heavy that it soon settles and forms a natural seal. After a month or so a moldy dry crust about 4 inches thick forms on top. There is no other spoilage and there seems to be no reason for tramping during the storage process, as in the case of silage. From personal observation of other efforts to store this material, it would seem that it can be stored in almost any manner, such as in a box stall, silo, pit, or feed room. There would seem to be little advantage in elevating such an easily kept material into a silo.

No effort has been made to determine the keeping qualities of the product. However, it happened that more was on hand than was needed for winter feeding and it was allowed to seal up in June. The latter part of August it was opened again and it proved to be in just as good condition as when first stored. This would indicate that it can easily be kept through the summer months, which undoubtedly is an advantage since this crop does not come on until October while succulence usually is needed during August and September.

EFFECT OF APPLE POMACE ON FLAVOR OF MILK

An investigation was made to determine the effect of feeding apple pomace on the flavor and quality of milk. Space will not be taken in this publication to discuss the methods or details of results. The results indicated that milk took up the apple pomace flavor from the barn odors. It was found, also, that apple pomace fed a short time before milking caused abnormal flavors in the milk, but that when the pomace was fed after milking no off-flavors could be detected.

Therefore, apple pomace should be fed immediately after milking in order to avoid abnormal flavors being taken up by the milk either from the cow's body or from the odors of the barn.