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HANOVER, N. H.,

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1. EFFECT OF FOOD ON BUTTER.
2. EFFECT OF FOOD ON QUANTITY OF MILK.

MAY, 1891.

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— OF THE —

NEW HAMPSHIRE

Agricultural Experiment Station.

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HARDNESS OF BUTTER:

THE EFFECT OF FOOD UPON.

A. H. WOOD AND C. L. PARSONS.

It is now commonly admitted that the composition of milk is mainly determined by the breed and individuality of the cow, and that the effect of any normal food upon the percentage of fat contained in the milk is very slight, hence the problem of feeding is, to the milk producer, narrowed to finding the food that will cause his herd to yield the greatest amount of milk at the least cost without injury to the health of his cows. To the maker of butter, however, the problem is still a very broad one, for even if the fat contents of the milk be practically constant and he be able to obtain the maximum quantity of butter it may fall far short of the highest quality, on account of the effect of the food upon the *composition* of the butter fat.

That the composition and characteristics of butter fat are affected by the food of the cow is not new, in fact, it is a matter of common observation and remark; but, without doubt, in many cases greater changes in the quality of butter are attributed to changes in foods than the facts justify.

The study of the effect of foods upon the resulting butter is an important and difficult one, and this Bulletin is intended only as a contribution to what has been, and an indication of what may be learned in this direction.

Within the last few years gluten meal has come into extensive use as a food rich in albuminoids; and as a milk producing food has proved itself one of the best.

As gluten meal is a by product in the manufacture of glucose from corn and contains all the substance of the original corn, with the exception of the bulk of the starch, it might be

expected that it would have a similar effect upon the character of the butter fat when fed to cows in a normal ration.

To test the relative effect of corn meal and its by-product gluten, in this direction, the following work was carried out: Eight cows were divided into four lots of two each, and were fed alternately upon rations having corn meal or gluten meal as the leading constituent. Each ration was fed continuously for two weeks and the milk given on the two last days in each period was taken to test the effect of the food upon the churnability of the resulting cream, both in regard to time and thoroughness of churning, and also its effect upon the hardness of the butter, its melting point and its volatile acids.

The cream was obtained from all lots by the use of the De-Laval hand separator, and allowed to stand twenty-four hours before churning. The cream was apparently sweet when churned, and therefore lower temperatures were maintained than where acid cream is used. Samples of the butter-milk and butter were analysed, and the comparative hardness of the butters determined by means of the method hereafter described.

In Table A the blackfaced type indicate gluten, the common type corn meal. The various rations are indicated as 1a, 2a, 6a and 7a, and were made up as follows:

	1a lbs.	7a lbs.	2a lbs.	6a lbs.
Ensilage,	44	44	44	44
Hay,	6	6	6	6
Corn meal,	—	6	1	5
Middlings,	3	3	3	3
Gluten,	6	—	5	1
Nutritive ratio,	1 : 5.2	1 : 9	1 : 5.6	1 : 8

Reference to Table A will show that these four lots of cows were alternated upon these rations, which were constant so far as coarse fodder and one-third the grain ration were concerned, and that the substitution of gluten, either wholly or in part, for corn meal, had a marked effect upon the characteristics of the butter fat, decreasing its churnability and softening the product. We would not discourage, on this account, the feeding of gluten to cows, for it has proved itself to be of much value as a milk producing food, both at this Station (see Bulletin No. 9) and elsewhere. We can only caution against its excessive use with cows that nat-

urally produce a somewhat soft quality of butter, and suggest that mixed with cotton seed it may very likely be of great advantage, since it may be seriously questioned if cotton seed in the winter season may not act too strongly in the opposite direction, producing a butter that is too hard.

TABLE A.

Lot.	Period.	Ration.	Nutritive Ratio.	Churning temperature. Deg. F.	Time churning. Min.	Fat in buttermilk. Per cent.	Hardness of butter. mm. of penetration.	Melting point of butter. Deg. C	Volatile Acids equal to — c c decinormal Ba(OH)$_2$.	Water in butter. Per cent.
A.	1	1a.	1:5.2	55–58½	11	1.23	8.4	33.8	32.9	9.14
	2	7a.	1:9	56–59	15	.54	9.5	32.4	33.0	9.49
	3	1a.	1:5.2	52–56	25	1.30	11.7	33.2	29.9	9.20
	4	7a.	1:9	52–56	65	.31	9.4	34.0	29.7	9.60
B.	1	1a.	1:5.2	55–58½	11	1.23	8.4	33.8	32.9	9.14
	2	7a.	1:9	56–59	15	.54	9.5	32.4	33.0	9.49
	3	1a.	1:5.2	52–56	25	1.30	11.7	33.2	29.9	9.20
	4	7a.	1:9	52–56	65	.31	9.4	34.0	29.7	9.60
	1	1a.	1:5.2	55–58½	11	1.23	8.4	33.8	32.9	9.14
	2	7a.	1:9	56–59	15	.54	9.5	32.4	33.0	9.49
	3	1a.	1:5.2	52–56	25	1.30	11.7	33.2	29.9	9.20
	4	7a.	1:9	52–56	65	.31	9.4	34.0	29.7	9.60
C.	1	2a.	1:5.6	55–57	15	1.58	7.9	34.7	30.4	9.32
	2	6a.	1:8	55–59	30	.98	7.5	33.2	31.6	9.01
	3	2a.	1:5.6	52–56	40	1.05	7.33	33.8	31.4	9.68
	4	6a.	1:8	53–56	80	.53	6.0	33.1	30.0	11.67
	1	2a.	1:5.6	55–57	15	1.58	7.9	34.7	30.4	9.32
	2	6a.	1:8	56–59½	30	.98	7.5	33.2	31.6	9.01
	3	2a.	1:5.6	52–56	40	1.05	7.33	33.8	31.4	9.68
	4	6a.	1:8	52–56	80	.53	6.0	33.1	30.0	11.67
D.	1	2a.	1:5.6	55–57	21	1.03	7.1	33.3	32.3	9.32
	2	6a.	1:8	56–59½	15	1.85	7.9	32.4	33.5	9.02
	3	2a.	1:5.6	52–56	45	.81	4.9	33.5	30.3	8.14
	4	6a.	1:8	52–56	95	1.92	6.6	34.2	29.5	9.80

In Table B the lots are also of two cows each, and the periods two weeks. The treatment of milk and cream was the same as previously described, with this exception, that the cream was raised in shallow pans.

Lot G and Lot X, in periods 1 and 2, represent a brief test of ensilage as compared with hay, the rations being as follows:

	4a lbs.	4a1 lbs.	6a1 lbs.	6a lbs.
Ensilage,	—	44	—	44
Hay,	22	6	25	6
Corn meal,	3 1/8	3 1/8	5	5
Middlings,	3 1/8	3 1/8	3	3
Gluten,	3 1/8	3 1/8	1	1
Nutritive ratio,	1 : 7.2	1 : 7.2	1 : 8	1 : 8

TABLE B.

N.	Y.	X.	G.	Lot.
1	1	1	1	Period
2	2	2	2	
3	3	3	3	
4	4	4	4	
4a, 4a2 4a1.	2a, 2a1. 2a, 2a1.	6a1. 6a. 2a. 2a.	4a. 4a1. 4a.	Ration.
1:7.72 1:7.72 1:7.72	1:5.6 1:5.6 1:5.6 1:5.6	1:8 1:8 1:5.6 1:5.6	1:7.72 1:7.72 1:7.72	Nutritive Ratio.
57 57-60 54-57	57 56-59 54-57 48-58	60 58 53-58 48-58	56-57 56-58 52-57	Churning temperature. Deg. F.
13 32 14	18 115 30 150	35 17 20 38	16 14 32	Time churning. Min.
1.35 .333 —	.57 .327 — .69	.39 .01 — 1.15	1.72 .96 1.40	Fat in buttermilk. Per cent.
8.5	10.7 6.5 9.5 5	13.3 6 9.5 14	8.2 8.7 7.6	Hardness of butter. mm. of penetration
37.6 33 32.6	37.8 36.9 37.4	32.6 34.6 33.1 35.7 34.33	31.7 31.5 36.1	Melting point of butter. Deg. C.
27.3 31.8 33.9	30 28 27.6	31 29.9 32.8 28.5 27.8	36.2 36.4 32.2	Volatile Acids equal to — c.c. decinormal $Ba(OH)_2$
36.8 29 38.4	31.2 27.9 31.6	32.4 32.7 38.8 41.4	— — —	Iodine absorption number.
11.36 11.48 11.33	10.42 10.22 12.93	10.62 10.06 10.93 14.47	9.48 9.54 8.40	Water in butter. Per cent.

In both lots *hay* apparently produced a harder butter than did *ensilage*. While as regards churnability Lot G favors hay and Lot X ensilage. Lot X, periods 3 and 4, is a change from

corn meal to gluten and reaffirms the verdict of Table A. Lot Y shows a test of gluten as compared with cotten seed, the black-faced type representing the cotton seed periods. The rations as fed were as follows:

	2a lbs.	$2a_1$ lbs.
Ensilage,	44	44
Hay,	6	6
Corn meal,	1	1
Middlings,	3	3
Gluten,	5	—
Cotton seed	—	5
Nutritive ratio,	1 : 5.6	1 : 5.6

The effect of the substitution of cotton seed for gluten is very marked in the hardness of the resulting butter, and corroborates the reports from stations in the South as to the effect in this direction of feeding cotton seed in quite large quantities.*

Lot Z represents a single test of feeding skim milk to cows, and, so far as the butter product is concerned, shows very favorable results. It is, undoubtedly, a good use for skim-milk when not needed for feeding younger animals. The rations were as follows:

	$4a_1$	$4a_2$
Ensilage,	36	36
Hay,	4½	4½
Corn meal,	2½	2½
Middlings,	2½	2½
Gluten,	2½	——
Skim-milk,	——	21
Nutritive ratio,	1 : 7.2	1 : 7.2

METHODS USED.

Wollny's modification of Reichert's method was used in the determination of Volatile Fatty Acids; Wiley's method for the determination of the melting point; and Hubl's for the Iodine Absorption Number. The hardness of the butters was measured at the same temperature by the depth of penetration of a weighted glass rod falling through a glass tube for a given

*See Bulletin 11, Texas, etc.

distance, the penetration being measured in millimeters. The following details are recommended:

The rod should be three mm. in diameter, twenty cm. long, and should weigh ten gms. It should be pointed, but the distance along inclined plane, from point to surface of rod, should be no greater than the diameter of the rod. It is easily made by pulling out a piece of glass tubing of the required size and pushing a small piece of cotton down the inside to the point thus made, filling with mercury until the whole weighs ten grams, and finally closing the open end. The tube through which the rod is to fall should be one meter in length, perfectly straight and of such diameter that the rod will fall perpendicularly through it without vibration and with scarcely any friction. At exactly the length of the rod from the lower end of this tube a millimeter scale should be attached with the scale reading downward. The butter prepared in the usual way should stand in a cool room several days, and then the depth of penetration should be taken at 15½° C., which is about the temperature at which dairy rooms are kept. The hardness of different butters is thus very simply compared, by bringing the tube in a perpendicular position over a plane surface of the butter at some distance from the edge of the mass; fixing the tube in this position, with the lower end lightly resting on the surface; then lower the ten gram rod into the tube as far as possible with the finger and thumb and let it fall. The penetration can then be read off on the scale. The greater the penetration the softer the butter. Except on very soft butters the differences in triplicate determinations is seldom over one millimeter. The results in the tables are averages of several determinations.

INDICATIONS.

The work in this direction is not as yet extensive enough to justify the drawing of conclusions, but our experiments thus far *indicate*

1st. That gluten meal tends to produce a much softer quality of butter than corn meal or cotton seed meal and, other things being equal, tends to lessen the churnability of the butter fat.

2nd. That with the same cows the hardness of butter depends much more upon the *character* of the food than upon the *nutritive ratio.*

3rd. That ensilage produces a somewhat softer butter than does good hay, but it is also favorable to the flavor and texture of the butter product.

4th. That skim-milk has a very favorable effect upon the churnability and quality of the butter fat, and in a single trial apparently reversed the general rule that the volatile fatty acids decrease as the period of lactation advances.

5th. That cotton seed meal tends to produce an unusually hard quality of butter, and that cotton seed meal and gluten meal might be used together with excellent results.

6th. That contrary to general belief the melting point of butter fat is not a good index of the commercial hardness of butter. That while in general a soft butter melts at a lower temperature than a hard butter *there is no definite relation between melting point and actual hardness.*

7th. That no relation can be traced between foods and volatile fatty acids, except in the case of skim-milk. That usually hardness and volatile acids vary inversely, hardness generally increasing and volatile acids decreasing, as the period of lactation advances.

8th. That the Iodine absorption of butter from gluten ra- is greater than that of butters from cotton seed or corn meal rations, and that so far as tried (see Table B) the Iodine absorption number follows very closely the hardness of butters.

QUANTITY OF MILK.

G. H. WHITCHER.

The work above reported on by Messrs. Wood and Parsons was carried on by them in connection with a series of experiments designed primarily to test the relative efficiency of a ration containing a large amount of albuminoids as against one containing a large amount of starch.

The materials for bringing about this variation in the rations were corn meal and gluten meal, the latter being a waste product from the manufacture of glucose from corn; it is, in fact, corn meal from which a large part of the *starch* has been removed, it is, consequently, rich in albuminoids and oil.

The following table gives a comparative statement of the average digestible matter in the two food stuffs:

	Corn Meal. per cent.	Gluten. per cent.
Albuminoids,	7.78	25.14
Non albuminoids,	71.60	61.90
Nutritive ratio,	1 : 9.2	1 : 2.4

Now, as both are made from corn, it follows that whatever difference may be noticed, either in quantity or quality of the product resulting from feeding these grains, must be due the *relative proportion of albuminoids and non albuminoids*, and not to any specific differences in the characteristics of the foods, as might and probably would be the case if linseed or cotton seed were contrasted with corn meal.

In almost every case, with each of the eleven cows, a change from gluten to corn meal, that is, a change from a *narrow* to a *wide* nutritive ratio, resulted in a decided falling off in the product, while the reverse change resulted in an equally decided increase. In some cases this variation is obscured by the natural shrinkage which was all the time taking place. The following table shows the detailed results, each period being for fourteen (14) days:

Nutritive ratio.	1:6	1:7	1:6	1:7	1:5.2	1:9	1:5.2	1:9	1:5.6	1:8	1:5.6	1:8	1:5.6
	lbs.	lbs.	lbs.	lbs.	lbs	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Snowflake, 2nd.	22.4	21.1											
Chinchilla,	21.7	20.5	21.2	15.13									
Countess Gazelle,					15.2	13.7	14.7	13.5	13.0				
Duchess,					32.3	29.0	32.0	27.7					
Pilots Lily,						16.6	18.8	16.5	15.6				
Maid of Arlis,						17.4	20.7	20.1					
Noethboro Belle,										20.4	21.2	17.8	
Duchess of Hanover,										14.6	14.7	12.8	
Duchess, 2nd,			25.0	24.4					16.4				
Clio,									24.7	23.5	25.4	23.2	
Frost,										24.5	28.7	28.2	30.09

The following conclusions seem fully warranted, namely:—

The proportion of albuminoids to non-albuminoids for the production of milk should not be much wider than 1 : 6.

A nutritive ratio of 1 : 5.2 produced eight per cent. more milk than a ratio of 1 : 9.

A ratio of 1 : 5.6 produced nine per cent. more milk than one of 1 : 8, and a ratio of 1 : 6 produced thirteen per cent. more than a ratio of 1 : 7.

G. H. WHITCHER, *Director.*

NOTICE.

The position of Station Entomologist having been filled by the election of Prof. C. M. WEED, we are now prepared to study the various problems connected with insect depredations, which, at the present time, are so disastrous to farm crops.

The Station will gladly undertake to identify specimens, if they are sent to us in some form of package which will insure their arrival in good state of preservation.

Any unusual outbreak of destructive insects will be promptly attended to if the Station is notified.

Address all communications to NEW HAMPSHIRE EXPERIMENT STATION, HANOVER, N. H.