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BULLETIN NO. 14.

MILK TESTS: METHODS OF TESTING MILK.

In this bulletin matters concerning dairy interests are treated under the following heads:

1. In continuation of the work published in bulletin No. 10, a report is given of tests made of the milk of 50 cows belonging to four herds in different parts of the state. Also a record of the tests made of the milk furnished in one day to two creameries, one having 48 patrons, and the other, 30 patrons who sell their milk by the amount of butter fat it contains, as shown by test. The tests all show that there is great variation in the value of cows for producing butter, and demonstrate the usefulness of an accurate "milk tester" by which any intelligent person can determine readily the butter fat in milk, skim-milk, buttermilk, or cream.

2. A description, with illustration, of a method of taking at creameries samples of milk for test.

3. A comparison of the Patrick, Babcock, and Beimling "milk testers" with each other and with gravimetric laboratory analyses, when used with the same sample of milk.

4. A description, with illustrations, of apparatus designed for use in measuring the acid for milk tests by the Babcock method.

5. Chemical analyses of *germ meal* and *oat dust feed*, two comparatively new feeding stuffs which some claim may be used with much profit in feeding milch cows when the prices of corn and oats are as high as now.

Experiment No. 106. Milk and Butter Tests.

TESTS OF MILK OF SEPARATE COWS, AND OF MILK AS BROUGHT BY PATRONS TO CREAMERIES.

The butter fat in milk is, for all practical purposes, a good measure of its value. It is, indeed, only one of the constituents, and of the others the casein is of greater importance to the cheese maker, while the protein substances, as well as the milk sugar and the ash, are valuable food. But the greatest importance must be ascribed to the fat, not only because it supplies us with butter but because it is also essential for the best cheese. It may also be accepted as a general rule that milk rich in butter fat has a proportionately high content of other solids not fat.

The richer milk is in its valuable constituents such as fat, etc., the greater are the receipts from the productions of the dairy, provided it does not cost more to produce the rich than the thin milk. Take, for example, two cows whose value and maintenance are equal: The milk from one produces 125 lb. of fat from which 125 lb. of butter can be made; the other, however, under the same conditions, produces 150 lb. It is plain then that the second animal is worth most to the dairyman. This fact remains unchanged whether the smaller quantity of 125 lb. was obtained from 3,000 lb. of milk with 4.17 per cent. of fat, from 4,000 lb. with 3.12 per cent., or from 5,000 lb. with 2.5 per cent; or whether the larger yearly amount of 150 lb. was obtained from 3,000 lb. of milk with 5 per cent. of fat, from 4,000 lb. with 3.75 per cent., or from 5,000 lb. with 3 per cent. For manufacturing butter, cheese, or condensed milk the absolute quantity of solids, especially fat, in the milk becomes of the first importance. The smaller the quantity of milk in which a certain quantity of the valuable constituents is contained; or in other words, the richer the milk, the less the cost of manipulation. An endeavor to procure milk of as rich a quality as possible is in the interest of higher receipts from the dairy.

In attempting to find a means for improving the quality of the milk from a herd, one thing necessary to do is carefully to inspect each cow. Not all cows fed and kept under the same conditions will produce the same quantity and quality of milk. They are not machines but living creatures, endowed with incalculable peculiarities and innumerable differences. It does not require much careful thought to convince one that the milk formation and separation, as well in amount as in richness, is measured by the individual capacity; and observation repeatedly teaches that among a number of cows fed and cared for in exactly the same way certain ones may be found which furnish milk differing extraordinarily in composition. The money value and profit that may be obtained from the so-called testing of dairy cows is so obvious that an explanation seems hardly necessary. The answer to the question, What shall we do in order to improve the composition of milk? is not very difficult. First of all it is necessary to determine quite frequently the amount of fat in the milk of each cow in a herd. The more tests and observations there are made and published, the more firmly established will be the foundation for any conclusions drawn, and the greater will be the zeal for further improvement in the composition of milk. To be sure, some veteran experimenters among dairymen have been thinking and working at this idea for a long time, and testing their cows by churning the milk of each one separately; but we should have cause for a great deal of encouragement if the number of cows whose butter value had been tested five years ago were compared with the much larger number at the present time that has been tested by some one or all of the multitude of milk tests of recent origin.

If a satisfactory dairy herd has been obtained by regularly testing the cows for some time, the next problem is to breed calves that shall have the desired qualities of the mother as regards quantity and composition of milk. Breeders' associations and herd-book societies could be very useful in this respect, if in their registers of milch cows they would include statements giving for each cow the amount of milk produced and the per cent. of fat it contained. When some such system as this shall have been adopted the dairyman will be in a better position to control many of the circumstances which now control him in a large measure.

One dairyman may be conscious that the butter produced by his herd is a little too soft, though it has a high flavor. Another one may produce butter that is hard and solid but has not flavor enough. If now records were kept both of the melting point of the butter fat of each cow and of the amount of the soluble fatty acid which gives to her butter its flavor, might not the one dairyman improve the texture and the other the flavor of his dairy output by adding to his herd cows capable of making such changes therein, or by removing from the herd the cows to which the defects were chargeable? At present it is much plainer what the defect is, than what the cow is; we need a more intimate knowledge of each cow. Some would improve on acquaintance; familiarity with others would breed contempt.

Extensive and accurate experiments have taught us some of the peculiarities of the different dairy breeds, and as a rule, thoroughbred stock can be depended on to furnish the quantity and quality of milk and butter characteristic of its breed; but there are exceptions even among cows of the same breed. An Experiment Station report* gives the following data in regard to two registered cows of the same breed:

	Cow No. 1.	Cow No. 2.
	cts.	cts.
Cost of milk per pound	.8674	1.411
" milk per quart	1.86	3.02
" solids per pound	5.87	9.08
" butter fat per pound	16.94	24.39
" cream per pound	3.76	6.09
" cream per quart	8.06	13.05
" butter per pound	15.72	24.35

These figures are probably as trustworthy as any that have been made, as they were obtained by recording during an entire year the weight of milk from each milking, of cream, of skim-milk, of butter, and of buttermilk, and a determination of the percentage of total solids and fat in the milk produced on five consecutive days in each month of the year. The method of computing these costs which are given here need not be considered as it was the same in both cases, so that the variations are due entirely to the differences between the cows. The figures include only

*The Maine Experiment Station report for 1889. Part II., p. 116.

the cost of the food the cows received. A good reason for this is that feeding stuffs have a market price and can be accurately measured or weighed, while the other expenses of producing milk can be best calculated by each individual who owns cows.

Another reference to the yearly record before mentioned shows that the total food eaten by one of these two cows, was 10,191 lb. and by the other 9,985 lb. a difference of only 206 lb. for the whole year, and 100 lb. of this difference was hay. Or, stating the case in another way, the total food eaten by one cow during an entire year exceeded that eaten by the other by 106 lb. of grain and 100 lb. of hay. The work of taking care of the cows was, of course, the same in both cases. The production from the two cows, for one year, was quite different.

	Cow No. 1.	Cow No. 2.	Difference.
No. of days milked	340	322	18
Yield of milk, lb	6,983	4,107	2,876
" milk solids, lb	1,015.2	638.4	375.8
" butter fat, lb	352	237.8	114.2
" butter, unsalted, lb	379.5	238	141.5
Average yield of milk per day, lb	20.2	12.7	7.5

This record shows that cow No. 1 gave 2,876 lb. more of milk than cow No. 2 and that the excess of butter produced was 141.5 lb. The excess of butter, at 25 cents a pound, was worth $35.37; and the excess of milk, at 3 cents a quart, was worth $43.14. Since the feed and labor are practically the same for keeping cows, it seems that it is quite worth while to test each cow and see what she is doing for her owner.

Tests of cows nearly as valuable as the one just given can be made by any intelligent person with the aid of a pair of scales; and probably many are doing what practically amounts to about the same thing. The time has come, however, when the butter value of a cow can be tested very accurately, and by the dairyman himself. Until within about two years dairymen were without any practical means of discovering which one of three causes, was responsible for a small return of butter from the dairy:

1. Whether the butter fat was left in the skim-milk.

2. Whether the cream was so manipulated that a considerable amount of fat was left in the buttermilk.

3. Whether the fault was in the cow.

There is unquestionably a great difference in the per cent. of fat left in skim-milk even when the milk of different cows is set under precisely the same conditions. A striking illustration of this is shown by the yearly record before referred to, in which 26 per cent. of the total butter fat produced by one cow was lost in the skim-milk; while in the case of another cow, 3.7 per cent. only of the butter fat was lost in the skim-milk. This difference in the butter capacity in cows is largely overcome by the butter extractor, or separator, which can be so worked as to remove all but one to two-tenths of one per cent. of fat from the milk of any cow. But there is an enormous amount of butter made by persons who separate the cream by "setting milk," and to them the thoroughness of cream separation is a matter of importance, even though the skim-milk is fed to calves; for it is cheaper to re-inforce skim-milk with grain than to feed cream. The process of getting the fat from the milk, either the creaming or the churning, is at fault, if the fat is not nearly all obtained by the butter maker. The test, if properly made, or the analysis, shows the total quantity of fat accurately; if the amount of butter is not about the same, the methods of the butter maker are somewhere wrong. The testing of milk for the amount of fat it contains is no longer confined to the chemists of the country only. The process has been made so simple that it is hardly an exaggeration to say that it is within the ability of any one who can turn a crank. It is certainly true that any one who can comprehend the use and necessity of testing his cows need have no fear of inability to manipulate the tester.

The following record of work done in this direction will illustrate the practical use that a dairyman can make of the testers. During the past year I have tested the milk of 142 cows. This test was in nearly all cases a determination of the fat in the milk given by each cow in 24 hours. The morning milk and the night milk were tested separately and over 500 analyses were made. Fifty of these tests are given in the table on the next page. In the table of extremes, which follows, the per cents. of fat in milk, given in the columns headed "a. m." and "p. m." in some cases do not represent the milk of the same cow at both milkings at one farm; but, with two exceptions, in the two columns giving the milk and fat produced in 24 hours at one farm, the figures apply to the same cow.

The feed the cows were receiving at the time of the tests was as follows:

Farm A. The daily feed to 28 head: One shock of ensilage corn, two shocks of sweet corn, and husked corn from 300 hills, equal to about two bu. of ears.

Farm B. Corn ensilage, some shocked corn, and a little wheat shorts or coarse middlings.

Farm C. Four bu. of corn in the ear daily, with hay; just beginning to feed shorts.

Farm D. One feed for 40 cows is a mixture of 5 bu. corn-and-cob meal ground coarse, 2½ bu. scalded malt sprouts, and ½ bu. fine linseed meal. This ration was fed morning and evening, also one feed of good tame hay and one of corn stover.

The milk from the first three farms is sold to a creamery; that produced on farm D is mostly used for making gilt-edged butter.

It may not be always fair to judge of a cow from the test of her milk for one day only; but when we compare in this way cows that calved in the same month, one important influence on the composition of the milk is the same in both cases. The thirteen cows tested at farm A had all calved in June, four months before the test was made. As they had

RECORD OF TESTS MADE OF MORNING AND NIGHT MILK, OR THE MILK PRODUCED IN 24 HOURS BY 50 COWS ON FOUR FARMS.

Number.	Breed.	Age, years.	Days since last calf, approximate.	Pounds of milk.		Per cent. of fat in milk.		Total pounds of milk.	Total pounds of fat.	Per cent. of fat, total.
				a.m.	p.m.	a.m.	p. m.			
	Farm A, October 28,	*1890.*								
1	Grade Shorthorn	8	120	4¾	5	3.3	5.25	9¾	.41	4.20
2	"	8	120	6¾	6¾	3.7	4.78	13¼	.57	4.30
3	"	4	120	7¾	7¾	3.4	4	15¼	.57	3.73
4	"	5	120	4	4¼	3.9	3.7	8¼	.30	3.63
5	"	5	120	5¾	3¾	5	4.65	9¼	.45	4.86
6	"	7	120	6¼	5¼	3	3.6	11½	.37	3.21
7	"	5	120	4¾	3¾	3.3	5.6	8¼	.36	4.36
8	"	7	120	7¾	6¾	3.5	3.85	14¼	.53	3.71
9	"	4	120	5½	6	3.35	3.6	11½	.39	3.39
10	"	7	120	6	5¼	3 65	4.4	11¼	.45	4.00
11	"	4	120	5	4¼	3.75	4.8	9¼	.39	4.21
12	"	5	120	7	6¼	3 9	4.45	13¼	.55	4.15
13	"	9	120	8	7¼	3.30	5	15¼	.62	4.06
	Farm B, October 29,	*1890.*								
14	Native	6[?]	28	11	11½	4	3.6	22½	.85	3.77
15	"	6[?]	21	14	14	3.6	2.8	28	.89	3.18
16	"	8	21	14½	14¼	3.8	3	28¾	.98	3.41
17	"	5	28	10¼	11	3.6	3.3	21¼	.73	3.43
18	"	10	35	13½	16	3.3	3.4	29½	.98	3.32
19	"	8	28	13¼	15½	3.2	3.4	28¾	.94	3.27
20	"	7	28	17¼	20¾	3.6	3	38	1.24	3.26
21	"	7	7	13	14	4.1	3.9	27	1.07	3.96
22	Grade Holstein	5	21	10¼	12¼	5.1	2.6	22½	.83	3.68
23	Grade Shorthorn	10	7	9	9	3.6	4.7	18	.74	4.11
24	Grade Holstein	5	21	10¼	9¼	3.8	3.6	19½	.71	3.64
25	Native	10	7	10	11	5.4	3.8	21	.95	4.52
26	Jersey and Holstein	5	21	9¼	8½	4 2	3.9	17¾	.70	3.94
	Farm C, October 30,	*1890.*								
27	High grade Shorthorn	8	210	9	5	3.2	2	14	.388	2.77
28	Native	3	42	7½	7	3.9	3.9	14½	.565	3.89
29	High grade Shorthorn	6	90	13	13	3.3	3.3	26	.858	3,30
30	Half Hereford	2	120	7	7	4.6	3.8	14	.588	4.20
31	Native	5	150	7	6	4.6	4.4	13	.586	4.50
32	Three-fourths Shorthorn	6	150	8	6	4.6	4.7	14	.65	4.64
33	Half Hereford	2	120	6	6	5	4.7	12	.58	4.83
34	Native	3	90	9	6	4.6	4	15	.65	4.33
35	Native	2	60	7¼	7	3.4	3	14¼	.456	3.20
	Farm D, January 5,	*1891.*								
36	Grade Shorthorn	5	120	12	10¾	3.48	3.7	22¾	.82	3.60
37	Grade Jersey	8	270	8½	7½	4.13	4.9	16	.72	4.50
38	Native	4	150	8¾	7¾	3.7	3.5	16½	.59	3.57
39	Native	10	120	13	12	3	3.2	25	.78	3.12
40	Grade Jersey	5	240	5¼	4¼	3.8	4.3	9½	38	4.00
41	Grade Shorthorn	7	150	8½	8	3.4	4 2	16½	.63	3.81
42	Native	12	240	7¼	7¾	Lost	3.2	15	....	.....
43	Native	7	270	5¾	6	4	3.8	11¾	.46	3.91
44	Grade Shorthorn	3	150	7¾	8	3.5	3.4	15¾	.54	3.42
45	"	8	90	11½	13	3.6	2.6	24½	.76	3.10
46	"	4	120	11¼	10⅛	3.3	3.3	21⅜	.70	3.27
47	"	3	120	8¾	9¾	3.5	3.4	18½	.65	3.51
48	"	5	60	10½	9¾	3.4	3.4	20¼	.69	3.40
49	Grade Jersey	7	60	13	12⅜	3.3	3	25⅜	.79	3.11
50	Native	9	60	12⅛	12⅛	3	2.7	24¼	.70	2.88

TABLE SHOWING A SUMMARY OF EXTREMES AND AVERAGES OF THE TESTS OF THE 50 COWS AT THE FOUR FARMS.

	Highest.				Lowest.				Average.			
	Per cent. of fat.		Produced in 24 hours, lb.		Per cent. of fat.		Produced in 24 h'rs, lb.		Per cent. of fat.		Produced in 24 hours. lb.	
	a.m.	p. m.	Milk.	Fat.	a.m.	p. m.	Milk.	Fat.	a.m.	p. m.	Milk.	Fat.
Farm A	5	5.6	15¼	.62	3	3.6	8¼	.3	3.6	4.4	11.5	.46
Farm B	5.4	4.7	38	1.24	3.2	2.6	17¾	.7	4	3.4	25	.9
Farm C	5	4.7	26	.86	3.2	2	12	.39	4.1	3.75	15	.59
Farm D	4.1	4.9	25⅜	.82	3	2.6	9½	.38	3.5	3.5	19	.65
Average	4.9	4.98	26⅛	.885	3.1	2.7	11.9	.52	3.8	3.76	18.5	.65
Extreme	5.4	3.68	38	1.24	3	2	8¼	.3	....	....	....	....

all had the same treatment, were of the same grade, and were all mature animals, the task of selecting the most profitable butter cows, or of weeding out the poor ones is not very complicated. The average quantity of milk given per cow in 24 hours was 11½ lb., the most milk given by any one cow was 15¼ lb., the least 8¼ lb. The cow giving the most milk produced the largest quantity of butter fat—.62 lb. The cow giving the least milk produced the least fat—.3 lb. The average weight of butter fat produced per cow was .46 lb., or a little less than half a pound. On the basis of the weight of butter fat produced, the best cow in this lot gave 100 per cent. more butter fat than the poorest, and there were five other cows that were producing less than 63 per cent. of the best cow's product, while four of the cows came within 8 per cent. of being as good as the best one. Further inspection of the table shows that there were six other cows from the different farms, Nos. 30, 33, 36, 39, 46, and 47, that had been milked about the same length of time since calving. Four of these produced over 100 per cent. more butter fat than cow No. 4, the poorest one in the comparison just made. Comparing No. 36 and No. 39 shows that the most butter fat is not always produced by the cow giving the most milk.

At farm B thirteen cows were selected that were all fresh in milk, having calved within a month. The average quantity of milk given per cow in 24 hours was 25 lb.; the most, 38 lb.; and the least 17¾ lb. In this case, the most butter fat was produced by the cow giving the most milk, the 38 lb. of milk containing 1¼ lb. butter fat; and the least butter fat was found in the milk of the cow giving the least quantity, 17¾ lb., and amounted to .7 lb. The average weight of butter fat given per cow, per day, was .9 lb. Measured by the weight of butter fat produced in 24 hours, this lot of cows was much more uniform than the one previously mentioned. The best cow of this lot was only 77 per cent. better than the one giving the least butter fat on this day; while in the previous comparisons the best was over 100 per cent. better than the poorest.

Granting that there is a vast difference in cows because of their varied capacity, it at once becomes evident how unfair it is to the patrons of a creamery to pay each and all of them the same price per pound for the milk they bring, no matter whether it contains 3 or 6 per cent. of butter fat.

Tests made at Creameries. The following table shows a record of tests made of milk brought by 78 patrons to two creameries in one day:

RECORD OF TESTS MADE OF MILK BROUGHT BY 78 PATRONS TO TWO CREAMERIES IN ONE DAY.

Per cent. fat in milk.	Creamery A—October 31, 1890.				Creamery B—October 30, 1890.			
	Pounds milk.	Pounds. fat.	Pounds of milk per lb. of fat.	No. of patrons contibuting.	Pounds milk.	Pounds fat.	Pounds of milk per lb. of fat.	No. of patrons contributing.
3.3	164	5.412	30.3	1	....	....	....	....
3.4	243	8.262	29.4	1	....	....	....	....
3.5	256	8.960	28.5	1	....	....	....	....
3.7	....	....	27	....	236	8.712	27	1
3.8	493	18.734	26.3	3	820	31.160	26.3	4
3.9	138	5.382	25.6	1	....	....	....	....
4	1,134	45.360	25	7	655	26.200	25	3
4.1	1,412	58.092	24.3	5	147	6.027	24.3	1
4.2	1,268	53.256	23.8	6	725	30.450	23.8	4
4.3	772	33.196	23.2	5	600	25.800	23.2	3
4.4	290	12.760	22.7	2	407	17.910	22.7	5
4.5	311	13.995	22.2	3	....	....	....	....
4.6	299	13.754	21.7	5	666	30.643	21.7	4
4.7	24	1.128	21.3	1	....	....	....	....
4.8	229	10.992	20.8	2	....	....	....	....
4.9	95	4.655	20.4	2	65	3.185	20.4	1
5	242	12.100	20	2	....	....	....	....
5.1	....	....	....	....	72	3.672	19.6	2
5.2	88	4.576	19.2	1	....	....	....	....
5.6	....	....	....	....	81	4.536	17.8	1
6.4	....	....	....	....	12	.768	15.6	1
Total. .	7,458	310.624	24	48	4,496	190.060	22.4	30

At creamery A the average per cent. of fat in the milk brought by the 48 patrons was 4.25; the highest, 5.2; the lowest, 3.3, or to make one pound of butter fat would require 19.2 lb. of milk in one case against 30.3 lb. of the poorest milk brought.

At creamery B, supplied by 30 patrons, the best milk brought was 57 per cent. richer in butter fat than the poorest milk.

The difference between the yield of butter by the churn and of butter fat by the tests, is the water, salt, and curd of the butter.

In the record of creamery A, as given above, the butter fat as found by test was 310.62 lb.; the yield of the churn that day was 333.5—an increase of the churn over the test of 22.88 lb., or 7.36 per cent.

The following table illustrates the method used by Gurler Bros., DeKalb, Ill., at the creameries where the patrons are paid on the test plan. The milk brought by each patron is tested once each week; an average of these tests is made every month; the total pounds of milk brought by each patron during the month is multiplied by his average per cent. for the month, the total amount being the total pounds of butter fat by test. Dividing the total number of pounds of butter fat, as shown by the test, delivered by all the patrons by the difference between this number and the actual yield of butter by the churn gives the per cent. of increase of the churn over test. (Taking the illustration below: 698.92—602.56=96.36; 96.36÷602.56=.16. Increase of churn over test=16 per cent.) Adding then to the number of pounds of butter fat delivered by each patron 16 per cent. of that number gives the number of pounds of butter with which he is credited and for which he is paid.

TABLE Showing Method of Paying Creamery Patrons on the Basis of the Amount of Butter Fat in Milk delivered.

Patrons.	Per cent. fat in milk as shown by tests.					Lb. milk brought during month.	Lb. butter fat by test.	Increase of churn over test, 16 per cent.	Actual butter made.	Received for butter, 23.9 cents per lb.	Lb. butter made per 100 lb. milk.	Received for 100 lb. milk.
	Nov. 7.	Nov. 14.	Nov. 19.	Nov. 26.	Average.							
1	3.7	3.6	3.7	4.2	3.8	1,556	59.13		68.59		4.40	$1.05
2	4	*	*	3.7	3.85	474	18.25		21.17		4.46	1.06
3	3.8	4	4.1	3.7	3.9	4,361	170.06		197.30		4.52	1.08
4	4.8	4	4.3	*	4.37	598	26.16		30.31		5.07	1.20
5	4	3.9	4.1	4.1	4.03	4,621	186.23		216		4.67	1.12
6	4.3	4.3	4.8	4.4	4.45	2,967	132.03		153.13		5.16	1.23
7	4.4	4.7	3.5	4.2	4.20	255	10.71		12.42		4.87	1.16
Total.	......	......	......	......	......	......	602.56		698.92		......	......

*No milk delivered.

A report of one of their creameries, made by Gurler Bros. for October, shows that the patrons, who were there paid on the test plan, received from 93 cts. to $1.32 per 100 lb. of milk.

The time and labor of the patrons was probably the same for producing the 100 lb. of milk that brought 93 cts., as for that which brought $1.32, and it has been demonstrated that the test is trustworthy; so there seems to be but one conclusion to draw—the cows need testing.

Methods of Taking Samples of Milk to be tested.

When any milk is to be tested a great deal of care is necessary to get a fair sample of it. Even new milk should be poured from one vessel to another. When the cream has risen on milk it can be mixed again by warming the milk to about the temperature of the body, 100° F., and carefully pouring it back and forth from one vessel to another until no small lumps of cream can be seen or known to be present. Shaking or stirring the milk in one vessel may separate the butter fat by churning it, and cannot safely be substituted for pouring.

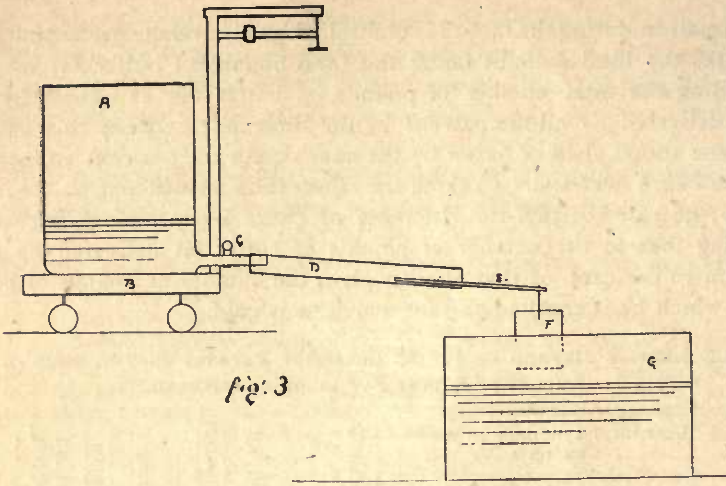

Fig. 3

Fig. 3 shows an arrangement used by Gurler Bros., DeKalb, Ill., in taking samples for testing the milk brought to a creamery by its patrons.

The milk runs from the weighing can A through the conductor D to the tank C. The brass tube E is about 2½ to 3 ft. long, with an inside diameter of 3-16 to 4-16 in. (The end over the small pail should be turned down.) This brass tube lies in the conductor spout, extending out about one foot, and a small pail F is hung under the end to catch the milk that runs through the brass tube while the milk in the weighing can A is running through D into C. The weight of the brass tube holds it in place. The milk collected in this way in the pail F, when mixed, is ready for making the test.

Comparison of different "Milk Tests" with each other and with Gravimetric Laboratory Analysis on the same Sample of Milk.

In *bulletin No. 10* of this Station a report was published of observations made with several milk tests. These included "Short's test," The Iowa Station "Milk Test," described by Patrick, and the Cochran "Milk Test."

Since that time Professor Patrick has suggested the use of a brine bath in connection with his test, and two other tests have been made public: the Beimling "Milk test," described in *bulletin No. 21, Vt. Experiment Station,* and Dr. Babcock's "Milk Test," *bulletin No. 24, Wis. Experiment Station.*

By the use of the brine bath with the Patrick test, a number of tests can be carried on at the same time and kept at a uniform stage in the process.* The details of this test have been very thoroughly worked out by its author and satisfactory results have so far been obtained, except

*Bulletin 11, Ia. Experiment Station, page 484.

Notes on the Babcock Test. When a large number of tests—30 to 60—are to be made by this method, each test bottle can be set in boiling hot water, as soon as the acid and milk have been thoroughly mixed. This keeps them hot till all are ready to be put in the centrifuge, and helps to get a clear and complete separation of fat.

The appearance of a white residue that is not fat, mixed with the fat, or forming a layer between it and the other liquid in the test bottle, is prevented by use of acid of the right strength.

The specific gravity of the acid recommended by Dr. Babcock is 1.82. The bottle of sulphuric acid must be tightly corked when not in use, because of the property this acid has of taking up from the air moisture, which dilutes the acid and weakens its action on the milk.

The greatest accuracy is obtained by testing milk when it is about the temperature of the body, and by measuring the column of separated fat at a temperature of 140° F.

Notes on the Beimling Test. The graduations for measuring the fat in the test bottles are very fine, so that strong eyes and light are necessary for reading the results.

The graduations do not represent percentages of fat, but a "ready reckoner" card is required which contains the per cents of fat corresponding to the graduations.

Two "compounds" must be added to each test, and the amount used of compound No. 2 is a variable quantity, because the test bottles are not of a uniform size, and the compound must be added till the neck of the bottle is filled. This may be the reason why more heat is developed in one test than in another.

A proper mixture of the milk with the chemicals in the test bottles often caused such a foaming that the liquid spurted out and the test was lost.

The safest method of manipulation I found to be first thoroughly to mix compound No. 1 with the milk in the test bottle, then to add compound No. 2 in successive portions, mixing after each addition. In nearly every test that I have made by this process it has been necessary to add hot water after running in the centrifuge in order to bring the fat up into the neck of the test bottle where it is measured.

The tests must be made in a warm room, otherwise when making 6 or more tests, the first one cools before the last one is ready to be put into the centrifuge.

With some skim-milks this test gives too high results—probably caused by the fusel oil in compound No. 1 which, if not expelled by the heat developed or the certrifugal motion, may accumulate in the neck of the test bottle and be measured as butter fat.

Professor W. W. Cooke says in *bulletin No. 21, Vt. Experiment Station*, "A rough idea of the fat percentage in skim-milk and buttermilk may be obtained by this [Beimling] method, but they cannot be accurately analyzed unless there be at least a [one] per cent. of fat present."

The results given on page 465 with skim-milk by this method were obtained by running the centrifuge two minutes and then stopping, except No. 533. In this case the skim-milk was from a separator. The trials were all made upon portions of milk taken from the same sample. In each of the five trials made by the Beimling method the centrifuge was run two minutes, stopped, and the reading of the fat taken. It was then run two minutes more and a second reading taken; and the same was done for third and fourth periods of two minutes each. A repetition of this trial by the Beimling method gave as an ultimate result with each of six portions .69 per cent. of fat. The table shows the details.

PERCENTAGE OF FAT FOUND BY REPEATED TRIALS BY DIFFERENT METHODS ON ONE LOT OF SEPARATOR SKIM-MILK.

Gravimetric.	Patrick.	Babcock.	Beimling. [Centrifuge run for 2 minutes before each reading.]				Cochran.
			First 2 min.	Second 2 min.	Third 2 min.	Fourth 2 min.	
0.25	0.25	0.25	0.26	0.52	0.69	0.78	0.35
0 25	0.30	0.25	0.35	0.69	0 69	0.78	0.47
0.20	....	0.30	0.35	0.61	0.69	0.78	....
0.14	....	0 30	0.43	0.61	0.61	0.78	....
....	....	....	0.52	0.52	0 61	0 78	....

TABLE SHOWING MILK, TIME, CHEMICALS, AND COST OF CHEMICALS REQUIRED FOR EACH ANALYSIS BY THE THREE METHODS NAMED.

Method of	Milk per analysi c. c.	Reagents or chemicals used.	Time for single analysis, approximate.	Estimated cost for chemicals, per analysis.
Patrick.	10.4	*"Acid mixture," about 10 c. c.	About 20 minutes. "Six analysis in one-half hour."	"Acid mixture" 20 cts. per lb. "One lb. makes 25 tests."
Babcock.	17.6	"Com. sulphuric acid, about 90 per cent. pure. Sp. gr. 1.82."	"Sixty tests may be made in less than two hours."	One-half to one-fifth of a cent.
Beimling.	15.	3 c. c. of †compound No. 1. "Fill the bottle compound No. 2** to the 0 mark."	"Five minutes," or 25 tests an hour.	"Less than one-fifth of a cent per test."

* "Acetic acid [90 per cent.] 9 volumes; commercial oil of vitrol, sp. gr. 1.83, 5 to 6 volumes. Mix, allow to cool, and add to the mixture about 2 per cent. by volume of rectified methylic alcohol."

† "Mixture of equal bulks of rectified amyl alcohol and com. conc. hydrochloric acid, sp. gr. 1.16 or above."

** Commercial concentrated oil of vitriol, sp. gr. 1.83.

The gravimetric methods* used for analysis of the milk were the Adams paper method, the sand method, by which the milk is first dried at 100° C. on about 20 grams cleansed sand, the dried residue and

*5 c. c. Milk: weighed from weighing bottle each time.

TABLE SHOWING PERCENTAGES OF BUTTER FAT FOUND IN SAMPLES OF WHOLE MILK, SKIM-MILK, AND BUTTERMILK BY GRAVIMETRIC METHODS, AND BY THE BABCOCK, THE PATRICK, AND THE BEIMLING "MILK TESTS."

	Lab. No.	Gravimetric methods.			Babcock.	Patrick.	Beimling.
		Adams'.	Sand.	Asbestos.			
Milk of one cow......	495	2.01 2.16	2.00 2.07	2.00 1.97	2.00 1.90	2.00 2.30	2.00 2.30
" "	496	2.70 2.77	2.61 2.82	2.65 2.51	2.55 2.50	2.60 2.70	2.61 2.70
" "	497	6.19 6.23	6.15 6.14	6 14	6.10 6.20	6.10 6.20	6.18 6.18
" "	498	5.43 5.43	5.44 5.41	5.35 5.09	5.40 5.30	5.40 5.30	5.40 5.50
" "	499	4.26	4.34	4.10	4.35 4.40	4.20 4.20	4.35 4.44
" "	500	1.95 2.11	1 87 1.80	1 95 1.88	1.80 1.85	1.80 1.80	1.83 1.91
" "	502	6.43 6.49	6.38 6.33	6.32 6.32	6.35 6.20	6.40 6.40	6.38 6.44
" "	501	5.44	5.45	5.30	5.35 5.30	5.35 5.40	5.50 5.58
" "	520	5.29	5.13	5.00	5.00 5.10	5.00 5.10	5.13 5.22
" "	522	6.29	6.23	6.01	6.00 6.00	6.00 6.20	6.18 6.10
" "	527	4.05	3.93	3.81	4.00 4.00	4.10 4.00	4.17 4.00
" "	526	6.06	6.08	5.81	6.00 5.90	5.90 5.90	5.83 5.91
Skim-milk	519	0.54	0.42	0.43	0 50 0.40	0.40 0.35	0.43 0.52
" "	525	1.44 1.44	1.35 1.32	1.27 1.24	1.40 1.40	1.35 1.40	1.48
" "	531	0.23 0.10	0.18 0.17	0.15 0.12	0.20 0.30	0.0	0.26 0.35
" "	532	0.48 0.49	0.41 0.24	0.20 0.24	0.40 0.40	0.30 0.20	0.43 0.26
Separator skim-milk..	533	0.25 0.25	....	0.20 0.14	0.25 0.30	0.25 0.30	0.69 0.78
Buttermilk	524	0.37 0.32	0.41	....	0.50 0.45	0.0	0.44 0.39
" "	523	0.56 0.55	0.59	0.51 0.50	0.50 0.45	0.0	0.43 0.43
" "	530	0.47 0.38	....	0.33 0.44	0.80 0.80	0.0	0.70 0.70

sand transferred to a fat extractor; and an asbestos method operated as follows: A tube 3 in. long and ⅞ in. in diameter was made of thin sheet-brass punched with holes 1-25 in. in diameter. One end of the tube was closed with this sheet-brass. The tube is filled with clean, fibrous asbestos and weighed; the weighed quantity of milk is run upon this asbestos, and the whole dried at 100° C. When dry, this tube is transferred to the fat extractor.

A Device for Measuring the Acid into the Test Bottles used with Dr. Babcock's Method.

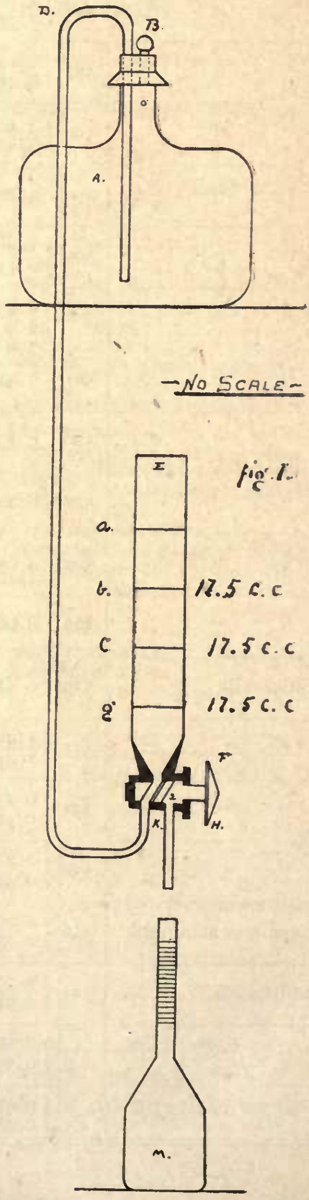

Fig. 1 shows the glass bottle, or carboy, A which holds the acid. The neck is closed by a tight-fitting rubber stopper. There are two holes in the stopper. One is for letting air into the bottle as the acid is drawn out; at other times it is tightly closed by the cork B. The glass tube D passes through the other hole in the stopper nearly to the bottom of the vessel A, and, as shown in the cut, connects with a glass burette E by means of a three-way glass stop-cock.

When the cork B is taken out, the siphon tube D being full of acid and the glass cock in the position shown in the cut, the acid will run in and fill the burette E, provided, of course, there is sufficient acid in the vessel A. When the burette E is as full as desired, that is, when the surface of the liquid cuts the line a, b, c, or g, the flow of acid from A through the tube D can be stopped by turning the glass cock F H until F H is horizontal instead of vertical. Then by turning the cock still more so that F and H change places, the acid is shut off from D and direct connection is made between the burette and the tube K, allowing the acid to flow into the test bottle M. When the required volume of acid has run into M, as indicted by the lines on the burette, the stop-cock is turned so as to shut off the flow of acid, and another test bottle takes the place of the first one and receives its charge of acid.

A suitable support for the burette E is a simple matter and can be adjusted by any one. Either attach the burette to a board by a wire or clamp it to a wooden or iron rod. The length of the burette will depend on how many measures of acid it is to hold.

There are advantages in using an automatic pipette, Fig 2, in the place of the burette E. With this pipette there can be no mistake made in the quantity of acid measured out, if the pipette is filled each time.

The diameter of the tubes, and passages of the cocks through which the acid runs, should be at least 3-16 in. so that the thick acid will run freely and not too slowly.

When not in use the glass cock should be left in such a position that the acid will drain out of it. By this arrangement the acid is kept tightly corked; it is ready for use at any time, and there is less chance of waste or pouring over the hands and clothing.

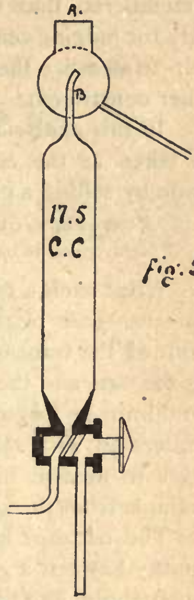

Fig. 2.

The apparatus illustrated in Fig. 1 has been made by a dealer in chemical apparatus for $2.50; that in Fig. 2, which must have with it the bottle A and tube D, for $2.25.

Chemical Analyses of "Germ Meal" and of "Oat Dust Feed."

The price of corn and oats during the present season causes certain bye products of manufacturing processes to come into more prominent notice as feeding stuffs. Two such have been analyzed from samples taken in November, 1890.

The germ meal was out of a car load from which farmers were buying at DeKalb, Ill.

The oat dust feed was obtained from the Rockford Oat Mills, Rockford, Ill.

The following table gives the analyses, together with an average of a great many analyses of some other common feeding stuffs:

TABLE Showing Composition of "Germ Meal" and "Oat Dust" Feed in Comparison with other well known Feeding Stuffs.

	Composition of dry feed containing no water.						Composition (as fed) when analyzed.					
	Timothy hay.	Corn meal.	Germ meal.	Oat dust feed.	Wheat bran.	Oats.	Timothy hay.	Corn meal.	Germ meal.	Oat dust feed.	Wheat bran.	Oats.
Water	.....	.....	.....	.....	.....	.....	10.24	15.93	9	7.91	12.48	10.94
Ash	4.66	1.73	1.12	8.28	6.53	3.31	4.11	1.46	1.02	7.63	5.70	3.97
Protein	6.74	10.89	12.70	13.43	17.21	12.70	6.06	9.16	11.56	12.37	15.07	11.38
Fat	2.36	4.53	7.03	4.61	4.31	5.41	2.12	3.81	6.40	4.25	3.78	4.81
N.-free ex't	52.49	80.70	68.94	51.54	62	67.44	47.10	67.84	62.72	47.47	54.26	60.05
Fiber	33.85	2.15	10.21	22.12	9.95	11.06	30.37	1.80	9.30	20.37	8.71	9.85
No. of analyses	53	56	1	1	63	25	.....	.....	.....	.....	.....	.....

In using this or any other table of feeding-stuff analyses, it should be remembered that chemical analyses of feeding stuffs serve as a guide only for judging one by another, and that the palatability and digestibility help to measure their value as food as well as the quantity of protein, and other constituents.

In this analysis the germ meal somewhat resembles oats. If one can be taken as the equivalent of the other in feeding value, what can be made by selling a crop of oats and buying germ meal?

A ton of oats, 63 bu. to the ton, at 45 cts. per bu. is worth....	$28.35
Germ meal, in car load lots, per ton..................................	16.00

When such a calculation as this is made it should not be forgotten that these are prices for the products at market, and that the apparent profit of the transaction should be diminished both by the cost of marketing the oats and the cost of bringing the germ meal to the farm. Also it should not be forgotten that the manufactured feed can often be easily adulterated with less valuable food so that it might be essential for the buyer to protect himself by a guaranty of purity, and by an analysis of a sample from the stock offered him.

The oat dust feed contains a high per cent. of fiber, not so much as timothy hay but a great deal more than oats. The nitrogen-free extract is also about like that of timothy hay and much less than in oats. The protein is equal in quantity to that of oats, while the ash is considerably higher. An examination of the ash showed that it contained about fifty per cent. of insoluble matter (sand, etc.).

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All communications intended for the Station should be addressed, not to any person, but to the

Agricultural Experiment Station, Champaign, Illinois.

The bulletins of the Experiment Station will be sent free of all charges to persons engaged in farming who may request that they be sent.

SELIM H. PEABODY,
President Board of Direction.