12-1-1910

Milk Powder Starters in Creameries

C. Larsen

W. White

BULLETIN NO. 123 DECEMBER 1910

AGRICULTURAL EXPERIMENT STATION

SOUTH DAKOTA STATE COLLEGE OF AGRICULTURE
AND MECHANIC ARTS

DAIRY HUSBANDRY DEPARTMENT

MILK POWDER STARTERS IN CREAMERIES

BROOKINGS, SOUTH DAKOTA

THE MITCHELL PUBLISHING COMPANY, PRINTERS, MITCHELL, S. D.

GOVERNING BOARD

Hon. A. J. Norby, Acting President.....Sisseton, S. D.
Hon. A. M. Anderson .....Sturgis, S. D.
Hon. A. E. Hitchcock .....Mitchell, S. D.
Hon. P. W. Dwight .....Sioux Falls, S. D.
Hon. August Frieberg .....Beresford, S. D.

STATION STAFF

A. J. Norby .....Regent Member
A. E. Hitchcock .....Regent Member
Robert L. Slagle .....President of College
James W. Wilson ....Director and Animal Husbandman
N. E. Hansen .....Vice Director and Horticulturist
James H. Shepard .....Chemist
E. W. Olive .....Botanist
E. L. Moore .....Veterinarian
C. Larsen .....Dairy Husbandman
Clifford Willis .....Agronomist and Supt. of Substations
S. Garver. Assistant in Agronomy, Cottonwood Substation
P. H. Moore. .Assistant in Agronomy, Eureka Substation
M. Champlin .....
(Co-operative) Asst. in Agronomy, Highmore Substation
O. E. White .....Assistant in Botany
J. H. Sarvis .....Assistant in Botany
William White .....Assistant in Dairying
D. E. Bailey.....Assistant in Dairying
Howard Loomis .....Assistant in Agronomy
R. A. Larson .....Secretary and Accountant
M. M. Johnson .....Bulletin Clerk and Stenographer

MILK POWDER STARTERS IN CREAMERIES

By C. LARSEN and W. WHITE

SUMMARY.

1. Milk powder can be successfully used for starter-making in creameries. It is a suitable substitute for natural skimmilk in creameries where skimmilk is not easily obtainable.

2. Two drums of dried milk were kept in good condition in a room adjacent to the creamery for over a year at ordinary room temperature.

3. Three ounces of milk powder to one quart of pure water are the proportions which gave the best results in these investigations.

4. The milk powder should be dissolved in pure warm water, preferably clean distilled water. Pure well water also give good results. Add powder to water rather than water to powder to get the quickest solution.

5. The cost of skimmilk powder is 16 cents per pound. When it is dissolved in water in proportions given above the cost is 11 cents per gallon and $1.32 per hundred pounds.

6. The advantages of skimmilk powder for starters in creameries are that a large supply may be secured at one time, it is always on hand when needed and always fresh and is not bulky to store and to transport.

7. The chief disadvantage of milk powder for starters is the cost and some additional work in preparing the starters.

INTRODUCTION.

Much experimental and practical work at various experiment stations and factories has demonstrated that a good starter properly used in cream in connection with the manufacture of butter improves the uniformity, quality, and keeping property of the butter.

With the introduction of the hand separator and the increased use of the skimmilk for feeding purposes on the dairy farms, and the centralization of butter factories, creameries have experienced increased difficulties in securing a uniform supply of a good quality of skimmilk for starters during the various seasons of the year. This is true especially in South Dakota and also in other central-west states.

Successful methods of reducing milk to powder have been in operation on a commercial basis but few years. With the advent of dried skimmilk which has good keeping properties and can be redissolved, and obtained at a reasonable cost, a new source of skimmilk for starters in creameries is at hand. The writer conceived the applicability of powdered milk in this connection three years ago while visiting the plant of Merrell-Soule & Co., in New York.

MOTHER STARTERS.

In starting to investigate the practicability of using a milk powder solution in place of the natural milk for starter-making, the first fact to be ascertained was whether this milk powder solution would furnish the proper conditions for the normal growth of the desirable or lactic acid producing germs. In making up the different milk powder solutions two conditions are under our control—(1) the purity of the water used and (2) the degree of concentration of the solution made.

Condensed steam from steam pipes was used for redissolving the powder. The common well water in the college creamery was also used with success. This water however is pure. Care should be taken to use only the best of water.

In order to determine the degree of concentration that would supply the best conditions for bacterial growth, solutions were made at the rate of 2, 3 and 4 oz. of milk-powder to 1 quart of water. These different solutions were placed into sterile pint glass bottles, which, together with a control sample consisting of a bottle of selected

fresh milk, were placed into a sterilizer and heated at 190 degrees Fahrenheit for 1 hour. Having been cooled, they were inoculated with a commercial culture and ripened, all under exactly the same conditions. When ripe they were scored, re-set and carried along from day to day as commonly done in practical creamery work and examined daily as stated above. The following table shows the relative quality of the powder solution starters as compared with the natural milk starters.

TABLE I.

	2 oz. Milk Powder to 1 qt. water	3 oz. Milk Powder to 1 qt. water	4 oz. Milk Powder to 1 qt. water	Natural Milk
Score	90	95	90	95
Remarks ..	Flat Watery	Good Keen Flavor	Sickening after Fruit Flavor	
Score	90	95	90	95
Remarks ..	Flat Watery	Keen Flavor, Little Rich	Rich, Sickening	
Score	90	95	92	95
Remarks ..	Flat Watery	Keen Acid	Too Rich.	
Score	88	95	90	95
Remarks ..	Under ripe flavor	Keen Acid Flavor	Sickening Flavor	Good Milk Acid
Score	88	95	90	95
Remarks ..	Lacking, Thin.	Clean Acid Flavor	Thick Rich	Clean Acid
Score	92	94	90	
Remarks ..	Flat	Good	Sickening	
Score	92	94	90	95
Remarks ..	Watery	Good	Sickening	Mild. Clean
Score	90	94	90	95
Remarks ..	Flat, Thin	Clean Acid	Too Rich	Good Keen Acid
Score	90	94	90	95
Remarks ..	Flat Watery	Keen Acid	Too Rich	Good Keen Acid
Score	92	95	92	96
Remarks ..	Watery	Good Clean Acid	Too Rich But Clean. Good.	Good Kean Acid
Average ..... Score	90.2	94.6	90.4	95.1

The data in the table shows the milk powder solution in the proportion of 3 oz. of powder to 1 quart of water gave much better results than the stronger and weaker solutions, that is, from the standpoint of quality as judged by the senses. Cultures grown in this solution produced a finely flavored starter which compared very favorably with that grown in the natural milk.

In scoring these milk powders starters the judge has omitted a consideration of the scorched flavor which all milk powder solutions have, at least those experimented upon. This flavor is similar to that developed in over-pasteurized milk, or milk heated until it begins to turn brown. However this flavor was not detected in any of the butter made.

The optimum temperature for ripening and the proper degree of acidity to develop are the same for milk powder starters as for natural milk starters. In fact, the milk powder in solution in the proportions recommended is practically the same as natural skimmilk and should be handled in exactly the same way as such at every step in the making of starters.

GROWTH OF BACTERIA IN MILK POWDER SOLUTIONS.

In order to obtain an exact knowledge of the growth and development of the bacteria in the different milk powder solutions as compared with natural milk, cultures were grown under laboratory conditions.

The five different solutions used were prepared as follows:

1. Two ounces of milk powder dissolved in one quart of water.
2. Three ounces of milk powder dissolved in one quart of water.
3. Four ounces of milk powder dissolved in one quart of water.
4. Natural skimmilk.
5. Natural skimmilk diluted with one-third water.

The perecentage of milk solids (9 per cent) in the solution of 3 ounces of milk powder to 1 quart water is approximately the same as that of natural skimmilk. And the percentage of solids (6 per cent) in the solution of 2 ounces powder in 1 quart of water is about the same as skimmilk diluted with one-third water.

The solutions were made, pasteurized in pint bottles at 190 degrees Fahrenheit for one hour, cooled to 80 degrees Fahrenheit and inoculated with a definite percentage of ripened culture. Sterile, graduated pipettes were used in making the inoculations and every possible precaution was taken to have conditions uniform and exact.

The specific gravity of the solutions was determined with the lactometer.

The acidity of the solutions before inoculation and after ripening was determined by titration with tenth-normal potassium hydroxide. The more concentracted solutions of milk powder have a greater initial acidity due to the greater percentage of solids present; so, to compare the amounts of acid developed in each case, the initial acidity was subtracted from the ultimate acidity, which gives the developed acidity.

The number of bacteria per cubic centimeter in each of the starters was ascertained by making cultures on lactose agar plates. These plates were incubated for 5 days at 21 degrees C.

Detailed data is given in the following table.

TABLE II.

Table showing the comparative development of acidity and bacteria in Mother Starters prepared from Milk Powder and Natural Skimmilk.

TABLE II.

Table showing the comparative development of acidity and bacteria in Mother Starters prepared from Milk Powder and Natural Skimmilk.

	Specific Gravity	Propagation First			Propagation Second			Propagation Third			Average of Developed Acidities	Average Number Bacteria per c. c.
		Acidity Before Inoculation	Acidity when ripe	Developed Acidity	Acidity Before Inoculation	Acidity when ripe	Developed Acidity	Acidity Before Inoculation	Acidity when ripe	Developed Acidity		
2 oz. Powder per qt. water	1.022	.09	.63	.54	.08	.60	.52	.08	.545	.465	.508	141,000,000
3 oz. Powder per qt. water	1.033	.13	.87	.74	.125	.88	.755	.12	.800	.680	.725	193.000,000
4 oz. Powder per qt. water	1.039	.18	1.00	.82	.17	1.00	.83	.175	.990	.815	.822	209.000,000
Skimmilk	1.035	.172	.87	.698	.19	.96	.77	.19	.840	.650	.706	203,000.000
2-3 Skimmilk & 1-3 water	1.023	.102	.64	.538	.11	.65	.54	.11	.580	.470	.516	160 000 000

The growth of the bacteria and the development of acid and flavor in the milk powder solutions are normal. Stained preparations of the bacteria from milk powder solutions appear the same under the microscope as those grown in natural milk.

A comparison of the specific gravities, amount of acid developed and number of bacteria per cubic centimeter, shows that the solution of 3 oz. powder in a quart of water furnishes for bacteria, conditions approaching very closely those found in natural milk.

The greatest desired bacterial growth as measured by the amount of acidity produced and total number of bacteria is obtained in the milk powder solution of greatest concentration. The diluted skimmilk and the weaker milk powder solution show a less bacterial growth.

The powder starters of greatest concentration, although furnishing a medium for greater bacterial development, were not scored the highest by the judge. This may be due to the fact that our standards for judging starters have been obtained from natural skimmilk, which has a

concentration similar to that of the medium strength milk powder solution experimented upon.

This data shows that it is not a good practice to dilute natural skimmilk with water for starters.

Considering the cost of milk powder, the consistency of the milk powder solutions for handling and use, the quality as judged by the senses and the comparative growth of germs, the proportion of three ounces of milk powder to one quart of water is most suitable.

MILK POWDER STARTERS IN BUTTERMAKING.

A great deal of work has been done by various experiment stations showing the value of good starters in buttermaking. It is an undisputable fact that the proper use of starters improves the quality of the butter. The purpose of this work is to determne the value of milk powder starters as compared with natural skimmilk starters.

A number of churnings were made to compare the quality of butter made from cream ripened with natural milk starters, with that of butter made from cream ripened with milk powder starters. The cream used was taken from the regular run of cream received at the college creamery. In all churnings the method employed was as follows: Cream for the two comparative churnings was placed into a vat, pasteurized, cooled and thoroughly mixed into a homogeneous mass, then divided into equal parts and ripened under exactly the same conditions (except the kind of starter used). In the churning, washing, salting and working, conditions were maintained as nearly the same as was possible so the only factor that could affect the quality of the butter was the starter used. A detailed record was kept of each step in the process of manufacture, but these details do not bear greatly upon the results so are omitted here.

The butter was scored by an impartial judge who was given no information regarding the identity of the butter. The acidity of the butter (no. c. c. tenth-normal potassium

hydroxide required to neutralize 10 grams butter) was determined at each scoring.

In all cases "natural milk starter" is the natural skim-milk or whole milk pasteurized and ripened with a commercial culture.

TABLE III.

Milk Powder Starters vs. Natural Milk Starters

Tub No.	Kind of Starter	Kind of Cream	Per Cent Starter	Acidity of Cream When Churned	Per Cent Fat in Cream Before Starter Was Added	Score and Acidity of Butter When							
						Fresh		2 wks.		4 wks.		6 wks.	
						Score	Acidity	Score	Acidity	Score	Acidity	Score	Acidity
1	Natural milk	Sweet	30	.76	34.	94	. . .	91	. . .	91	2.0	90	2.1
2	Milk Powder	Sweet	30	.65	34.	94	. . .	91	. . .	90	2.0	90	2.1
3	Natural Milk	Sweet	21	.58	30.	95	. . .	95	. . .	93	1.8	92	1.9
4	Milk Powder	Sweet	21	.67	30.	95	. . .	95	. . .	93½	1.9	93	1.9
5	Natural Milk	Sour.	40	.58	30.	95	1.6	92	1.7	86	1.9	. . .	. . .
6	Milk Powder	Sour.	40	.61	30.	94½	1.6.	92	1.8	86	1.8	. . .	. . .
7	Natural Milk	Sour .	30	.45	31.	92	1.0	93	1.2	90	1.5	. . .	. . .
8	Milk Powder	Sour.	30	.48	31.	92	1.0	93	1.1	90	1.4	. . .	. . .
9	Natural Milk	Sweet	12	.57	45	95	2.0	. . .	. . .	. . .	. . .	. . .	. . .
10	Milk Powder	Sweet	12	.57	45	95	1.9	. . .	. . .	. . .	. . .	. . .	. . .
11	Natural Milk	Sweet	8	.51	45.	93	1.6	. . .	. . .	. . .	. . .	. . .	. . .
12	Milk Powder	Sweet	8	.51	45.	92½	1.6	. . .	. . .	. . .	. . .	. . .	. . .
Average Milk Powder....						93.8	1.25	93.66	1.45	89.87	1.77	91.50	2.05
Average Natural Milk....						94.0	1.55	93.66	1.45	90.00	1.8	91.00	2.05
Grand Average Milk Powder ...						92.207	1.697						
Grand Average Natural Milk ...						92.165	1.712						

The sweet cream used was separated from the milk at the college creamery. Sour cream was farm separated.

Butter made from cream ripened with milk powder starter scored on an average of .042 points higher and showed an acidity of .015 c. c. less than the butter made from cream ripened with natural milk starter.

DISSOLVING THE MILK POWDER.

Milk powder is of about the same consistency as flour and dissolves in water with similar difficulty. It was found that if the powder was put into the can and the water

poured in on top of it, the powder would stick to the bottom and dissolve very slowly; also, the powder would form into little balls or lumps with a wet, sticky coating on the outside, but dry inside. And it was found that the powder dissolved more quickly in warm or hot water than in cold. The following method was adopted because it brought about the solution of the powder with the greatest ease and rapidity.

The pure water was weighed or measured into the starter can and the steam turned on. While the water was heating the proper amount of milk powder was weighed out, then emptied upon the surface of the warm water and stirred or beaten violently with a stirring rod until dissolved. When lumps formed the stirring was repeated at intervals of about ten minutes until all were dissolved. The heating was continued and the milk pasteurized the same as any other starter milk.

COST OF MILK POWDER STARTERS.

Skimmed Milk Powder costs 16c. per pound by the barrel. Using the solution in the proportion of three ounces of powder to one quart of pure water makes the cost of starters 11c. per gallon or $1.32 per 100 pounds.

Many creameries and especially central plants have difficulties in securing a uniform supply of good quality of milk for starters. Whenever such is obtained the price is usually almost as high as that prepared from powdered milk.

Skimmilk powder keeps well and may therefore be secured in large quantities and be kept in a dry cold place ready for immediate use. A drum of milk powder was kept at this Station at room temperature for more than a year. The cost of this starter per pound of butter made depends upon the percentage of starter used. This in turn depends upon the quality and richness of the cream. Cream rich in fat, old, and of poor quality needs a larger percentage of starter to overcome as much of the undesirable cream

characteristics as possible. A large percentage of starter, if good, does not injure any cream. The amount should be governed by general creamery conditions and the per cent fat in the cream.

If between 8 and 25 per cent of starter is used in cream containing between 25 and 35 per cent fat the cost will range from .3c. to 1c. per pound of butter manufactured.

HOW MILK IS POWDERED.

The following is taken from a paper entitled, "Economic Reasons for the Reduction of Milk to Powder," by Lewis C. Merrell, read before the Syracuse, (N. Y.) Section of the American Chemical Society, Nov. 23rd, 1908:

"Fresh whole milk is drawn into a vacuum pan and a portion of its water removed. This condensation is halted while the milk is still in a fluid condition and before any of the milk albumen has been cooked on to the walls of the vacuum chamber. The milk is then drawn from the vacuum pan and sprayed into a current of hot air. The moisture in the milk is instantly absorbed by the air and the particles of milk solids fall like snow. Upon examination, they are found to contain less than 2 per cent, and sometimes not more than one-half of one per cent of moisture. The hotter the air is the more rapid the drying effect and the less danger there is of injuring the milk solids by heat."

"No bacterial action has been discovered in milk powder containing less than 3 per cent moisture, and no chemical deterioration takes place. It is, therefore, evident that the milk powder product described above, fulfills my definition of an ideal preserved milk, for decomposition is prevented merely by dryness and without the use of preservative substances and without changing the chemical composition of the milk."

"I will say, however, that this whole milk powder is in use in place of fresh milk at several of the United States soldiers' homes and military posts as well as in the navy. It has been subjected to the most exhaustive tests by the United States Department of Agriculture, Bureau of Chem-

istry, and by the Experiment Stations of different states. The Pacific fleet carried a ton of it around the Horn under an absolute guaranty as to keeping quality, and has since re-ordered largely."

CONCLUSIONS.

The foregoing pages show the practicability of using milk powder solutions in place of natural milk as a medium for growing starters for buttermaking. In making butter from sour, hand separator cream and in making butter from sweet, fresh cream, the milk powder starter has produced the same good flavor as natural milk starter, so that the one may replace the other in practical creamery work. The cost of the milk powder is greater than that of natural milk under normal creamery conditions, but the location of many big central plants in large cities makes conditions such that an ample supply of good milk cannot be obtained at the usual price. It is under these or similar conditions that milk powder has its value for starter-making.