dried WHEY in BAKED PRODUCTS and CONFECTIONS

by Emma J. Thiessen
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</tr>
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Wyoming Agricultural Experiment Station
H. M. Briggs, Director
Laramie
Dried Whey in Baked Products and Confections

How to Make Them and Why They are Nutritious

By Emma J. Thiessen

Home Economics Research Associate

Dried whey is an acceptable food. It is high in minerals and the B vitamins—both frequently short in diets. It has moisture-retaining properties which prevent baked products and confections from drying out as quickly as those without whey. The dried whey used in these tests is a by-product of Swiss cheese manufactured at Thayne, Wyoming.

Dried whey has not been in general use for human consumption, probably because homemakers have not known how to incorporate it into culinary products or how much to use. They may not be aware of its high nutritive values. For quite some time, farmers and ranchers have used dried whey in rations for calves. Poultrymen have added it to feed for their flocks. Livestock have thrived on it.

A general chemical analysis of dried whey shows that it contains the following nutrients in 100 grams*: protein 12.5 g., fat 1.2 g., lactose 72.4 g., ash 7.7 g., calcium 679 mg., phosphorus 576 mg., thiamin 0.49 mg., riboflavin 2.5 mg., niacin 0.8 mg., Vitamin A 50 I U.1

Statement of the Problem

The problem has been to utilize dried whey in culinary products commonly used in homes. Advantages and disadvantages in its use were evaluated for each product.

Bread: The phases in relation to bread were to determine the best proportions to use per pound loaf as measured by the effect of whey upon fermentation of dough, volume, texture, color, and palatability of the bread as well as upon moisture retention when baked and stored.

Cakes and Cookies: The phases in relation to its use in cakes and cookies were similar. Effects upon texture, color, palatability, and moisture retention were evaluated.

Confections: Some types of candy were developed in which whey was most satisfactory. Finish temperatures for whey candy were determined. Flavor, texture, and shelf life were evaluated.

*453.6 grams = 1 pound, 1000 milligrams = 1 gram, IU are International Units.

1Nutrition and Diet in Health and Disease, McLester, J., and Darby, W., W. B. Saunders Publishing Co. 6th ed., 1952.

‡ Resigned June 30, 1956.
Nutritive Values

The extent to which whey brought up nutritive values in all these products, as compared with controls in which no whey was used, was calculated from food-composition tables.

Storage of Whey: Dried whey is hygroscopic. It cakes and hardens if exposed to the atmosphere. If kept in polyethylene bags tightly closed or in closed tin containers, it remains in a powder and in good condition for months.

Procedure

Baked products were made with and without dried whey for comparative evaluation in each test. Variables from the control formulas with the addition of dried whey were a corresponding reduction of sugar and fat if needed, as well as increases in liquid.

Quality: Home economists judged the whey products. Palatability, texture, and color were compared with control products containing no whey.

Moisture in Bread: Moisture was determined by the method recommended by the American Association of Cereal Chemists.

The weight of the loaf was recorded one hour after baking. The loaf was placed on a smooth sheet of wrapping paper and cut into about 1/4-inch slices. Cut slices were allowed to stand on the paper in the open air until dried out, which usually required overnight. They were then ground into a coarse meal, taking care not to lose any of the sample. The loss in weight by air-drying was recorded. The ground material was sifted in a U.S. Standard Sieve, No. 30, 28 mesh.

Determination of moisture by air/oven method: Two to five grams of the mixed sample were placed in a small covered aluminum weighing pan that had previously been dried at 100° C., and the pan, cover, and contents were dried at 130° C. for one hour. The pan was covered while still in the oven, transferred to a desiccator, cooled, and weighed soon after room temperature was attained. The loss in weight was reported as moisture.

The moisture of the entire loaf of bread was calculated from the formula:

\[
TM = A (100-A) B \\
100
\]

Moisture in Cookies: The technique was similar to that described above, but overnight drying was omitted since the moisture content is considerably lower in cookies than in bread. An Elconap drying oven was used.

Equipment used for Mixing and Baking

For Bread: Bread doughs were mixed in a Kitchen-aid mixer equipped with a dough hook. Dough was placed in calibrated expansion tubes 4 1/2 inches in diameter and 9 inches deep and fermented in an electrically heated incubator maintained at 30° C.

Baking Pans: Bread was baked in regulation test-baking pans. Standard-size aluminum pans were used for baking cakes and cookies. All products
were baked in electric ovens controlled by thermostats.

Basic Formula: Bread formulas developed with whey are given below. Control loaves (no whey) were baked at the same time and under similar conditions from a standard high-altitude formula previously developed in the Food Research Laboratory of the Wyoming Experiment Station.

**WHITE WHEY BREAD**

Straight dough procedure

<table>
<thead>
<tr>
<th>INGREDIENTS</th>
<th>MEASURE</th>
<th>WEIGHT (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flour, enriched</td>
<td>6 c.</td>
<td>672.0</td>
</tr>
<tr>
<td>Whey, dried</td>
<td>4 to 8 T.</td>
<td>32.4 to 64.8 (4.8% to 9.64%)</td>
</tr>
<tr>
<td>Sugar</td>
<td>1 T.</td>
<td>12.5</td>
</tr>
<tr>
<td>Salt</td>
<td>2 t.</td>
<td>9.2</td>
</tr>
<tr>
<td>Milk</td>
<td>3/4 c.</td>
<td>183.3</td>
</tr>
<tr>
<td>Water</td>
<td>3/4 c.</td>
<td>177.4</td>
</tr>
<tr>
<td>Fat</td>
<td>2 T.</td>
<td>23.1</td>
</tr>
<tr>
<td>Yeast, quick-dry</td>
<td>1/2 pkg.</td>
<td>3.6</td>
</tr>
<tr>
<td>Water</td>
<td>1/3 c.</td>
<td>78.8</td>
</tr>
</tbody>
</table>

Modification with whey: Less sucrose is used; it follows the amount of dried whey in the formula. Sucrose could not be omitted entirely, since some is necessary to speed fermentation of dough. The odd percentages of whey result because measurements are even in order that homemakers may duplicate the recipes more easily.

Method of Mixing
1. Allow yeast to soften in 1/3 cup of lukewarm water (90° F.) for 3 minutes.
2. Sift flour, whey, sugar, and salt into a mixing bowl. Make a “well” in the center.
3. Mix together the dissolved yeast, other liquids, and melted fat. Pour this into the well of dry ingredients.
4. Mix for 10 minutes at the low speed of mixer (Kitchen-aid) or knead by hand for 15 to 20 minutes.

Fermentation of Dough
1. Place dough in expansion tube or bowl. Grease the top of dough and cover top of container with wax paper held in place with elastic bands to prevent crusting of dough which frequently occurs in this semiarid climate. Ferment the dough in an incubator or a closed cabinet to maintain even temperatures.
2. Allow the dough to rise until it is double in bulk before the first punch.
3. Punch down by pushing down and away from the sides of container. Turn dough over.
4. Allow dough to double in bulk again and pan it as described below.

Panning
1. Flatten dough by hand on board, fold it over from either side to center. Stretch dough and fold again to eliminate gas. Form into loaf. Place loaves into individual greased pans. Grease top of loaf.
2. Pan-proof the dough until it doubles in bulk—a practical test is to press with the finger and if indentation remains, it is proofed sufficiently.

Baking
Bake at 400° F. for 30 minutes. Remove loaves from pan immediately when baked. Cool on a wire rack.
WHOLE-WHEAT WHEY BREAD
(8.2% whey based on flour)

Straight dough procedure

INGREDIENTS MEASURE WEIGHT (grams)
--------------------------
White flour, enriched 3 1/2 c. 392.0
Whole wheat flour 2 1/2 c. 314.5
Dried whey 4 T. 32.4
Brown sugar 1/4 c. 56.0
Salt 3 t. 13.8
Milk 3/4 c. 183.8
Water 3/4 c. 177.4
Fat 2 T. 23.1
Yeast, quick-dry 1 pkg. 7.2
Water 1/2 c. 118.3

Method of Mixing
1. Soak yeast in one-half cup of lukewarm water for 10 minutes.
2. Scald milk, add salt, sugar, and fat and let it cool until barely lukewarm.
3. Heat water to lukewarm (85°F).
4. Sift whey with white flour, then blend the two flours, make a well in center, and add yeast and other ingredients.
5. Mix for 10 minutes with an electric mixer or knead by hand for about 15 to 20 minutes.

FERMENTATION SCHEDULE OF WHITE BREAD WITH AND WITHOUT WHEY

<table>
<thead>
<tr>
<th>Percentage of whey used (based on flour)</th>
<th>2.4 (percent)</th>
<th>4.8 (percent)</th>
<th>9.64 (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixing (minutes)</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>First punch</td>
<td>32</td>
<td>50</td>
<td>122</td>
</tr>
<tr>
<td>Second punch</td>
<td>33</td>
<td>32</td>
<td>50</td>
</tr>
<tr>
<td>Pan proof</td>
<td>110</td>
<td>88</td>
<td>115</td>
</tr>
<tr>
<td>Total fermentation and mixing</td>
<td>185</td>
<td>180</td>
<td>297</td>
</tr>
<tr>
<td>Baking</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Total time</td>
<td>3 hrs. 35 min.</td>
<td>3 hrs. 30 min.</td>
<td>5 hrs. 27 min.</td>
</tr>
</tbody>
</table>

6. Let rise in a covered container at 80°F to 85°F until dough is double its bulk.
7. Punch down, fold from side to center, and turn over.
8. Let it rise a second time until double in bulk, punch down.
9. Make into loaves as described for white yeast bread.
10. Let loaves rise at 85°F to 90°F until they are double in bulk or until indentation remains in dough when pressed with finger.
11. Bake at 375°F for 35 minutes.

Results
Whey dough is pliable and easy to handle. The rate of gas development varies with the amount of whey used. The 2.5 percent of dried whey based upon amount of flour had no measurable effect upon depressing gas production as compared with control doughs. With 4.8 percent whey, 1 hour and 52 minutes longer was required to produce an equal volume of gas as compared with the control. With 9.64 percent whey, 2 hours and 20 minutes longer was required for equal gas production.
Fermentation of Whole-Wheat Bread

Fermentation of whole-wheat bread containing 50 percent whole-wheat and 50 percent white flour followed the above pattern for white bread. The total fermentation required was about the same as for white bread, or 3 hours and 20 minutes.

Moisture in Bread

Moisture in the white loaf of bread in which 9.64 percent whey was used averaged 36 percent and after storage for 3 days dropped to 34 percent, or a loss of 2 percent. In the plain loaf, baked from a similar formula but with whey omitted, moisture averaged 34.5 percent and after 3 days' storage dropped to 33 percent, or a loss of 1.5 percent.

From a survey of the literature it was found that the Federal Food and Drug Administration have set a maximum limit of 38 percent upon moisture content of bread. Barber (1952) showed that moisture in plain homemade white bread may range from 32.76 to 38 percent.

Humidity of Room

Humidity of the heated laboratory averaged 25.8 percent during the time these tests were made and over a period of several months. Such low humidity shows the necessity of using precautions to prevent crusting of dough during fermentation and in preventing the drying out of flour by storing it in tight tin containers.

Volume of Whey Bread

A decreased loaf volume was obtained with the higher levels of whey unless the loaves were allowed extra fermentation time. With longer fermentation the volume was approximately the same as in plain bread.

Organoleptic Tests

Effects of whey upon texture, color, and palatability of white bread were measured. A distinctive flavor was imparted to bread at the 2.4 percent level of whey and above. This flavor was not objectionable up to 9.64 percent as shown by preferences for whey bread on unidentified samples over control samples with no whey. Improvement in texture, flavor, and moisture retention was evident with the addition of dried whey at each level in which it was used. Excellent crust color resulted.

Toast made from whey bread was tastier than from the plain.

NUTRITIVE VALUES OF WHEY BREAD

Addition of dried whey to bread added essential nutrients often lacking in the diet. This contribution is shown in Table 1. From 10 to 26 percent of the National Research Council's recommended daily allowance of certain essential nutrients were supplied by 100 grams or 3 slices of whey bread daily. A comparison of whey bread (9.64%) with plain bread shows especially the more generous contribution in riboflavin, phosphorus, and calcium. Any food which contributes 10 percent of

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2“Relationship Between Dough, Volume, and Moisture Content of Bread.” Barber, Joan, University of California (1952).
the daily requirement of a given nutrient in each 200 calories of that food is considered a good source of that nutrient. (See Figure 1.)

<table>
<thead>
<tr>
<th>Nutrients and calories</th>
<th>NRC allowances for physically active man*</th>
<th>Plain bread 100 g. contributing</th>
<th>Percentage of daily allowance</th>
<th>Whey bread 100 g. contributing</th>
<th>Percentage of daily allowance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>65 g.</td>
<td>8.46 g.</td>
<td>13.00</td>
<td>8.90 g.</td>
<td>13.69</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>1200 mg.</td>
<td>90.60 mg.</td>
<td>7.55</td>
<td>128.50 mg.</td>
<td>10.70</td>
</tr>
<tr>
<td>Calcium</td>
<td>1000 mg.</td>
<td>35.40 mg.</td>
<td>3.54</td>
<td>83.90 mg.</td>
<td>8.39</td>
</tr>
<tr>
<td>Thiamin</td>
<td>1.6 mg.</td>
<td>0.33 mg.</td>
<td>0.20</td>
<td>0.35 mg.</td>
<td>21.90</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>1.6 mg.</td>
<td>0.25 mg.</td>
<td>0.15</td>
<td>0.42 mg.</td>
<td>26.25</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>5000 I U</td>
<td>32.0 I U</td>
<td>0.64</td>
<td>33.70 I U</td>
<td>0.67</td>
</tr>
<tr>
<td>Calories</td>
<td>3200</td>
<td>311.50</td>
<td>9.73</td>
<td>312.40</td>
<td>9.76</td>
</tr>
</tbody>
</table>


**HOT BREADS WITH WHEY**

Whey was used in a basic sweet dough for rolls. Rolls differ from bread in that they are sweeter and richer. The dough is usually softer and they are lighter when baked. Many different shapes of rolls with and without a filling were made from this basic sweet-whey dough. It could also be used for refrigerated and icebox rolls.

Success in making whey rolls depended upon the proper balance of ingredients and upon the care and skill with which the dough was handled and baked. Further to increase nutrients, egg yolks were substituted for whole eggs, and both milk and whey were added.

**HIGH-ALTITUDE WHEY ROLLS**

(5.8% whey based on flour)

<table>
<thead>
<tr>
<th>INGREDIENTS</th>
<th>MEASURE</th>
<th>WEIGHT (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flour, enriched</td>
<td>5 c.</td>
<td>560.0</td>
</tr>
<tr>
<td>Dried whey</td>
<td>4 T.</td>
<td>32.4</td>
</tr>
<tr>
<td>Sugar</td>
<td>4 T.</td>
<td>50.0</td>
</tr>
<tr>
<td>Salt</td>
<td>2¼ t.</td>
<td>10.4</td>
</tr>
<tr>
<td>Milk</td>
<td>1 c. plus</td>
<td>291.0</td>
</tr>
<tr>
<td></td>
<td>3 T.</td>
<td></td>
</tr>
<tr>
<td>Fat</td>
<td>¼ c.</td>
<td>46.3</td>
</tr>
<tr>
<td>Egg yolks</td>
<td>4</td>
<td>72.0</td>
</tr>
<tr>
<td>Yeast, quick dry</td>
<td>1½ pkg.</td>
<td>10.8</td>
</tr>
<tr>
<td>Water</td>
<td>¼ c.</td>
<td>59.1</td>
</tr>
</tbody>
</table>

**Method of Mixing: Fermentation and Baking**

1. Soften yeast in lukewarm water.
2. Scald milk. Add fat, sugar, and salt to the hot milk. Then cool to lukewarm (85°F).
3. Sift flour with dried whey into a large bowl. Make a well in the center of the flour.
4. Add softened yeast, slightly beaten egg yolks, and the liquid mixture. The dough should be soft. Add more liquid if needed.
5. Turn dough out on a lightly floured board and knead by hand until smooth and satiny, or blend for 6 minutes in a Kitchen-aid or dough blender.
6. Place dough in greased bowl, cover, and let it rise in a warm place until doubled (about 1½ hours). When light, punch down.
7. Cover and let rest 10 minutes. Roll out and cut into various shapes and make into rolls or coffee cakes. Put into greased pans.
8. Let rise until it has doubled (about 35 minutes).
Fermentation of Basic Sweet-Whey Dough

This sweet-whey dough should be properly matured in about 2 hours with the first punch in about 1½ hours, and the dough made out into rolls about 30 to 40 minutes later.

Quality of Rolls

An excellent crust color and a desirable hardness in the crust of the rolls resulted with the addition of whey.

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FIG. 1—Nutrient contribution of dried whey to white bread. Percentage of daily allowances.
Cakes with Whey

WHEY CAKES

The addition of dried whey to both plain and chocolate cakes was desirable. There was an improvement in the tenderness, texture and keeping quality of both cakes.

STANDARD YELLOW LAYER WHEY CAKE*

(16.2% whey based on flour)

<table>
<thead>
<tr>
<th>INGREDIENTS</th>
<th>MEASURE</th>
<th>WEIGHT (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flour, cake</td>
<td>2 c.</td>
<td>200.0</td>
</tr>
<tr>
<td>Whey, dried</td>
<td>4 T.</td>
<td>32.4</td>
</tr>
<tr>
<td>Baking powder</td>
<td>1 ½ t.</td>
<td>5.4</td>
</tr>
<tr>
<td>Salt</td>
<td>¾ t.</td>
<td>3.5</td>
</tr>
<tr>
<td>Sugar</td>
<td>1 c.</td>
<td>200.0</td>
</tr>
<tr>
<td>Eggs</td>
<td>2</td>
<td>96.0</td>
</tr>
<tr>
<td>Fat</td>
<td>½ c.</td>
<td>92.5</td>
</tr>
<tr>
<td>Milk</td>
<td>1 c. less 1 T.</td>
<td>229.7</td>
</tr>
<tr>
<td>Vanilla</td>
<td>1 ½ t.</td>
<td></td>
</tr>
</tbody>
</table>

Mix-Easy Mixing Method

1. Place the fat in mixing bowl and stir slightly to soften it.
2. Sift flour, whey, baking powder, salt, and sugar together and over the fat.
3. Add 2/3 of the milk and stir mixture until all flour is dampened.
4. Beat the batter two minutes in an electric mixer at moderate speed, or by hand using 150 strokes per minute.
5. Add remaining milk, eggs, and flavoring and continue beating for 1 minute longer.
6. Line the bottom of pans with paper. Pour equal amounts of the batter into two 8-inch layer pans.
7. Bake at 375° F. for 25 to 30 minutes or until done.
8. Cool 10 minutes before removing from the pans.

VARIATIONS WITH WHEY

Varied amounts of dried whey were used in this cake, namely, 8 to 16.2 percent. The sucrose was lessened according to the amount of whey and ranged from 200 to 225 grams. Evaluation of the whey product was against similar cake that contained no whey. Average ratings are listed below.

ORGANOLEPTIC TESTS OF STANDARD QUICK CAKES WITH AND WITHOUT WHEY

Average scores four hours after baking

<table>
<thead>
<tr>
<th></th>
<th>Cake without whey</th>
<th>Cake with whey using</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8%</td>
<td>12%</td>
</tr>
<tr>
<td>Flavor</td>
<td>25</td>
<td>24</td>
</tr>
<tr>
<td>Tenderness</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>Grain</td>
<td>20</td>
<td>18</td>
</tr>
<tr>
<td>Texture</td>
<td>20</td>
<td>18</td>
</tr>
<tr>
<td>Crust color</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>Crumb color</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

*This recipe is adjusted for 7000 ft. altitude. At 5000 ft. add an extra tablespoon of sugar and ¼ teaspoon more baking powder.
Moisture in whey cake (16.2%) Moisture in plain cake

<table>
<thead>
<tr>
<th></th>
<th>Fresh (percent)</th>
<th>After 4 days' storage (percent)</th>
<th>Loss (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture in whey cake</td>
<td>30.0</td>
<td>27.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Moisture in plain cake</td>
<td>28.1</td>
<td>25.1</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Tenderness, grain, and texture of cakes in which whey was used showed improvement over the control (no whey). Flavor was not affected by whey in moderate amounts.

**Moisture Retention in Standard Cakes Made With and Without Whey**

Moisture was determined by the same methods used with bread. Moisture in plain cakes as listed in the Agriculture Handbook, No. 8, was 28.8 percent.\(^a\)

**Nutritional Contribution of Whey to Standard Cake**

The excellent contribution that dried whey (16.2% based on flour) made to standard cake in riboflavin and thiamin and also in phosphorus and calcium is shown in Table 2 and graphically represented in Figure 2. A similar representation is shown for chocolate cake (18% whey based on flour) in Table 3 and in Figure 3.

**TABLE 2—Nutrient Contribution of Standard Cake With and Without Whey**

<table>
<thead>
<tr>
<th>Nutrients and Calories</th>
<th>NRC allowances for physically active man(^a)</th>
<th>Plain standard cake 100 g. contributing</th>
<th>Percentage of daily allowance</th>
<th>Standard whey cake 100 g. contributing</th>
<th>Percentage of daily allowance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>65 g.</td>
<td>4.13 g.</td>
<td>6.35 g.</td>
<td>5.5 g.</td>
<td>8.46 g.</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>1200 mg.</td>
<td>65.60 mg.</td>
<td>5.46 mg.</td>
<td>89.0 mg.</td>
<td>7.41 mg.</td>
</tr>
<tr>
<td>Calcium</td>
<td>1000 mg.</td>
<td>41.8 mg.</td>
<td>4.18 mg.</td>
<td>68.6 mg.</td>
<td>6.86 mg.</td>
</tr>
<tr>
<td>Thiamin</td>
<td>1.6 mg.</td>
<td>0.03 mg.</td>
<td>1.87 mg.</td>
<td>0.48 mg.</td>
<td>3.0 mg.</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>1.6 mg.</td>
<td>0.09 mg.</td>
<td>5.62 mg.</td>
<td>0.18 mg.</td>
<td>11.20 mg.</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>5000 I U</td>
<td>171 I U</td>
<td>3.42 I U</td>
<td>176 I U</td>
<td>3.52 I U</td>
</tr>
<tr>
<td>Calories</td>
<td>3200</td>
<td>318.0</td>
<td>9.93</td>
<td>316.6</td>
<td>9.89</td>
</tr>
</tbody>
</table>

\(^a\)National Research Council's Recommended Daily Dietary Allowances, 1953.

FIG. 2—Nutrient contribution of dried whey to standard cake. Percentage of daily allowances.

**CHOCOLATE/WHEY CAKE**
(18.5% whey based on flour)

<table>
<thead>
<tr>
<th>INGREDIENTS</th>
<th>MEASURE</th>
<th>WEIGHT (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flour, cake</td>
<td>1 3/4 c.</td>
<td>175.0</td>
</tr>
<tr>
<td>Whey, dried</td>
<td>4 T.</td>
<td>32.4</td>
</tr>
<tr>
<td>Soda</td>
<td>3/4 t.</td>
<td>3.3</td>
</tr>
<tr>
<td>Salt</td>
<td>1 t.</td>
<td>4.6</td>
</tr>
<tr>
<td>Sugar</td>
<td>1 c. plus 1 T.</td>
<td>212.5</td>
</tr>
<tr>
<td>Eggs</td>
<td>3</td>
<td>144.0</td>
</tr>
<tr>
<td>Fat</td>
<td>2/3 c.</td>
<td>123.3</td>
</tr>
<tr>
<td>Milk</td>
<td>1 c. plus 1 1/2 T.</td>
<td>268.0</td>
</tr>
<tr>
<td>Chocolate</td>
<td>3 squares</td>
<td>84.9</td>
</tr>
<tr>
<td>Vanilla</td>
<td>1 t.</td>
<td></td>
</tr>
<tr>
<td>Mint</td>
<td>few drops</td>
<td></td>
</tr>
</tbody>
</table>

Mixing Method and Baking

1. Set oven control at 375°F.
2. Melt chocolate squares in original wrapping over hot water and cool slightly.
3. Line bottom of two 9 inch layer cake pans 1 1/2 inches deep with brown paper and grease lightly.
4. Sift together three times the flour, sugar, whey, soda, and salt.
5. In a bowl, cream the fat, add sifted dry ingredients, add 3/4 of the liquid,
and mix until all flour is dampened, then beat 2 minutes at low speed in an electric beater, or by hand 150 strokes per minute.

6. Add remaining liquids, eggs, and melted chocolate. Beat 1 minute longer or 150 strokes. Stir in flavorings.

7. Turn batter into pans. Bake at 375°F. for 30 minutes or until done. Cool 10 minutes before removing from pan.

**Whey Cookies**

Dried sweet whey added to cookies had favorable effects upon quality. Whey was desirable in chocolate-chip drop cookies, oatmeal drop cookies, butterscotch cookies, and others. It was not as desirable in rolled cookies, depending for palatability upon a delicate butter flavor.

Yield: about 4 dozen.

**Mixing Method**

1. Sift flour, whey, baking powder, soda, and salt. (Table 4, Fig. 4.)

2. Mix the fat until soft, gradually blend in the sugar. Add eggs and beat for 1 minute.

3. Sift in 1/2 of dry ingredients and mix for 1 minute.

4. Blend in milk and flavoring.

**MOISTURE IN WHEY VS. PLAIN DROP COOKIES**

<table>
<thead>
<tr>
<th></th>
<th>Moisture drop cookies</th>
<th>Loss</th>
<th>Plain drop cookies</th>
<th>Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh</td>
<td>10.42</td>
<td>......</td>
<td>9.51</td>
<td>......</td>
</tr>
<tr>
<td>One day old</td>
<td>9.68</td>
<td>0.74</td>
<td>6.56</td>
<td>2.95</td>
</tr>
<tr>
<td>Two days old</td>
<td>6.82</td>
<td>0.86</td>
<td>4.87</td>
<td>1.69</td>
</tr>
<tr>
<td>Three days old</td>
<td>6.48</td>
<td>0.34</td>
<td>4.60</td>
<td>0.27</td>
</tr>
<tr>
<td>Five days old</td>
<td>5.94</td>
<td>0.44</td>
<td>4.10</td>
<td>0.50</td>
</tr>
</tbody>
</table>
### TABLE 4—Nutrient Contribution of Plain and Whey Drop Cookies

<table>
<thead>
<tr>
<th>Nutrients and Calories</th>
<th>NRC allowances for physically active man</th>
<th>Plain drop cookies 100 g.*</th>
<th>Percentage of daily allowance</th>
<th>Whey drop cookies 100 g.*</th>
<th>Percentage of daily allowance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>65 g.</td>
<td>5.2 g.</td>
<td>8.00</td>
<td>5.80 g.</td>
<td>8.92</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>1200 mg.</td>
<td>63.1 mg.</td>
<td>5.25</td>
<td>92.50 mg.</td>
<td>7.70</td>
</tr>
<tr>
<td>Calcium</td>
<td>1000 mg.</td>
<td>31.8 mg.</td>
<td>3.18</td>
<td>66.16 mg.</td>
<td>6.61</td>
</tr>
<tr>
<td>Thiamin</td>
<td>1.6 mg.</td>
<td>0.16 mg.</td>
<td>10.00</td>
<td>0.19 mg.</td>
<td>11.80</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>1.6 mg.</td>
<td>0.33 mg.</td>
<td>20.60</td>
<td>0.46 mg.</td>
<td>28.70</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>5000 I U</td>
<td>114.00</td>
<td>2.28</td>
<td>117.00 I U</td>
<td>2.34</td>
</tr>
<tr>
<td>Calories</td>
<td>3200</td>
<td>381.00</td>
<td>11.90</td>
<td>370.00</td>
<td>11.60</td>
</tr>
</tbody>
</table>

*15 cookies 1½" x 1½"

![Bar Chart](image)

**FIG. 4—Nutrient contribution of dried whey to drop cookies. Percentage of daily allowances.**
5. Add rest of dry ingredients and mix for 1 minute.
6. Add chocolate chips and nuts if desired.
7. Drop on greased cooky sheet 1 inch apart and bake for about 12 to 14 minutes at 375° F. or until done. Remove from cooky sheet while still warm.

Comparison of the above data shows comparative losses in moisture in cookies with and without dried whey and stored over a period of 5 days. The plain drop cookies lost considerably more in the first two days of storage than did whey drop cookies.

### Recipes for Other Cookies with Whey

#### OATMEAL/WHEY DROP COOKIES
(14.4% whey based on flour)

<table>
<thead>
<tr>
<th>INGREDIENTS</th>
<th>MEASURE</th>
<th>WEIGHT (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flour, all purpose</td>
<td>1 c.</td>
<td>112.0</td>
</tr>
<tr>
<td>Whey, dried</td>
<td>2 T.</td>
<td>16.2</td>
</tr>
<tr>
<td>Baking powder</td>
<td>1 t.</td>
<td>3.6</td>
</tr>
<tr>
<td>Soda</td>
<td>¼ t.</td>
<td>1.1</td>
</tr>
<tr>
<td>Salt</td>
<td>½ t.</td>
<td>2.3</td>
</tr>
<tr>
<td>Sugar</td>
<td>⅓ c.</td>
<td>100.0</td>
</tr>
<tr>
<td>Fat</td>
<td>⅓ c. plus 1 T.</td>
<td>57.9</td>
</tr>
<tr>
<td>Egg</td>
<td>1</td>
<td>48.0</td>
</tr>
<tr>
<td>Milk sour</td>
<td>4 T.</td>
<td>61.2</td>
</tr>
<tr>
<td>Rolled oats</td>
<td>1 c.</td>
<td>78.0</td>
</tr>
<tr>
<td>Raisins</td>
<td>1 c.</td>
<td>130.0</td>
</tr>
<tr>
<td>Nuts</td>
<td>½ c.</td>
<td>60.0</td>
</tr>
</tbody>
</table>

Yield: about 5 dozen

**Mixing Method**

1. Sift flour, whey, baking powder, soda, and salt together.
2. Beat egg and add sugar.
3. Add melted fat and rolled oats.
4. Add sifted dry ingredients alternately with sour milk.
5. Add nuts and raisins (soak raisins if very dry and drain them well).
6. Drop mixture by teaspoon onto a greased cooky sheet.
7. Bake 12 to 15 minutes at 375° F. or until done. May be placed on top grate of oven for Browning the last 2 minutes.

#### BUTTERSCOTCH/WHEY REFRIGERATOR COOKIES
(14.4% whey based on flour)

<table>
<thead>
<tr>
<th>INGREDIENTS</th>
<th>MEASURE</th>
<th>WEIGHT (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flour, all purpose</td>
<td>2 c.</td>
<td>224.0</td>
</tr>
<tr>
<td>Whey, dried</td>
<td>¼ c.</td>
<td>32.4</td>
</tr>
<tr>
<td>Soda</td>
<td>½ t.</td>
<td>2.2</td>
</tr>
<tr>
<td>Salt</td>
<td>½ t.</td>
<td>2.3</td>
</tr>
<tr>
<td>Sugar, brown</td>
<td>⅓ c.</td>
<td>168.0</td>
</tr>
<tr>
<td>Sugar, white</td>
<td>⅓ c.</td>
<td>50.0</td>
</tr>
<tr>
<td>Fat</td>
<td>½ c.</td>
<td>92.5</td>
</tr>
<tr>
<td>Egg</td>
<td>1</td>
<td>48.0</td>
</tr>
<tr>
<td>Milk</td>
<td>1 to 2 T.</td>
<td>15.3 to 30.6</td>
</tr>
<tr>
<td>Vanilla</td>
<td>½ t.</td>
<td></td>
</tr>
<tr>
<td>Nuts</td>
<td>½ c.</td>
<td>60.0</td>
</tr>
</tbody>
</table>

Yield: about 3 dozen

**Mixing Method**

1. Cream the fat and sugars.
2. Add egg and vanilla; beat well.
3. Sift together flour, soda, salt, and dried whey.
4. Add ¼ of sifted dry ingredients to the creamed mixture. Then add milk and the rest of dry ingredients in 4 additions alternately and end with dry ingredients. Add nuts to the last addition of dry ingredients before mixing.
5. Make into rolls, wrap in waxed paper, pack rolls in polyethylene bags, seal, and freeze.
6. Remove from freezer; thaw partially. Slice and bake on greased cooky sheet at 375° F. for 9 to 10 minutes or until done.

7. Dough may be frozen a week or several months before baking.

OATMEAL/WHEY REFRIGERATOR COOKIES (19% whey based on flour)

Yield: about 4 dozen

Method of Mixing
1. Sift flour, whey, soda, salt, and cinnamon.
2. Blend the fat with white and brown sugar.
3. Add eggs and vanilla and beat well.
4. Add sifted flour mixture and blend in well.
5. Add oatmeal and nuts. If needed add milk to mold into a dough.
6. Shape in small rolls, wrap in waxed paper, pack in polyethylene bags, seal and freeze. May be frozen a week or several months.
7. Remove from freezer; partially thaw. Slice and bake on greased cooky sheet at 350° F. for 9 to 10 minutes. Place a nutmeat in center of each cooky before baking.

Whey Custards

In our tests, dried whey added to custards favored palatability and increased values. (See Table 5 & Fig. 5.)

CUSTARDS WITH DRIED WHEY

| 1 egg       | pinch of salt |
| 2 T. sugar  | 1/8 t. vanilla|
| 1 T. whey   | dash of nutmeg|
| 1 c. milk   |               |

Method of Mixing
1. Mix sugar and whey; blend in milk gradually.

<table>
<thead>
<tr>
<th>Nutrients and Calories</th>
<th>NRC allowances for physically active man</th>
<th>Plain Custard 100 g.</th>
<th>Percentage of daily allowance</th>
<th>Whey custard 100 g.</th>
<th>Percentage of daily allowance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>65 g.</td>
<td>4.88 g.</td>
<td>7.5</td>
<td>5.21 g.</td>
<td>8.00</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>1200 mg.</td>
<td>109.20 mg.</td>
<td>9.1</td>
<td>124.78 mg.</td>
<td>10.30</td>
</tr>
<tr>
<td>Calcium</td>
<td>1000 mg.</td>
<td>104.60 mg.</td>
<td>10.4</td>
<td>122.90 mg.</td>
<td>12.00</td>
</tr>
<tr>
<td>Thiamin</td>
<td>1.6 mg.</td>
<td>0.04 mg.</td>
<td>3.0</td>
<td>0.06 mg.</td>
<td>3.80</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>1.6 mg.</td>
<td>0.18 mg.</td>
<td>8.5</td>
<td>0.20 mg.</td>
<td>13.00</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>5000 I U</td>
<td>130.1 I U</td>
<td>2.6</td>
<td>131.48 I U</td>
<td>2.63</td>
</tr>
<tr>
<td>Calories</td>
<td>3200</td>
<td>97.26</td>
<td>3.04</td>
<td>106.54</td>
<td>3.33</td>
</tr>
</tbody>
</table>

Test for doneness: If the custard does not adhere to an inserted silver knife, it is ready to remove from the oven. Chill and serve plain or with cream. A caramel syrup or fruit juice may be poured over custard before serving.
Dried sweet whey is a desirable addition to caramels. Caramels belong to the waxlike candies. Unlike the taffies they are not pulled. They are strictly a pan candy, since the hot syrup is poured into a cooling pan and is allowed to cool without further manipulation. (Table 6 and Fig. 6.)

Whey is now used in caramels by some commercial candy manufacturers and by the U. S. Army.

Fudges as a class are relatively short-lived candies. They readily give up moisture and under many conditions may become dry and unpalatable within a few days. Dried whey extended the shelf life of both fudge and fondant. Whey fudge stored in polyethylene bags, sealed, and frozen remained soft for weeks and in good condition.

Mixing Method for Caramels

1. Mix dry whey and sugar thoroughly, add corn syrup, evaporated milk, salt, and water. Stir to solution.

Whey Candy

CHOCOLATE/WHEY CARAMELS

(16.2% whey based on sugar)

<table>
<thead>
<tr>
<th>INGREDIENTS</th>
<th>MEASURE</th>
<th>WEIGHT (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar</td>
<td>2 c.</td>
<td>400.0</td>
</tr>
<tr>
<td>Dry whey</td>
<td>1/2 c.</td>
<td>64.8</td>
</tr>
<tr>
<td>Light corn syrup</td>
<td>1 c.</td>
<td>296.0</td>
</tr>
<tr>
<td>Evaporated milk</td>
<td>1/2 c.</td>
<td>126.0</td>
</tr>
<tr>
<td>Water</td>
<td>1/2 c.</td>
<td>118.3</td>
</tr>
<tr>
<td>Butter</td>
<td>2 T.</td>
<td>28.0</td>
</tr>
<tr>
<td>Chocolate</td>
<td>4 sq.</td>
<td>113.2</td>
</tr>
<tr>
<td>Vanilla</td>
<td>1 t.</td>
<td></td>
</tr>
<tr>
<td>Nuts</td>
<td>1/3 c.</td>
<td>40.0</td>
</tr>
<tr>
<td>Salt</td>
<td>1/8 t.</td>
<td>0.6</td>
</tr>
</tbody>
</table>

2. Melt chocolate squares in original wrapper in top of double boiler, squeeze chocolate out of wrapper into above solution, and mix thoroughly.

3. Boil moderately to 116° F. Add the butter and boil slowly to 31° to 32° F. above the temperature of boiling water at your altitude as registered.
on the thermometer, or to a firm ball by the water test.

4. Remove from heat. Allow to cool to 150° to 160° F. Then stir in vanilla and nuts quickly. Pour into a lightly buttered candy pan to depth of \( \frac{3}{4} \) inch. Do not scrape out cooking vessel into candy in cooling pan.

5. When cold, remove to cutting board and cut into suitable size pieces. Kitchen shears may be used if candy is not too hard. Shape with fingers, wrap in wax paper. Pack in polyfilm bags, seal, and store in refrigerator or freezer.

### TABLE 6—Nutrient Contribution of Plain and Whey Caramels

<table>
<thead>
<tr>
<th>Nutrients and calories</th>
<th>NRC allowances for physically active man</th>
<th>Plain caramels 100 g. contributing</th>
<th>Percentage of daily allowance</th>
<th>Whey caramels 100 g. contributing</th>
<th>Percentage of daily allowance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>65. g.</td>
<td>1.60 g.</td>
<td>2.46</td>
<td>2.2 g.</td>
<td>3.38</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>1200 mg.</td>
<td>43.30 mg.</td>
<td>3.60</td>
<td>72.8 mg.</td>
<td>6.06</td>
</tr>
<tr>
<td>Calcium</td>
<td>1000 mg.</td>
<td>35.20 mg.</td>
<td>3.50</td>
<td>70.0 mg.</td>
<td>7.09</td>
</tr>
<tr>
<td>Thiamin</td>
<td>1.6 mg.</td>
<td>0.03 mg.</td>
<td>1.87</td>
<td>0.05 mg.</td>
<td>3.12</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>1.6 mg.</td>
<td>0.04 mg.</td>
<td>2.50</td>
<td>0.18 mg.</td>
<td>11.20</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>5000 I U</td>
<td>131.0 I U</td>
<td>2.62</td>
<td>126.0 I U</td>
<td>2.52</td>
</tr>
<tr>
<td>Calories</td>
<td>3200</td>
<td>260.0</td>
<td>8.12</td>
<td>260.0</td>
<td>8.12</td>
</tr>
</tbody>
</table>

**VANILLA/WHEY CARAMELS**

(16.2% whey based on sugar)

<table>
<thead>
<tr>
<th>INGREDIENTS</th>
<th>MEASURE</th>
<th>WEIGHT (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar</td>
<td>2 c.</td>
<td>400.0</td>
</tr>
<tr>
<td>Dry whey</td>
<td>( \frac{1}{2} ) c.</td>
<td>64.8</td>
</tr>
<tr>
<td>Corn syrup</td>
<td>1 c.</td>
<td>296.0</td>
</tr>
<tr>
<td>Evaporated milk</td>
<td>( \frac{1}{2} ) c.</td>
<td>126.0</td>
</tr>
<tr>
<td>Water</td>
<td>( \frac{1}{2} ) c.</td>
<td>118.3</td>
</tr>
<tr>
<td>Butter</td>
<td>2 T.</td>
<td>28.0</td>
</tr>
<tr>
<td>Nuts</td>
<td>1( \frac{1}{3} ) c.</td>
<td>40.0</td>
</tr>
<tr>
<td>Vanilla</td>
<td>1( \frac{3}{8} ) t.</td>
<td>6.2</td>
</tr>
<tr>
<td>Salt</td>
<td>( \frac{1}{8} ) t.</td>
<td>2.2</td>
</tr>
</tbody>
</table>

**Mixing Method**

1. Mix the dry whey and sugar thoroughly. Add corn syrup, evaporated milk, salt, and water. Stir to solution.
2. Boil moderately until 116° F. is reached. Add the butter and boil slowly to 30° to 31° F. above the boiling point of water at your altitude as registered on the thermometer, or to a firm ball by the water test.

3. Remove from heat. Allow to cool to 150° to 160° F. Stir in vanilla and nuts quickly. Pour into a lightly buttered candy pan to depth of \( \frac{3}{4} \) inch.

4. When cold, remove to cutting board and cut into suitable-size pieces. The kitchen scissors may be used if candy is not too firm.

5. Shape with fingers, wrap in wax paper. Pack in pliofilm bags, seal, and store in refrigerator or freezer.

WHEY FUDGE
(8.1% whey based on sugar)

<table>
<thead>
<tr>
<th>INGREDIENTS</th>
<th>MEASURE</th>
<th>WEIGHT (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar</td>
<td>4 c.</td>
<td>800.0</td>
</tr>
<tr>
<td>Dried whey</td>
<td>( \frac{1}{2} ) c.</td>
<td>64.8</td>
</tr>
<tr>
<td>Evaporated milk</td>
<td>2 c.</td>
<td>504.0</td>
</tr>
<tr>
<td>Butter</td>
<td>( \frac{1}{4} ) c.</td>
<td>56.0</td>
</tr>
<tr>
<td>Chocolate bits</td>
<td>2 pkg.</td>
<td>12 oz.</td>
</tr>
<tr>
<td>Marshmallow creme</td>
<td>1 can</td>
<td>8 oz.</td>
</tr>
<tr>
<td>Vanilla</td>
<td>2 t.</td>
<td></td>
</tr>
</tbody>
</table>

Mixing Method

1. Mix whey and sugar thoroughly. Add evaporated milk and butter. Stir to solution.

2. Boil slowly until thermometer registers 16° F. above the temperature of boiling water or 215° F. at 7200 ft.

3. Remove from heat and stir in chocolate bits until melted.

4. Stir in marshmallow creme, add vanilla.

5. Pour into greased pan. Cool and place in refrigerator.

6. Cut into pieces, pack in polyethylene bags, wrap each piece separately, or place wax paper between layers. Freeze.

WHEY FONDANT
(8.1% whey based on sugar)

<table>
<thead>
<tr>
<th>INGREDIENTS</th>
<th>MEASURE</th>
<th>WEIGHT (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar</td>
<td>2 c.</td>
<td>400.0</td>
</tr>
<tr>
<td>Dry whey</td>
<td>( \frac{1}{4} ) c.</td>
<td>32.4</td>
</tr>
<tr>
<td>Water</td>
<td>1 c.</td>
<td>236.6</td>
</tr>
<tr>
<td>Corn Syrup</td>
<td>2 T.</td>
<td>37.0</td>
</tr>
<tr>
<td>Vanilla</td>
<td>1 t.</td>
<td></td>
</tr>
<tr>
<td>Cocoanut</td>
<td>( \frac{1}{2} ) c.</td>
<td>112.0</td>
</tr>
<tr>
<td>Chopped nuts</td>
<td>( \frac{1}{2} ) c.</td>
<td></td>
</tr>
</tbody>
</table>

Mixing Method

1. Mix whey and sugar thoroughly. Add corn syrup and water. Stir to solution, wipe down crystals from side of pan.

2. Boil slowly until temperature is 23° F. above that of boiling water (222° F. at 7200 ft. altitude). Some stirring is essential to prevent burning. Remove scum while cooking.

3. Remove from heat, pour into a bowl, cool to 110° F. Beat until soft and creamy.

4. Add vanilla and knead until it is smooth and no lumps remain.

5. Store in tight container and allow to ripen 2 to 3 days before using.

6. Work in coconut and nuts. Make into a loaf, pack in polyethylene bags or in tight containers, and store in refrigerator or preferably in the freezer. It will keep for months if frozen. This fondant may mold if stored at room temperature in tight containers.
SUMMARY

1. The addition of dried whey up to 9.6 percent, based upon flour, improved texture, and bloom, aided in moisture retention in bread. This was also the case with rolls.

2. Cakes with an addition of dried whey had a better volume and softer texture than cakes containing fluid or dried milk. Shelf life was lengthened.

3. The shelf life of drop cookies was lengthened with the addition of dried whey. Moisture in whey cookies was higher than in plain cookies, particularly during the first two days of storage.

4. Dried whey supplied a high percentage of riboflavin to all products to which it was added. It also supplied good amounts of thiamin, calcium, phosphorus, and protein. All these nutrients were considerably higher than in similar control products in which no whey was used.

5. Around 16 percent of dried whey, based upon the sugar, could be used satisfactorily in caramels. Whey could also be used in fudges but in smaller amounts. Whey candies did not dry out as speedily as plain candies.

6. There was an increase in riboflavin with the use of 16 percent whey based upon the sugar in caramels. There was also a considerable increase in calcium and phosphorus.

7. Storage of dried whey in ploiofilm bags, tightly sealed or in tin containers, prevented caking and hardening.

Acknowledgment is made to Connie Mahan, who worked on whey in the Foods Research Laboratory for her Master’s thesis, and to other home economics students who assisted in testing whey products.

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