Milk Products in Bread Making

By Rae H. Harris[1]

Introduction

The original use of milk in bread was in domestic or home baking, and probably dates from antiquity. No doubt the increase in nutritive properties of the bread was one of the major reasons which first induced the use of milk. Much of the initial investigational work was directed toward learning how to prepare milk suited to breadmaking and finding the proper quantities for optimum results.

The convenience, economy, and uniformity of dry milk solids have greatly increased their use by the baker. These advantages have been further augmented by research and experimentation by the dry milk producers, which have resulted in a product which will appreciably improve bread quality.

Milk may be altered both in physical and chemical properties by heating. Since the production of powder from fluid milk may involve the application of heat, the milk industry has spent much time and expense in ascertaining the influence of heat upon milk properties. It has been found that heating skimmilks for 30 minutes at 77°, 88°, and 96° C. before drying greatly improves the baking quality of the product.

Effect on Nutritive Properties

Milk tends to improve the quality of the resultant bread and to increase the nutritive value. It has been reported that white bread can be made equal or superior to whole wheat bread in nutritive properties by the addition of suitable amounts of non-fat dry milk solids, and that this is perhaps more effective than the use of enrichment ingredients according to recent standards. Bread containing 6 per cent non-fat dry milk solids has approximately three times the nutritional value of water bread, or enriched water bread.[2] These solids supply the essential amino acids, lysine and valine. The chief deficiency nutritionally of wheat protein is lysine, and the secondary deficiency is valine. These deficiencies are removed when milk is used, and the growth-promoting potentialities of the bread are thus increased. The same workers stated that white water bread is a much better food than many consumers realize. Milk solids not fat are valuable both for nutritive purposes and for increasing bread quality.

Carlson, Hafner, and Hayward have pointed out that whole wheat protein probably does not furnish sufficient amino acids for growth requirements when the food intake is restricted to a low (10%) protein diet.

[1]Cereal Technologist.
[2]Census of Dry Milk Distribution 1948. American Dry Milk Institute, Inc., 221 North LaSalle Street, Chicago, Illinois.

Effect on Bread Quality

Dry milk solids added to a maximum of six per cent of the flour weight tend to increase loaf volume and the interior quality of the loaf. Fermentation tolerance, which is the length of time during which the dough can be fermented without injury to quality, is increased. Water absorption is also raised, and this increases the yield of bread per sack of flour. Milk adds a distinct, pleasant flavor to the loaf. Ofelt and Larmour have advised that the water absorption of experimental doughs made with milk be increased one per cent for each one per cent of dry milk solids added until a maximum of six per cent is attained. When eight per cent of solids was employed, the absorption increase was the same as for six per cent dry milk, or six per cent absorption increase above the dough without milk. If eight per cent absorption above the normal was used the doughs became too sticky to handle properly. There appeared to be an inverse relation between responses to bromate and to milk in patent or straight bread flours.

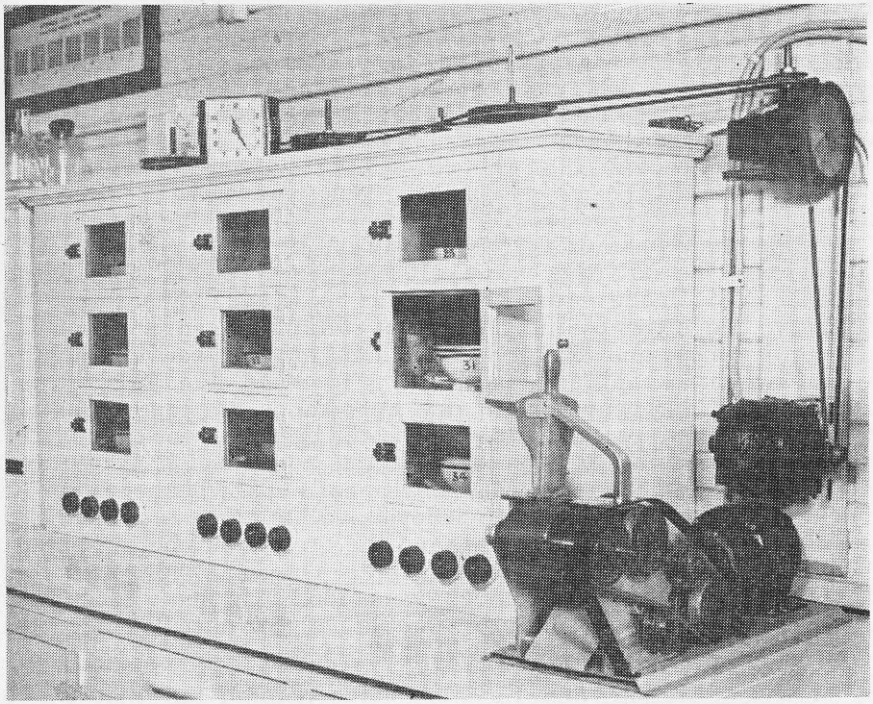

Fig. 1. Fermentation cabinet and dough sheeter in experimental baking laboratory. Doughs are fermented in the dishes shown in the cabinet which is held at constant humidity and temperature. Doughs are punched by running through the sheeter which expels carbon dioxide gas and brings fresh dough surfaces into contact with the yeast.

Dry milk solids also protect flours from the ill effects of over-oxidation, or bleaching; that is, they increase the flour's tolerance to bleaching and thus indirectly assist in obtaining maximum results from a flour. They further augment tolerance to overmixing, particularly in high-speed dough mixes. These attributes of milk are very important to the commercial baker and justify more intensive study.

Raw milk is very rarely used in the bakery. Upon standing, the acidity increases, and sour milk has a tendency to increase the fermentation period. The influence of dry milk solids on the baking quality of durum wheat flours has not been investigated to any great extent. There has been some data reported indicating a low response to oxidizing agents and milk solids, but more experimental work is required to evaluate more completely the effect of oxidation and milk supplementation upon durum flours. Since durum wheat is used principally for the manufacture of semolina for the production of macaroni products, there has not been the same incentive for studying its bread-making potentialities as for bread wheats. There is a fruitful field for ascertaining the influence of bread supplementing agents on durum flour bread.

Conflicting data have been published on the effect of dry milk solids on the rate of bread staling. Early work indicated no staleness-inhibiting action, but later studies showed some beneficial effect when dairy products, including dry skim milk, were incorporated in the dough.

Variations in Baking Quality

Harland, Ashworth, and Golding showed that the chief differences between milks of good and poor baking quality lay in the non-dialyzable fraction. This fraction was determined by ultrafiltration, followed by dialysis against tap water at 15° C. for 24 hours, then finally against distilled water for another 24 hours at 40° C. The baking quality of this fraction was improved by heating. There was little heat effect on the dialyzable portion of the milk. The non-dialyzable fraction consisted of different forms of casein, as rennet whey-casein, acid-whey casein, and casein precipitated from skim milk by acid. It is well recognized that heat treatment improves the baking quality of milk. Fresh milk and milk products such as condensed or dried milk which have not been exposed to sufficient heat do not produce as good quality bread as properly heated milk. A number of explanations have been advanced to explain this difference, such as the destruction of proteolytic enzymes by heat, denaturation and coagulation of the proteins, changes in the colloidal properties of the salts, and alterations in the oxidation-reduction systems.

No relation has been shown between the pH of dry milk solids and baking quality.

Trends in Consumption

Table 2 shows comparisons between 1941 and 1948 for trends in non-fat dry milk solids consumption. The total production of dry milk solids has almost doubled during the 1941-1948 period (366 to 658.5 million pounds). In the same period non-domestic use has increased from 10.7 to 31.9 per cent of the total produced, while domestic other than government consumption has fallen 21.2 per cent of the total. Within the domestic market, bakery utilization has accounted for approximately two-thirds of the total consumed, with dairy products themselves only using at present 18.6 per cent, as compared with 23.2 per cent in 1941. Bakery use has shown a slight increase of 2.9 per cent in this period, equivalent to an increased consumption of 87.8 million pounds. Meat processing activities are the next largest users of dry milk products, taking slightly more than seven per cent of the total. Other uses are relatively minor. It is quite clear that the bakery market offers the most favorable outlet for increased dry milk consumption.

Table 1. TRENDS IN CONSUMPTION OF COMMERCIAL BAKERY PRODUCTS IN THE UNITED STATES
(Census of Dry Milk Distribution—1948)

Year	Value in millions Dollars	Per capita consumption lbs.	Wheat flour used (million 100 lb. sacks)
1923	1.123	75.5	68
1929	1.526	80.8	78
1939	1.412	80.1	86
1947	3.427	94.0	127

Note: 1947 values calculated from a preliminary Census report.

The demand for dry milk solids in the baking industry depends upon the consumption of bakery products which contain these solids and also upon the quantity of solids employed in the formula. The increase in consumption in dollar values was not caused entirely by increases in population or in the cost of bakery products, as the per capita consumption also increased. The same trend is noticeable in the increased use of wheat flour in the industry. However, total per capita consumption of wheat flour during the same period has declined, and this has led to the assumption that the utilization of bakery products is showing a steady long-term decline.

The increased use of bakery products in 1947 may be accounted for by higher consumer incomes accompanied by a shift from home baking during the war when women entered the labor force. More intensive merchandising of bread, etc., probably also had an influence.

In 1939 the baking industry used 169 million pounds of dry milks. Advance estimates for 1947 indicated a consumption of 304 million pounds, with probably a slightly higher consumption for 1948. Because dry milk solids are used in various quantities in

different bakery products as well as in variable quantities for the same product, any index of their general utilization must be an average of the total used by all bakers. The pounds of dry milk used per hundredweight of flour is a satisfactory index, and an increase in this value indicates greater use of milk solids for bread-making purposes. The index was 1 97 in 1939, and increased to 2.39 in 1947—a rise of approximately 21.3 per cent in that period.

Summary

Dry milk solids increase both the nutritive properties and the baking quality of bread. Research studies have resulted in improving the baking quality of milk, particularly through the application of heat. No doubt further investigations would ultimately result in wider use of milk in the baking industry. This industry apparently offers most promise for increasing the market for dry milk solids.

Table 2. TRENDS IN USE OF NON-FAT DRY MILK SOLIDS[1]

	Million pounds		Per cent of total production		Per cent of change
	1941	1948	1941	1948	
Comparison of End Use of Non-Fat Dry Milk Solids					
Total production	366.0	658.5	100.0	100.0	....
Sales other than domestic, (exports, gov't purchases, and subsidized exports)	39.0	210.0	10.7	31.9	21.2
Total domestic non-gov't use	327.0	448.5	89.3	68.1	—21.2
Comparisons within the Domestic Market					
Total domestic non-gov't use	327.0	448.5	100.0	100.0	....
Bakery	200.0	287.8	61.3	64.2	2.9
Dairy[2]	76.0	83.3	23.2	18.6	— 4.6
Meat processing	23.0	33.8	7.1	7.5	0.4
Confectionery	11.0	10.1	3.4	2.3	— 1.1
Prepared mixes	10.0	14.1	3.1	3.1	0.0
Institutional use and soups	6.0	6.1	1.6	1.4	— 0.2
Packaged for home use	1.0	2.3	0.3	0.5	0.2
All other uses	....	11.0	....	2.4	2.4

[1]From **Census of Dry Milk Distribution - 1948.** American Dry Milk Institute, Inc., 221 North LaSalle Street, Chicago, Illinois.
[2]Sum of ice cream, buttermilk, cottage cheese, chocolate drinks, etc.

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TALL GROWS THE CORN

The 86 million U. S. acres which grew the 1949 corn crop are spotted here, there and almost everywhere in all the 48 states.

An accurate map, showing all corn areas in black, would present a mosaic pattern with the greatest areas of black concentrated, of course, in the corn belt. But if all those big and little black spaces were massed together you would have a solid cornfield of 134,275 square miles; slightly larger than the combined states of Illinois, Indiana, and Ohio. This cornfield would have a maximum east-west distance of 583 miles. From north to south its longest row of corn would stretch 385 miles.

If it were possible to bring all the corn, harvested as shelled grain, from our big field to a single loading platform we'd tell the railroad we wanted a train of 1,934,246 box cars, each to take 1,825 bushels, to move this corn to the farms and industrial plants where it's needed.

The railroad might object, and not without reason, for a train that size would be sort of hard to handle, being 16,480 miles long. Going at 50 miles an hour, it would take 13 days and 18 hours to pass you if you were waiting at the Broadway crossing in Fargo for the gates to go up. You could break it up into six trains, if you wished—five long ones and one not so long. Each of the long ones would reach from New York to San Francisco; even the shorter one, if headed west with its engine in Des Moines, would have its caboose in New York City.

If we wanted to store all this corn we would need 17,572 grain elevators, each elevator 50 feet square and 100 feet high. A single storage elevator in the shape of a cube, capable of holding our corn grain harvest, would have to be 1,638 feet on a side and 1,638 high . . . If converted into an apartment house, it would give each man, woman and child in North Dakota an apartment considerably larger than the ordinary family dwelling house.—(JB)

1947 ISSUE OF CONSIDERABLE INTEREST

There are still available several copies of the September-October 1947 Bimonthly Bulletin of this station, which includes several papers of considerable current interest. C. C. Volkerding and T. E. Stoa, for example, discuss soil fertility and phosphate fertilizers in two papers in that issue. Eleanor McGuigan tells the vitamin C content of some North Dakota fruits and plant tissues. Chemical control of the wireworm is discussed by R. L. Post, J. A. Munro and R. B. Knapp, while other articles discuss flax rust, sheep and lamb care, farm wage rates, hatchery statistics. Write the North Dakota Agricultural Experiment Station, Fargo, if you wish a copy of this bulletin.