Homogenized Milk and Public Health*

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IN the midst of uncertainty regarding the future of the homogenizer in the dairy industry, Baldwin (1916) prophesied:

"Just what attitude public health officials should take toward homogenized products might depend on circumstances; but it would seem as though there should be no general objection unless an unhealthful product is made or one which would tend to deceive the consumer.

"With the exception of the occasional fraudulent use of the process, homogenization apparently marks a distinct advance and the product thus made seems to be of better flavor and texture than unhomogenized cream containing the same amount of fat. Another feature of distinct advantage to the public in homogenized products is that they are practically all pasteurized."

The attitude of the public at that time, toward the use of the homogenizer was undoubtedly well expressed in another statement by Baldwin (1916) who believed that

"For the most part homogenizing is done to secure some commercial advantage either through cheapening or improving the quality of the product, or the elimination of difficulties incident to customary methods, but there are some cases in which the process is distinctly fraudulent."

That the use of the homogenizer in the market milk industry was not only debatable but questionable is not surprising. First of all, the homogenizer was a comparatively new machine, the most obvious effects of its use being the reduction in the size of the fat globule making fat-bearing liquids homogenous. That "dispersed cream lines told no tales" connoted its use toward fraudulent purposes. Second, the sanitary features of a high pressure machine which could not be disassembled readily for washing and sterilizing naturally led officials to question the advisability of its adoption, nor were these fears without foundation.

Bishop and Murphy (1917) had demonstrated that this newly introduced machine was apparently a great source of contamination. Homogenizing raw milk at a temperature sufficiently high to liquefy the fat globules yet low enough not to kill off the bacteria, they secured counts of 1,500,000 before homogenizing and 11,500,000 after homogenizing, an increase of approximately 8 fold. Their experiments on cream showed that a low fat cream properly homogenized appeared much richer in fat; that after homogenizing milk the cream did not rise by gravity and could not be separated by centrifugal separation; that homogenized cream could not be churned and when added to coffee did not mix so readily as normal cream. All of which seemed to indicate that its chief merit was deception and this attended with difficulties. However, since ice cream made from homogenized products was superior in texture to that made from non-homogenized products, thus contributing to its palatability, the use of the homogenizer seemed destined to remain in that branch of the dairy industry.

Furthermore, early studies on the feeding value of homogenized milk lent little encouragement to its use. In their extensive studies, Washburn and Jones (1916) concluded in part that

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"The homogenization of the fat does not seem to be helpful in the feeding of the young, if we may judge by the clinical evidences. The pigs fed the milks thus treated ate their food less greedily and, whenever the fat content of their ration was increased, went 'off feed' more quickly than did those receiving milk containing normal fat. However, the curds formed from milk, the casein of which had been homogenized, were made so much more flocculent and friable as a result of this process that the writers are led to feel that perhaps benefit may be expected from such treatment."

In the light of present knowledge on homogenized milk it is interesting to speculate as to the reason why the pigs did not relish the homogenized milk as they did the non-homogenized. In most of the feeding trials, the milk was homogenized raw at 85° F., a condition approaching optimum for inducing rancidity. Likely, therefore, the homogenized milk was extremely rancid and bitter at time of feeding.

Several years later James (1923) using sterilized water demonstrated what contamination might be expected from a homogenizer supposedly "sterile". Making five runs with pasteurized skim milk using a machine previously treated with boiling water rendering it practically sterile, he found that the comparative numbers of organisms before and after homogenization ranged from a ratio of 1 to 1.5 to 1 to 4.5. These increases were undoubtedly the result of breaking up of clumps rather than from contamination.

USE IN MARKET MILK

The discovery of vitamins focusing the attention of dieticians to the necessity of a proper diet, especially for the young, contributed in part to the adoption of milk in the schools. However, not until Kelly (1932) pointed out that school children were leaving behind a considerable portion of the milk fat did homogenization of milk for school children seem desirable. He reported that a survey in cities throughout the United States, in which half-pint bottles of milk were being served school children that the average quantity of the milk left behind was 5.63 percent whereas the quantity of fat left averaged 15.83 percent.

These data indicated that school children were deprived of a portion of the butterfat served them. Kelly suggested that the remedy to the situation was better mixing by shaking and homogenization. In the experience of the intervening years homogenization of milk for school children seems to have gained the preference over better mixing by shaking.

By this time the second and successful introduction of homogenized milk on a commercial scale in Canada was at best an experiment of not more than half a decade standing. Apparently a successful enterprise there, its growth, problems, acceptance and possibilities were being scrutinized closely by the market milk industry in the United States. In fact, a few courageous United States dairymen already had dared to introduce the product despite the fact that many of its problems were yet unknown and hence unsolved. The success of these early commercial ventures, coupled with the enthusiasm of the housewives themselves for homogenized milk as noted in a survey by Tracy (1936), forced others to place homogenized milk on the market.

At first reluctant to permit the sale of homogenized milk, boards of health in the larger cities now recognize it as a standard milk product. The United States Public Health Service (1939) recognizes and defines homogenized milk specifically as follows:

"Homogenized milk is milk which has been treated in such manner as to insure break-up of the fat globules to such an extent that after 48 hours storage no visible cream separation occurs on the milk and the fat percentage of the top 100 cc. of milk in a quart bottle, or of proportionate volumes in containers of other sizes, does not differ by more than 5 per cent of itself from the fat percentage of the remaining milk as determined after thorough mixing."

The machine once of questionable character in the milk industry, after a

quarter of a century of development and research, has been accepted as standard equipment. It is interesting to note what developments have been made during the past 25 years which have been responsible largely for the change in attitude of the public and its officials toward homogenized milk. Many may be cited but five are worthy of further consideration. These are:

1. Introduction of new, completely-demountable, stainless steel homogenizers which may be disassembled readily for washing and sanitizing.

2. Development and introduction of more efficient washing powders and chemical sterilization.

3. Marked improvement in the general raw milk supply to milk plants.

4. Introduction of home refrigeration making low-temperature storage and quantity fresh food buying possible.

5. Extensive research on homogenization of milk and problems related thereto.

The major objection to the early homogenizer, namely, that even with conscientious cleaning it with its inaccessible stuffing boxes was a potential source of contamination, has been overcome in today's machine. Each part with which milk comes in contact is now demountable, washable, and sanitizable. Made chiefly of stainless steel its valves and pistons resist wear and are no longer seats of marked grooves which defy adequate cleaning. Disassembled after each run, the parts must be kept in first-class condition at all times that the machine will perform efficiently under the pressure required.

In the field of cleaning and sanitizing dairy equipment, the methods employed and materials used today are a marked contrast to those of a quarter century ago. Then, generally one alkali served all dairy purposes; today, a specific chemical compound is available for each specific purpose. The milk-stoned equipment of yesterday is the polished surface of today. Hot water was available for sterilizing then as now, but in addition today chemical sterilizers are at the service of the plant manager.

The bacteriological quality of the milk supply today as contrasted to that of the turn of the century represents an improvement which is little less than a marvel in the field of food engineering. Routine inspection with specific tests, improved methods of production, facilities for prompt and adequate cooling and storing milk on the farm, covered trucks, refrigerated transportation and in some territories twice-a-day delivery have resulted in a milk supply of comparatively low bacteria count. Consequently, bottled pasteurized milk today often has such a low biological oxygen demand that at certain seasons development of flavors resulting from chemical activity are a serious problem to the distributor. The home refrigerator making possible lower temperatures and longer storage of milk has been a factor in this problem. Research has shown that homogenization stabilizes the milk against these oxidative changes.

HOMOGENIZATION TECHNOLOGY

During the past decade many data have been presented by research workers on various aspects of homogenized milk. In the light of these data, both the processor and public health officials have come to recognize certain facts associated with homogenized milk which are of distinct value to public health. A few having especial public health significance are herewith presented and discussed briefly:

1. *Homogenized milk must be a pasteurized product.* This should be of special interest to the public health official. Bundesen (1937) stated "We maintain that proper pasteurization is the front line of defense against milk-borne disease, and it is a defense which can never be allowed to waver or break down."

When the raw milk is homogenized, it soon becomes bitter, rancid, and undrinkable, due to the activity of the enzyme lipase which is present in all

milk. Lack of palatability will defeat milk sales so quickly that no plant manager would risk inadequate pasteurization of homogenized milk.

2. *Homogenized milk is capable of being pasteurized at a higher temperature and maintained for a longer holding period than regular pasteurized milk.* Since properly homogenized milk is homogeneous throughout showing no cream line, the destruction of creaming ability of milk by heat treatment is of no concern in homogenized milk. Thus, the fear of high temperatures affecting the creaming of milk is out. Furthermore, the cooked flavor does not occur in milk until momentary temperatures around 175° F. have been reached. Gould and Sommer (1939) showed that the appearance of the cooked flavor in milk was a function of time as well as temperature, the flavors appearing at temperatures of momentary heating at around 80° C. (176° F.) and at 30 minutes holding at 70° C. (158° F.). Consequently, the upper temperature limit of pasteurization of milk for homogenization purposes may be materially raised, thereby resulting in greater pasteurization efficiency without affecting the palatability of the product.

In a recent survey of 23 Michigan milk plants homogenizing milk, Trout and Scheid (1941) found that 14 or 60.8 percent of them were pasteurizing at 145° F. and above; that 11 or 47.8 percent at 147° F. and above, and that 8 or 34.8 percent at 150° F. and above. With the exception of one plant pasteurizing at 160° F. for 20 minutes, the time of holding in each case was 30 minutes.

3. *Homogenized milk cannot be mixed with raw milk without developing rancidity.* Experiments with mixtures of raw and pasteurized homogenized milk by Gould and Trout (1939) and by Larsen, Trout, and Gould (1941) demonstrate fully the necessity of inactivating the enzyme lipase in homogenized milk if development of rancidity is to be avoided. Rancidity in milk is so easily detectable by taste and is so repulsive that such milk will not be consumed; and it follows that that which will not be consumed will not merit repeat sales.

4. *Clarification is a companion process with homogenization.* Jones (1929) early pointed out the possibility and occurrence of sedimentation in bottled homogenized milk and advised the necessity of clean milk for homogenization purposes. This defect was more fully described by Trout and Halloran (1932) (1933) who reasoned that with a lack of creaming as the result of homogenization any silt present might readily settle out together with some casein or milk cells. These investigators found the sediment compared very favorably in appearance and chemical composition to separator slime, which from earlier investigations by Hammer (1916) and by Marshall and Hood (1918) was known to have cell counts, in some cases, approaching or even exceeding one billion per gram. Clarification was resorted to therefore, as the practical remedy for sediment in homogenized milk.

Babcock (cited by Kelly, 1932) showed that homogenized milk sediment was high in leucocytes and demonstrated (1934) that settling of leucocytes did occur in homogenized milk, the lower portion of bottled homogenized milk being extremely high in them as compared to the upper portion. The above observations and remedies have been later substantiated with supporting data and limitations by many other investigators.

Despite the settling of body cells and the importance of low cell milk for homogenization purposes the importance of clean milk cannot be minimized as shown by Charles and Sommer (1935). Furthermore, the plant operator well appreciates the value of general plant sanitation and cleanliness where homogenized milk is being processed. Observations made by the writer of a plant changing from an old "stuffing box" type of homogenizer

through the use of which sediment in homogenized milk could be demonstrated at will to a modern demountable type of homogenizer with which, using the same source of milk supply, slight sedimentation could be demonstrated only with difficulty convinces him that the use of low cell milk alone is not the solution, but that sanitation of the machine itself is of very vital importance also in eliminating sediment in homogenized milk.

5. *The process of homogenization has been an educational influence to the milk processor making him more "milk-conscious".*

In processing and merchandising homogenized milk, the processor soon learns that

a. Prompt adequate heat treatment must accompany the process to inhibit the development of rancidity.
b. Homogenized milk exposed to light is prone to develop the so-called "sunshine flavor". The manager, therefore, has a vital, personal reason for instructing the milkman to set the milk out of the sun and may even provide his customers with milk boxes.
c. Because of sedimentation, homogenized milk must be of high quality and preferably clarified.
d. Homogenized milk must be protected in transit from heat to prevent leaky caps and from freezing to prevent watery appearance as shown by Hood and White (1934) and Trout (1940) (1941).
e. Inasmuch as the homogenizer not only is another piece of equipment with which the milk comes in contact, but breaks up bacterial clumps yielding higher apparent counts as well, the plant operator becomes more conscious of the necessity of efficient plant sanitation throughout.

6. *The bacterial count of commercial homogenized milk is comparable to that of regular pasteurized milk.*

Despite contamination from the homogenizer and breaking up of clumps of bacteria, factors which cannot be denied, thus yielding a higher plate count as shown by James (1923), Tracy (1938) and others, the fact remains that homogenized milk is meeting boards of health bacterial standards throughout the country every day. Data presented by Hollingsworth (1931), Hood and White (1934), and Tracy (1938) show that homogenized milk of comparatively low bacteria count is being marketed regularly. Often fully unappreciated is the fact that, since cream line is not a factor in homogenized milk, heat treatment is not limited to a few degrees, but may be raised markedly to secure greater pasteurization efficiencies. Furthermore, the flash of temperature of a few degrees resulting from the processing pressure undoubtedly contributes further toward a lower bacteria count. Furthermore, contamination from the modern completely demountable homogenizer would seem to be nil in comparison to that of the old-type machine.

7. *The fat content of homogenized milk may be easily and reliably determined by the modified Babcock method.*

It is generally recognized today that Babcock fat tests of properly homogenized milk are well within 0.1 percent of that of the same milk non-homogenized. Doan and Swope (1927) found that homogenization even at high pressure exerted but little influence on the Babcock test. Halloran and Trout (1932) made similar observations. Trout (1933) and Trout, Halloran and Gould (1935) using sulphuric acid standardized at 1.82 sp. gr. demonstrated that accurate fat tests could be made on homogenized milk. Babcock (1934), however, found in every case that the homogenized milk showed a lower fat test, ranging from 0.05 to 0.15 percent with an average of 0.10 percent, than the same milk before being homogenized. Hood and White (1934) found the lowering of the fat test due to homogenization to average

0.08 percent. Tracy (1935) using the modified procedure for homogenized milk stated, "In general, no great difficulty was encountered in securing tests comparable to the results secured on the unhomogenized samples." Apparently, therefore, health authorities may confidently and at will, using available Babcock equipment, check the milk supply to ascertain if the fat content meets local board of health requirements. The fact that milk is homogenized does not put it into a class which defies chemical analyses — a class wherein allurements to deception might be a public health problem.

8. *Homogenized milk is an important factor in increased milk consumption.*

Smallfield (1929), having made a customer preference study involving homogenized milk, stated:

> "The questionnaires which were returned showed that all those reported on it liked the homogenized milk. Sixty-two per cent preferred it to the unhomogenized milk. Nearly all the families in this group had small children. Some replied that they preferred it on account of its greater apparent richness."

This consumer reaction to homogenized milk, to a greater or lesser extent, has been made also by Irwin (1931), Hudon (1931), Doan (1932), Babcock (1934), and Tracy (1936). Tracy's 36 reasons furnished by the customer's themselves as to why they prefer homogenized milk are almost classic.

Two factors, contributing to the greater palatability of homogenized milk, seem to stand out. These are: first, the homogeneity of the milk. Homogenized milk exhibits no flakes, specks, or granules of cream or butter in the glass, such as are frequently encountered in non-homogenized milk; and second, the continuous wholesomeness of good flavor upon prolonged storage. The latter is very important, as regular pasteurized milk upon storage at certain seasons of the year is prone to develop various stages of oxidized flavor, rendering it less palatable. Homogenization has been shown by Tracy, Ramsey, and Ruehe (1933) to inhibit or delay oxidative changes. This observation has been substantiated since by several other investigators.

With the wealth of scientific information available pointing to the necessity of including milk in the diet, health authorities are vitally interested in a safe, sanitary product which would tend to increase the present consumption of milk, particularly a milk which will assure children that they are getting the full amount of fat in each glass.

A foregone conclusion is that public health officials through establishment of standards and through rigid and routine inspection have played no minor role in the development of the present market milk industry. Ever cautious in accepting and adopting new products and processes, they have kept the good of the public in mind. Presented with facts supported by adequate research, they are accepting today and even welcoming homogenized milk, which was a product of suspicion less than a quarter of a century ago.

LITERATURE CITED

1. Babcock, C. J. The Effect of Homogenization on Certain Characteristics of Milk. U. S. Dept. Agr. Tech. Bul. 438. 1934.
2. Baldwin, H. B. Some Observations on Homogenized Milk and Cream. *Am. J. Pub. Health*, 6, 862 (1912).
3. Bishop, J. L., and Murphy, R. M. The Homogenizing of Milk and Cream. Master's thesis. Univ. of Wis. (1913).
4. Bundesen, H. E. Inaugurating Grade A. Pasteurized Milk in the City of Chicago. *Am. J. Pub. Health*, 27, 680 (1937).
5. Charles, D. A., and Sommer, H. H. Causes and Practical Methods for Control of Sedimentation in Homogenized Milk. *Milk Plant Monthly*, 24 (4), 26 (1935).
6. Doan, F. J., and Swope, W. D. Studies of the Viscolizing or Homogenizing Process. *40th Am. Rept. Pa. Agr. Exp. Sta. Bul.* 213, 22 (1927).
7. Doan, F. J. Homogenized Milk and Soft-Curd Milk. Two New Tendencies in Institutional Milk Supply and the Advantages Claimed for Them Discussed. *Milk Plant Monthly*, 21 (2), 44 (1932).
8. Gould, I. A., and Trout, G. M. Lipase Action in Mixtures of Raw and Pasteurized Milk. *Mich. Agr. Exp. Sta. Quart. Bul.*, 22 (2), 101–105 (1937).

9. Gould, I. A., and Sommer, H. H. Effect of Heat on Milk with Especial Reference to the Cooked Flavor. *Mich. Agr. Expt. Sta. Tech. Bul.*, **184**, 48 (1939).

10. Halloran, C. P., and Trout, G. M. The Effect of Viscolization on Some of the Physical Properties of Milk. (Abstract) 27th Ann. Meeting. *Am. Dairy Sci. Assoc.*, p. 17 (1932).

11. Hammer, B. W. Studies on the Clarification of Milk. *Iowa Agr. Expt. Sta. Res. Bul.* 28 (1916).

12. Hollingsworth, J. B. Homogenized Market Milk—How It Is Increasing Consumption. *Milk Dealer*, **20** (9), 63 (1931).

13. Hood, E. G., and White, A. H. Homogenization of Market Milk. *Can. Dept. Agr., Dairy and Cold Storage Br. Mimeo.*, 25 (1934).

14. Hudon, M. H. Homogenized Milk Finds Favor in Canada. *Food Ind.*, **3**, 153 (1931).

15. Irwin, R. E. Homogenized Market Milk in the United States. *Milk Dealer*, **20** (9), 62 (1931).

16. Jones, W. F. Dispersed Cream Lines Tell No Tales. *Milk Dealer*, **18** (9), 134 (1929).

17. Kelly, E. Effect of Certain Factors on Amount of Fat Consumed in Milk Served to School Children. *21st Ann. Rpt. Internat'l. Assoc. Dairy and Milk Insp.*, p. 197–201 (1932).

18. Larsen, P. B., Trout, G. M., and Gould, I. A. Rancidity Studies on Mixture of Raw and Pasteurized Homogenized Milk. *J. Dairy Sci.*, 24, 771 (1941).

19. Marshall, C. E., and Hood, E. G. Clarification of Milk. *Mass. Agr. Expt. Sta. Bul.* 187 (1918).

20. Smallfield, H. A. Is There a Future for Homogenized Milk for the Retail Trade? *Can. Dairy and Ice Cream Jour.*, February, 1929.

21. Tracy, P. H., Ramsey, R. J., and Ruehe, H. A. Certain Biological Factors Related to Tallowiness in Milk and Cream. *Ill. Agr. Expt. Sta. Bul.* 389 (1933).

22. Tracy, P. H. Properties, Virtues and Possible Drawbacks of Homogenized Milk. *Milk Plant Monthly*, **24** (4), 28 (1935).

23. Tracy, P. H. Certain Problems Related to the Marketing of Homogenized Milk. *Milk Dealer*, 25 (4), 30–32; (5) :60, 62, 64, 66, 68 (1936).

24. Tracy, P. H. Problems in the Processing and Marketing of Homogenized Milk. *12th Ann. Rept. N. Y. State Assoc. Dairy and Milk Insp.*, p. 69 (1938).

25. Trout, G. M., and Halloran, C. P. Sediment in Homogenized Milk. *Mich. Agr. Expt. Sta. Quart. Bul.* 15 (2) :107 (1932).

26. Trout, G. M., and Halloran, C. P. Sediment Test Not a Reliable Guide in the Selection of Milk for Homogenization. *Mich. Agr. Expt. Sta. Quart. Bul.* 15 (4) : 271 (1933).

27. Trout, G. M. Physical and Chemical Effects of Homogenization on Milk. *26th Ann. Conv. Internat'l. Assoc. Milk Dealers*, Lab. Sect., p. 199 (1933).

28. Trout, G. M., Halloran, C. P., and Gould, I. A. The Effect of Homogenization on Some of the Physical and Chemical Properties of Milk. *Mich. Agr. Expt. Sta. Tech. Bul.* 145 (1935).

29. Trout, G. M. Watery Appearance of Frozen Homogenized Milk. *Mich. Agr. Expt. Sta. Quart. Bul.* 23 (1) :10 (1940).

30. Trout, G. M., and Scheid, M. V. The Influence of the Time and Temperature of Homogenization on Certain Properties of the Milk. *Mich. Agr. Expt. Sta. Quart Bul.* 24 (2) : 122–131 (1941).

31. Trout, G. M. The Freezing and Thawing of Milk Homogenized at Various Pressures. *J. Dairy Sci.*, 24, 277 (1941).

32. United States Public Health Service. Milk Ordinance and Code. *Pub. Health Bul.* 220, p. 4 and 22 (1939).

33. Washburn, R. M., and Jones, C. H. Studies of the Values of Different Grades of Milk in Infant Feeding. IX. Homogenized Milk (p. 55–69). *Vt. Agr. Exp. Sta. Bul.* 195. 144 (1916).