AN APPRAISAL OF THE GERBER TEST FOR MILK FAT IN MILK AND MARKET MILK PRODUCTS[1]

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Most of the milk provided to consumers is "homogenized;" a major portion of the balance, supplied in paper containers marked "pasteurized" is a variable blend of "homogenized" and "creamline."

While the laws of many states including your state (*13*) require that milks be tested for fat by only the Babcock Method, this procedure is not appropriate for either homogenized milks or its blends. In order to determine their compliance with standards, or to get figures so that you can account for fat (the costliest commodity), you as well as others, are either (*a*) testing these homogenized and blended milks, with slight success, by one or another of the (illegal) Babcock modifications, or (*b*) resorting to the expensive (and also illegal) Roese Gottlieb solvent-gravimetric (or its Mojonnier modification).

You would like a fat test as simple, or preferably simpler, than the Babcock, that you could use on any milk-creamline or homogenized or blend, or sweetened, flavored, or soured or cultured, that would give you data of the same order of accuracy as the solvent-gravimetric procedure. If you found such a method, it should be easy enough to ask your legislature to modify your current law to permit it—the purpose of a law is to promote citizens' best interests.

From experience with Babcock modifications, one might feel that such a test is not possible—but it is not only possible, it has been in existence almost as long as the Babcock. We will review this test and appraise it to see how well it satisfies the needs.

THE GERBER TEST

Origin and Hypothesis

Researchers in Europe were, like many in America, in 1880-90, seeking a simple replacement for the costly, time-consuming solvent-gravimetric method for determining fat in milk. In continental Europe, milk was regularly boiled before consumption. Dr. Nicholas Gerber, a Swiss chemist, found, shortly after the Babcock Method was published, that it did not bring all of the fat of these "heat-homogenized" milks into the bottles' graduated areas. Gerber learned that a specific iso-amyl alcohol, added to the sulfuric acid-milk mixture, decreased the interfacial tension of the fat, to permit it to rise completely.

Years before Bailey (*2*) and Herreid, Jenness and Whitman (*9*) reported that the use of strong acid increased the moisture of the material which rose into the column of the Babcock bottle, Gerber recognized that to achieve constancy of composition of the fat which was to be measured, the concentration and volume of reagents had to be kept constant. To insure that they would not be altered, he limited the capacity of his test bottle. Years before Lucas and Trout (*12*) pointed out that charring is avoided by adding acid in increments, Gerber learned it, and adopted a bottle design which provided it automatically. Gerber's bottle consists of a large upper bulb connected to a smaller bottom one by a calibrated column; the entire charge of acid is added at one time, but its specific gravity entraps a fourth of it in the small bulb and stem; it is released only when the bottle is inverted.

Working with heat-homogenized milk, Gerber could not make an empiric correction for the small fat gobules which did not rise from raw milk, as did Babcock. That the correction Babcock utilized (the depth of a meniscus) was inaccurate, was obvious: the meniscus depth is contsant, all other conditions being equal; a raw milk-distilled water mixture containing 2% fat, prepared from a 4% raw milk, will possess half the number of small gobules per unit volume as the original; yet both samples will be given the same meniscus depth as a "correction," in the Babcock test. Gerber sought to eliminate menisci as a source of confusion years before Bailey (*2*). Sanmann (*11*) and Dahlberg (*3*) pointed out that not only did different observers read the same test differently, but an individual might not replicate his own readings, because it was difficult to tell where the top of the upper meniscus ended, and capillary creep began; and because the depth of the meniscus increased, as bottles cooled from water bath temperature toward room temperature. Gerber used a flat glass stem — wherein the fat-reaction mixture interface is a straight line, and the fat-vapor interface is a

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shallow, clearly defined constant meniscus, which can be read promptly, by anyone.

Years before Hileman, Rush and Moss (*11*) showed that Babcock "tolerances" prevented accurate accounting for the fat of non-homogenized milk, and Gould (*7*) commented that calibrating Babcock milk bottles to ± 0.05% instead of the AOAC specification (*1*) of ± 0.1% was desirable, Gerber required the maximum error of his milk bottles' stems not to exceed ± 0.05%.

Gerber's reaction to the slow introduction of reagents in Babcock's test, through the stem whose maximum i. d. (at the minimum length of 63.5 mm.) is 5.7 mm., was to put a wide neck on the large bulb of his bottle. Reagents may be introduced rapidly—with automatic dispensers, if desired.

The open Babcock bottle must be swirled; it can not be shaken—its corrosive contents might be expelled—ruining tests and dispositions; Gerber stoppered the bottle, so that it could be safely shaken as rapidly as any hand or mechanism might permit.

Gerber, like Babcock, employed centrifugal force to accelerate fat separation; using a narrower bottle (25 mm. o. d. max. as contrasted to Babcock's 37 mm.) Gerber employed higher speeds with safety. Since the bottle is filled right at the beginning, only one centrifuging is required. To avoid the need for external heat, Gerber used a revolving turntable centrifuge, within which the bottles remain adequately hot. To avoid guessing operational speed at any time, he made a simple liquid-filled speed indicator an integral part of the turntable.

To insure uniform conditions at the time of measuring the fat, Gerber, like Babcock, tempered the bottles after centrifuging. The lower extremity of the Gerber fat column remains a straight line at all times; the shallow upper meniscus elongates very slightly on cooling, instead of greatly, as do both Babcock menisci. Gerber used pressure on the stopper, to elevate the straight line at the bottom of the fat column, to bring it promptly into registration with a unit graduation. The reading at the bottom of the shallow upper meniscus was then made, the unitage at the bottom meniscus substracted, and the fat test recorded.

Thus by means of the Gerber Test, all of the fat of any milk sample is brought, at constant composition, into a precisely graduated stem, where it is rapidly measured to yield data which agrees with that obtained by Roese-Gottlieb solvent-gravimetric method to within 0.05%. The Gerber test sounds quite modern; it appears to cope satisfactorily with all of the problems that American dairy technology literature has established as existing in the Babcock. Yet it is far from new—it first appeared in 1892. (*6*).

Gerber Equipment

Specifications for Gerber equipment will not be included here — they are reviewed in detail, in the releases of the British, German, Dutch, Belgian, Swiss, Irish, South African, French and many other governments' Bureau of Standards, and will appear in the forthcoming 11th Edition of Standard Methods for the Examination of Dairy Products, of the American Public Health Association.

The Gerber Test for Fresh Milk

By way of review, the Gerber procedure for testing milk, step by step, is as follows:

(a) Into a Gerber 8% milk bottle, add 10 ml. 70°F. sulfuric acid (1.820-1.825 sp. gr.), using preferably, an automatic syringe which delivers the volume accurately, rapidly, and without time loss for drainage.

(b) Fill the "11 ml." Gerber pipette with the prepared milk sample. Discharge slowly at first (to prevent "local action") then allow to drain. After free flow stops, wait 3 seconds, then blow out last drop.

(c) Add 1 ml. Gerber "pretested, certified" iso amyl alcohol (128-131°C. Boiling Point). Preferably use automatic syringe.

(d) Distend self-sealing lock-stopper with key. Insert into bottle; release pressure to seat stopper firmly.

(e) Shake bottle, without allowing terminal bulb to empty. After curd which first forms is completely dissolved, invert four times to permit acid entrapped in terminal bulb and stem to mix thoroughly with the balance. (Bottles held in Quick-Lock racks may be shaken in almost any mechanical unit, and the rack inverted to mix in the concentrated acid of all of the bottles at one time).

Note: any bottle whose liquid contents do not fill stem almost completely when terminal bulb is uppermost, is evidence that a reagent or sample was not measured accurately.

(f) Balance bottles in centrifuge, terminal bulbs towards center. Spin for four minutes at 1100 r.p.m.

(g) Immerse to bulb in a water bath at 140°F. for 5 minutes.

(h) Remove bottles singly; by applying gentle pressure to the lock stopper, bring bottom line of fat column to coincide with a unit graduation. Read bottom of upper meniscus on scale to nearest 0.05%; substract bottom unitage and record.

(i) Return bottle to water bath. When all tests are read, invert bottle; remove stopper and rinse in water. The lead sulfate precipitated from sulfuric acid is impacted at the base of the stopper: it, and fat are both removed from the bottle as the reagent mixture drains out; the stem is clean — has been

cleaned by fat-free reagent mixture; the bottle is completely cleaned, finally, by rinsing with water.

The Gerber Test for Preserved Milk

Milks which must be warmed before sampling, or milks to be sampled at one time or place, and tests completed at another, should be introduced before the acid. Do not add acid until ready to complete tests. Arrange the bottles in racks so that the flat faces of their stems are parallel to the rack's long axis. Support one end of the rack to bring its base 30° off the horizontal. Chill the acid to 45°. 50°F.; introduce 10 ml. into each bottle. The acid will rapidly flow down the lower side of the flat glass stem to displace the milk from it and the terminal bulb without "local action." Add iso-amyl alcohol and complete tests as before.

Gerber Tests for Other Fluid Milk Products

Cream is tested by identical procedure excepting that a 5.00 g. portion is weighed into a 50% (graduated in 0.5%) or a 25% (graduated in 0.2%) bottle, then followed with 5 ml. of water.

Chocolate-flavored (sugar sweetened) milks and drinks, if not viscous, are measured out by milk pipette; if viscous, 11.125 g. are to be weighed out; special weights are available. Because of the high sugar contents, the acid must be modified – 94 parts by volume of standard acid to 6 parts of water. (Note – to prepare acid safely, weigh out ice; add acid to ice, slowly, in rubber or plastic container).

Skim milk is tested in 1% bottles (graduated in 0.01%); since phospholipid is extracted by Roese-Gottlieb solvent, but is not a true fat (*8-11*), Gerber skim milk tests will be lower than solvent-gravimetric results; since all skim milks' fat globules rise in the Gerber, its results will be higher than Babcock.

Cultured or soured milks must first be brought to homogeneity. Since these are viscous and may entrap air, they must also be weighed, rather than measured, into the bottle. Excepting only for weighing in 11.125 g., proceed as in the test for milk.

APPRAISAL OF THE GERBER TEST

At this point perhaps many questions come to mind. Is the simple Gerber Method actually able to test homogenized milks so readily? The answer, as supplied by Trout and Lucas, in their "Comparison of Babcock, Gerber, Minnesota, Pennsylvania and Mojonnier methods for Determining the Percentage of Fat in Homogenized Milk" (*15*): "In making the Gerber tests of homogenized milk the following factors were striking: (*a*) the clarity of the fat column and supporting liquid, (*b*) the identical reading of the duplicate tests, (*c*) the consistent check with tests on the non-homogenized milk and (*d*) the complete freedom of any char formation . . . Homogenization does not affect the Gerber test . . . the Gerber test was by all odds the most satisfactory test studied for making fat tests of homogenized milk."

If the Gerber Test, obviously simpler than the Babcock, is so much more fool-proof, hasn't it been appraised by others before this? Yes – but it was not compared from the aspect of practicality, even when only unhomogenized milks were considered. For example, Fisher and Walts, in 1925 (*5*) said: "The Babcock and Gerber methods for milk and cream seem to rank about the same from the standpoint of accuracy . . . as the Babcock method for milk and cream is recognized as an official method and generally used in the United States, there can be no advantage to the industry in introducing another method which is not more accurate or practical."

Dahlberg, Holm and Troy in 1926 (*4*) were equivalently unenthusiastic: "This investigation has shown that from the standpoint of accuracy the Babcock and Gerber tests are comparable. Whether the Gerber test should be introduced into this country or the Babcock test into Europe, is a question which the dairy industries of the countries concerned must settle for themselves through personal preference in respect to the technic of making the tests. One good practical test for fat in milk and cream is better than two of equal merit because of the confusion which would be created in the industry by the use of two tests." Gould in 1955 (*7*) also reviewed the advantages of the Gerber Test but concluded his appraisal with paraphrasing the above – "it would be better to have one generally accepted test in the United States." In spite of this, Gould recommends the Lucas-Trout modification of the Babcock for use on milks which might contain homogenized fat, even though its own authors point out that it is erratic in performance (*12*).

What is the actual limit of error of the Gerber test on milks? Competition yields bottles whose errors are well below the maximum permitted tolerance of ± 0.05%. Replicate tests are either identical, or come within 0.05% of each other. Their average will match within 0.05%, the mean of replicate Roese-Gottlieb (or Mojonnier) tests, which themselves range ± 0.03 (*4, 10*).

Has the Gerber Test been legally recognized by any states? Yes; by New York and New Jersey 30 years ago; by California a few years ago, and (in February 1959) by Pennsylvania.

Has it caused confusion? Quite the reverse! It has not only decreased confusion, it has made technicians much more efficient and fat testing much more accurate!

Is the Gerber Test easy to learn and to perform? If there were a simpler test of equivalent accuracy, this paper would not have been presented today. Try the Gerber yourself, on any kind of milk. Whether homogenized or creamline or a blend — you will get uniformly perfect, easily read, accurate columns rapidly; without acid spillage, repetitive bottle swirling, water additions, nursing a centrifuge, finger sticking, the need for a revelation to disclose the top of the top meniscus, and in spite of all care, globs in the fat columns.

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AN OFFICIAL LOOKS AT SANITATION[1]

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Editorial Note: In the December 1959 issue of the Journal there appeared an article entitled, "What is Wrong with Official Regulation of Food Sanitation," by J. Lloyd Barron, Director of Sanitation, National Biscuit Co., and Past President of the National Association of Bakery Sanitarians. There are two sides to every question. In the article below Mr. A. E. Abrahamson, Chief, Wholesale Division, New York City Health Department, discusses the subject of food sanitation regulation from another point of view.

This topic ordinarily calls for an evaluation of current practices. I am taking the liberty of a broader inquiry. I believe that the official who looks at sanitation should do so not with the view of law enforcement alone. Experience has long ago established that policing a food industry solely on the basis of "do it because you must" yielded unenduring results in too many instances. Recognizing this the laws regulating the sanitation of food processing establishments and other phases of food control permitted administrators of these laws the use of an educational approach. This is revealed for instance, in Section 306 of the Federal Food, Drug and Cosmetic Act which reads, "nothing in this Act shall be construed as requiring the Secretary to report for prosecution, or for the institution of libel or injunction proceedings, minor violations of this Act whenever he believes that the public interest will be adequately served by a suitable written notice or warning." The new Health Code of the City of New York takes a similar view. It provides under Section 3.13 "in lieu of enforcement of this Code by way of prosecution, recovery of civil penalties, revocation of permits, seizures and embargoes and condemnations, and other compulsory means, the Department may seek to obtain the voluntary compliance with this Code by way of notice, warning or other educational means, - - - ."

I am reminded of a telephone call received by an administrator of a food control agency who was asked, "for Pete's sake when is the inspector going to revisit my establishment." This seemed an odd request. Further inquiry disclosed that the restaurant

[1]Presented at the annual meeting of the Institute of Sanitation Management, New York City, September 24, 1959.