

A Zeiss Butter Refractometer

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The history and nature of refractometry, as well as a survey of the various refractometers owned by the Oesper Collections, were reviewed in our museum booklet series (1). Since then, the collections have acquired, thanks to the generosity of Dr. Richard Paselk of Humboldt State University, a specialized industrial refractometer for the characterization of butter and other fats and oils.

The first instrument of this type was proposed by Amagat and Jean in 1889 and was known as an “oleo-refractometer” (2, 3). Three years later the Zeiss optical company produced its own version of this instrument under the simplified name of the “butter refractometer” (figure 1). In the well-known Abbe and Pulfrich refractometers, described in reference 1, the optical tubes are rotated until the dark-light border produced by the critical angle is aligned in the eye piece

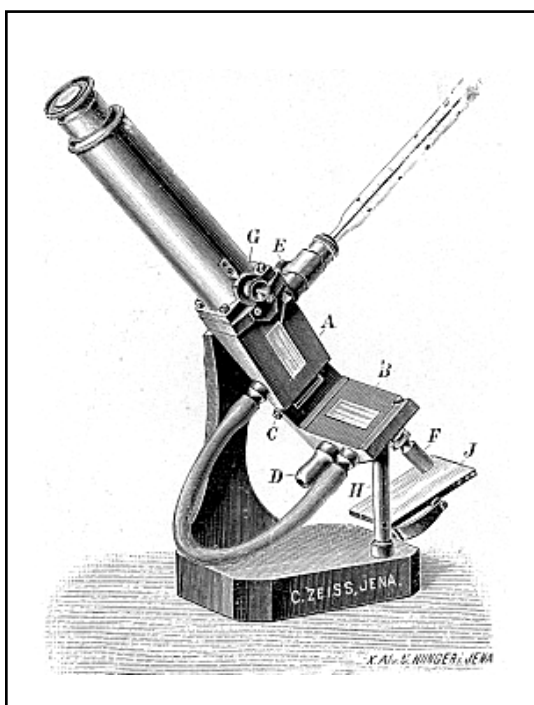


Figure 1. The original 1892 Zeiss butter refractometer shown with the cell compartment open.

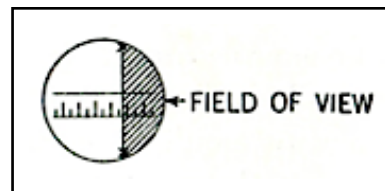


Figure 2. A drawing of the view through the eyepiece showing the superposition of the numerical scale on the dark-light border.

within a set of cross hairs, and the refractive index is then read from an attached, curved, external vernier scale. In contrast, the butter refractometer uses an optical system similar to that of the dipping refractometer in which the dark-light border is projected directly onto a superimposed linear scale and the refractive index determined from an accompanying conversion table (figure 2). If the border does not fall directly on one of the scale marks, a calibrated micrometer screw is used to measure the fractional distance required to displace the border to the nearest scale division. This arrangement is possible because the refractive indices of most commercially important fats and oils fall within a narrow range between 1.42 and 1.49 (4).

The Zeiss model donated by Dr. Paselk dates from around 1920 (figure 3). Like the original model in figure 1, the sample cell can be heated using warm water so as to insure the liquefaction of any solid fats. These instruments were used largely to determine purity and especially to detect the difference between pure butter and various oleomargarine substitutes. Indeed, modern digital refractometers for this purpose are still being sold today (5).

The first version of oleomargarine was patented in 1869 by the French chemist, Hippolyte Mège-Mouriès, in response to a prize offered by Napoleon III for an inexpensive butter substitute to feed the army and the poor. Originally margarine was made from animal fats, which are solid and saturated, but also relatively expensive. However, with the discovery of catalytic hydrogenation by Paul Sabatier in 1897, it became possible to convert inexpensive, unsaturated, liquid vegeta-

ble oils into saturated solid fats and these soon displaced the earlier animal products. The ongoing resistance of the dairy industry to these products, especially in this country, has been recounted in the book by Riepma (5). This sometimes went to ridiculous extremes (figure 4), such as passing laws making it illegal to sell margarine that had been pre-dyed yellow to resemble butter, thus forcing manufacturers to include a small capsule of dye in each tub for the housewife to beat into the product after purchase.

References and Notes

1. W. B. Jensen, *Refractometers*, Oesper Museum Booklet No. 3, University of Cincinnati: Cincinnati, OH, 2014. Available on line at <http://www.che.uc.edu/jensen/W.%20B.%20Jensen/Museum%20Booklets/03.%20Refractometers.pdf>
2. E-H. Amagat, F. Jean, "Sur l'analyse optique des huiles et du beurre," *Compt. rend.*, **1889**, 109, 616-620.
3. C. A. Mitchell, "Fixed Oils, Fats, and Waxes," in S. S. Sadler et al, Eds., *Allen's Commercial Organic Analysis*, Vol. 2, Blakiston's Son & Co: Philadelphia, PA, 1924, pp. 58-62.



Figure 3. The circa 1920 Zeiss butter refractometer recently acquired by the Oesper Collections. It is shown with the cell compartment closed and no rubber tubing attached to the water nipples. The micrometer screw, which is to the left of the optical tube, is not visible in this photo.

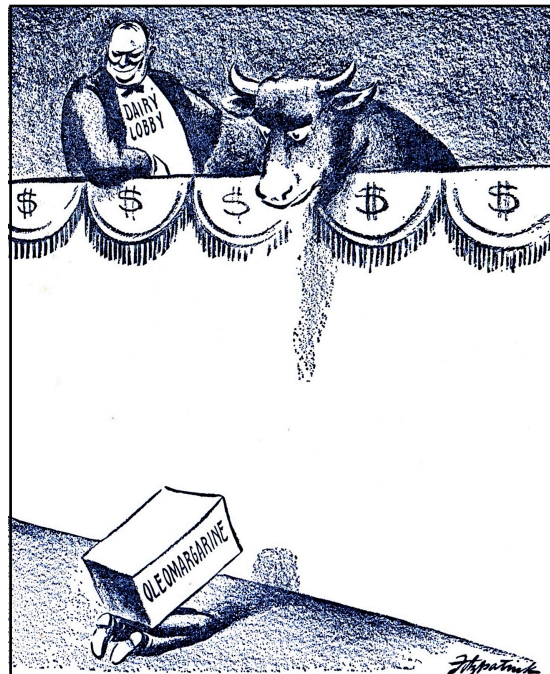


Figure 4. "At the mercy of the sacred cow." A typical period political cartoon commenting on the ongoing attempts of the dairy lobby impose restrictions the manufacture and sale of oleomargarine.

4. For a table of typical values, see A. E. Bailey, *Industrial Oil and Fat Products*, Interscience: New York, NY, 1945, p. 77.
5. www.anton-paar.com/us-en/products/applications/distinguishing-between-butter-and-margarine/
6. S. F. Riepma, *The Story of Margarine*, Public Affairs Press: Washington, DC, 1970.