Physicochemical Properties of Fractionated Beef Tallows[1]

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The relationships among composition, melting point, titer and solid fat index of beef tallow and its respective liquid and solid fractions obtained by industrial dry fractional crystallization are determined. The relationships between composition and titer do not permit one to distinguish beef tallow from the fractionated ones of the same melting range. On the other hand, the relationships between melting point and titer are different: the oleomargarines have melting points lower than their corresponding titers, and those of the beef tallow and oleostearins are higher. The fractionated fats have different contents of oleic and stearic acids compared with the unfractionated ones, but their percentage of palmitic acid does not vary remarkably. The dilatometric curves are displaced in a parallel relationship without important changes in their shape.

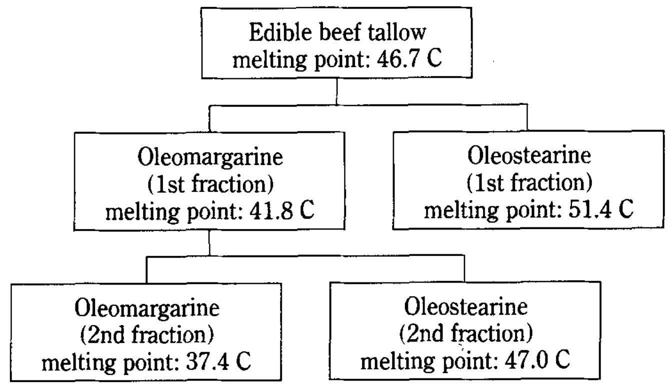
Beef tallow has a poor plastic range and is extremely hard at room temperature, making it difficult to use in certain foods. It contains 18% saturated triglycerides that do not melt in the mouth, producing an unpleasant sensation. Thus, the object of the fractionation process is to achieve a modification in the texture and thermal behavior of such tallow.

A comparison of our previous results (1) with those described in the literature shows that Uruguayan tallow contains a higher percentage of stearic acid (25.2-33.6%) and a lower percentage of palmitic (20.2-27.3%) and oleic (43.2-47.8%) acids. The titer (43.2-47.8 C) and the melting point (45.0-48.8 C) tend to be higher than the average. This makes it necessary to obtain soft phases by fractional crystallization for certain food uses.

Two methods for the fractional crystallization of fats are currently practiced on a commercial scale: crystallization from the melt (dry fractionation) or from solvent (solvent fractionation), with detergent fractionation falling into the first category because the crystallization stage of the process is carried out from the melt. There are many publications about the dry fractionation of palm oil, but only a few about beef tallow. Much of the published data are fragmentary and sometimes repetitive, in general emphasizing the methodology and equipment used and not the properties of the resulting fractionated products (2-7). The present work summarizes some of the physicochemical properties of fractionated beef fats with the object of a better understanding of their behavior and potential end-use applications.

EXPERIMENTAL PROCEDURES

The edible fats studied were obtained by the industrial dry fractionation process. A wide variety of products can be obtained, ranging from oleostearin of melting point 53 C down to oleomargarine of melting point 35 C. The general scheme used was as follows (the melting points are examples):



Typical operating conditions were: First fractionation, crystallizer temperature, 42 C; time to reach 42 C, six hr; crystallizer holding time at 42 C, one hr. Second fractionation, crystallizer temperature, 37 C; time to reach 37 C, six hr; crystallizer holding time at 37 C, one hr.

Samples of different beef tallows, different oleomargarines obtained by single and double dry fractionation and different oleostearines produced by one-step dry fractionation were studied.

Fatty acid methyl esters were prepared and analyzed by GLC (8). A Shimadzu Model GC-6 AMPrF gas chromatograph equipped with 10% SP-2330 columns on 100/120 Supelcoport, 10′ × 1/8″ stainless steel, obtained from Supelco Inc., Bellefonte, Pennsylvania, was used for all gas chromatographic analyses. Titers were determined by AOCS method Cc 12-59, open-tube melting point by AOCS method Cc 3-25 and solid fat index by AOCS method Cd 10-57 (8).

RESULTS

Table 1 shows titer values, melting points and percentages if the three most important fatty acids for each of the samples analyzed. In Figure 1 titer vs the stearic/oleic ratio is plotted, for the samples of Table 1. These values fall within a well limited zone of variation and are not random. This zone (limited by means of two full line curves) is in excellent agreement with that reported in the literature (9), which was exclusive for nonfractionated beef tallows.

In Figure 2 melting points are plotted vs titer. Two zones can be distinguished, an upper one in which the melting point is numerically higher than the respective titer and includes the oleostearines and the beef tallows (nonfractionated), and a lower one where the relationship is reversed and includes only the oleomargarines (first and second fractions).

In Figure 3 for each type of beef tallow product studied, mean melting point vs mean percentage of palmitic, stearic and oleic acids is plotted. Palmitic acid shows little variation with fractional crystallization but oleic and stearic acids do

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vary; for example, oleomargarines have more oleic acid and less stearic acid.

In considering their use in foods, knowing the solid content over a range of temperatures is particularly useful. In Figure 4 solid fat index (average from each type of beef tallow product studied) vs temperature is plotted: When fats are fractionated the curves are moved parallel to themselves, without any important change in the shape.

DISCUSSION

According to the literature (9), beef tallows have a linear relationship between the percentage of the most important fatty acids and their titer, contrary to the assumption when

TABLE 1

Fatty Acid Composition and Physical Properties of Different Oleomargarines[a], Nonfractionated Beef Tallows and Oleostearines[b]

	Palmitic %	Stearic %	Oleic %	Titer (C)	Melting point (C)
Oleomargarines	23.9	17.2	43.2	40.0	37.6
(2nd fraction)	25.6	14.8	44.6	39.6	38.0
	24.2	21.5	42.0	41.9	38.8
	24.2	12.3	45.7	37.9	35.8
	25.2	11.9	47.5	37.6	36.0
	23.1	19.1	46.4	41.6	36.0
	23.3	19.7	45.4	41.4	36.8
	25.5	22.7	40.9	41.8	37.4
	21.8	20.6	46.2	41.8	38.6
	23.1	19.4	45.6	41.8	36.8
	23.7	19.2	45.8	41.9	38.0
	25.8	19.9	46.7	42.0	38.0
	20.8	22.3	43.4	43.0	37.0
	20.9	22.0	46.8	42.2	35.0
mean values	23.7	18.8	45.0	41.0	37.1
Oleomargarines	25.2	22.8	39.0	42.7	42.8
(1st fraction)	28.3	17.7	39.8	41.9	41.0
	22.8	20.1	47.6	42.1	42.6
	27.0	15.5	45.6	40.1	41.6
	24.8	21.1	43.8	42.7	41.8
	23.9	20.5	43.6	42.4	42.8
	23.0	20.0	44.0	42.0	42.6
	22.8	20.4	44.9	42.2	42.0
	24.2	24.3	40.0	42.7	40.6
	24.3	25.9	39.6	43.7	40.4
	26.8	25.0	37.9	43.8	41.9
	24.2	22.3	40.4	41.8	40.9
mean values	24.8	21.3	42.2	42.3	41.8
Nonfractionated	24.4	22.2	42.2	43.4	45.0
Beef Tallows	23.8	21.3	39.7	43.3	46.6
	27.5	25.8	35.6	44.4	46.2
	26.8	29.4	33.1	45.9	48.0
	27.7	23.3	38.1	43.2	45.7
	25.4	24.8	38.9	44.7	46.4
	24.4	23.6	39.6	44.1	46.8
	24.1	22.8	39.8	43.8	46.8
mean values	25.5	24.2	38.4	44.1	46.4
Oleostearines	27.6	29.4	32.6	45.4	49.2
(1st fraction)	27.7	31.4	31.5	46.8	50.4
	29.1	34.4	27.5	48.8	52.6
	27.8	37.3	26.3	49.0	52.7
	27.5	35.8	26.1	48.8	52.2
	25.8	29.8	33.2	45.5	50.0
	25.0	30.4	34.5	47.8	52.6
	24.3	29.5	34.5	47.6	51.3
mean values	26.9	32.3	30.8	47.5	51.4

[a]Obtained by single and double dry fractionation.
[b]Produced by one-step dry fractionation.

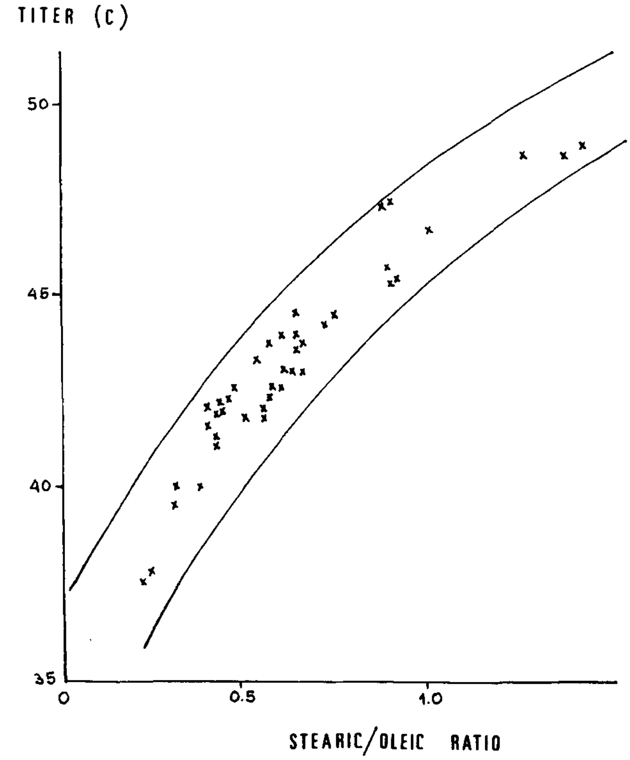

FIG. 1. Effect of stearic/oleic ratio on the titer of different beef tallow products obtained by dry fractionation.

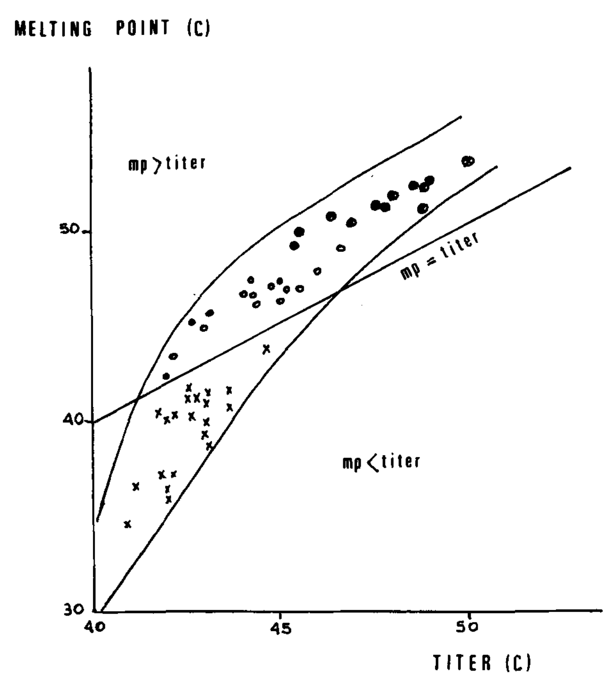

FIG. 2. Relationship between melting point and titer of beef tallow products. Two zones can be distinguished. The upper zone (in which mp > titer) includes oleostearines and beef tallows. The lower zone (in which mp < titer) includes only oleomargarines (1st and 2nd fractions). Oleomargarine, ×; oleostearine, ⊗; beef tallow, ○.

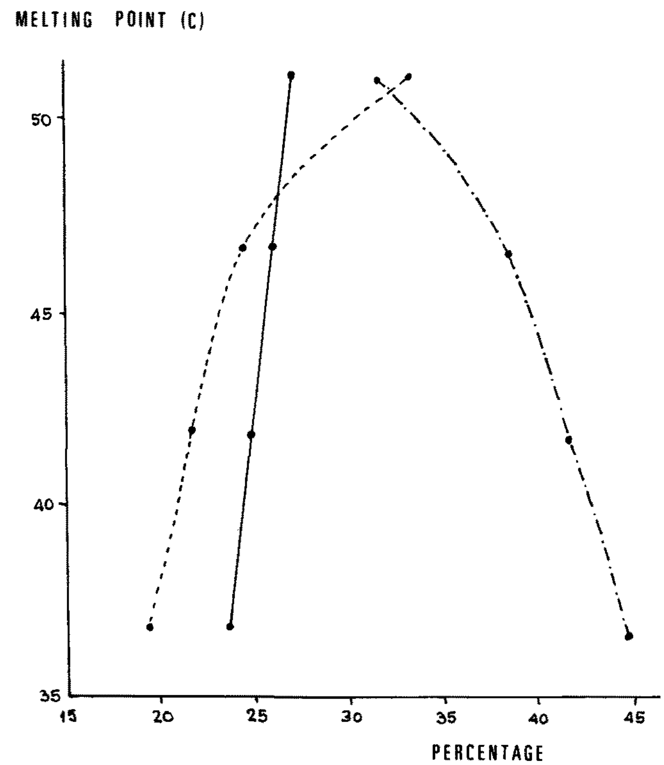

FIG. 3. Relationship between mean melting point and mean fatty acid composition of oleomargarines (1st and 2nd fractions), beef tallow and oleostearine (1st fraction). Palmitic, •————•; stearic, •— — — —•; oleic, •— • — • —•.

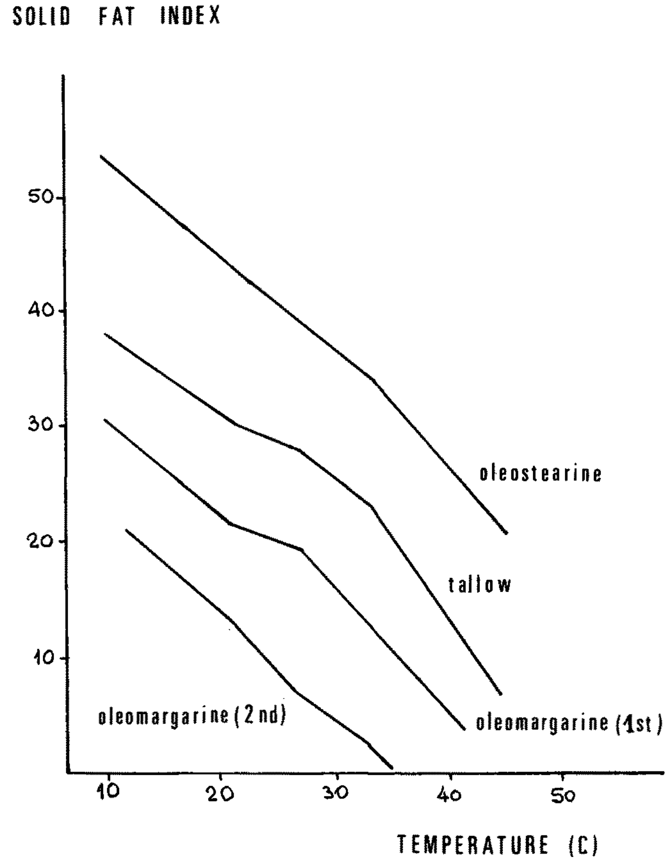

FIG. 4. Solid fat indices of each type of beef tallow product studied.

mutual solubilities and partial miscibilities in the solid state are taken into account. In the present paper, straight line equations (from Table 1 data) are also determined by means of the least squares approximation:

$$\text{Palmitic (\%)} = 0.34\ (\text{titer}) + 10.2$$

$$\text{Stearic (\%)} = 2.09\ (\text{titer}) - 67.2$$

$$\text{Oleic (\%)} = -\ 1.95\ (\text{titer}) + 124.6$$

The straight line equations for the stearic and oleic acids agree with data previously obtained (9) for unfractionated beef tallows. For palmitic acid the differences among those are not so important; both slopes are small so that little variations in distribution of points change them.

The following can be concluded: The relationship between the composition and the titers is not a good criteria to use to distinguish between oleomargarines, oleostearines and nonfractionated tallows, but the relationship between melting point and composition (or titer which depends on composition) is good. Such differences are also observed in dilatometric curves.

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