Technical News Feature

Manufactured Hard Butters[1]

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ABSTRACT

The physical characteristics of various commercial hard butters are compared by determining their solid contents (dilatometrically) and melting thermograms (DSC). For most applications in the confectionery industry, hard butters manufactured by the hydrogenation and interesterification of fats and oils offer economic advantages over those obtained by the fractionation of fats.

INTRODUCTION

Hard butters suitable for a variety of confectionery formulations can easily be made from vegetable and animal fats by hydrogenation and interesterification. For certain applications, products with narrow melting characteristics are made by fractionation. In this paper, a discussion of the hard butters obtained from the vegetable fats and oils is presented.

The various types of hard butters, their estimated share of the U.S. market, and the 1977 selling prices are given in Table I. About 60% of the total hard butters produced in 1977 were obtained by the hydrogenation and interesterification of lauric type oils; another 10% were obtained by the hydrogenation of domestic oils. The remaining 30% were manufactured either by fractionation or pressing of nautral or hydrogenated fats. This production pattern was due to the high cost involved in the fractioantion of fats.

MANUFACTURE

The general practice of manufacturing hard butters consists of partial saturation of the vegetable oils and fats by hydrogenation and rearrangement of the fatty acids on and/or between different triglycerides by transesterification. The use of these processes for hard butters production is widely illustrated in the patent literature.

To produce a confectionery fat from domestic oils, it is desirable to hydrogenate at conditions which favor high selectivity and trans-isomers formation, and thus limit the formation of high melting triglycerides. The reason for choosing these conditions is to have triglycerides of various desired melting ranges in a hydrogenated fat or oil. Optimally, a confectionery fat should have a solid contents close to zero at body temperature. Thus, the hydrogenation process should not produce tristearates (SSS) and distearate-elaidate (SSE). The desired triglycerides in the partially hydrogenated oils and fats are trielaidates (EEE), monostearates dielaidates (SEE), and monoleate distearate (OSS) which melt between ambient and body temperature.

In hard butters manufacture, interesterification of a single fat or a mixture of fats has great importance. The rearrangement of fatty acids brought about by interesterification either from one position to another in a single triglyceride, or from one glyceride to another in fats and oils, causes distinct changes in their physical properties. For example, palm kernel oil (mp 30 C), when partially hydrogenated results in a fat containing a sizable fraction which does not melt at body temperature. As a result, it has a waxy taste. If this fat is interesterified, its high melting fractions disappear without significantly reducing the SCI at room temperature. By blending palm kernel oil, with both partially hydrogenated and partially hydrogenated and interesterified palm kernel oil in various proportions, a hard butter of any desired melting point between 35 C and 46 C can be produced.

To provide structural strength in hard butters, the lower melting fractions are removed either by pressing the fat to

[1]Condensed from the paper presented at the AOCS Meeting, May 1977 in New York.

TABLE I

Hard Butter Classes and Markets (U.S.)

Classes	1977 Selling Price $/lb	1977 Selling % of market
I. Lauric type (PKO, CNO)		
A. Interesterified	.35-.45	60
B. Solvent fractionated	.70-.75	5
C. Nonsolvent fractionated	.70-.75	5
II. Nonlauric (soya, CSO, palm)		
A. Hydrogenated (nonfractionated)	.35-.40	10
B. Solvent fractionated	.60-.70	10

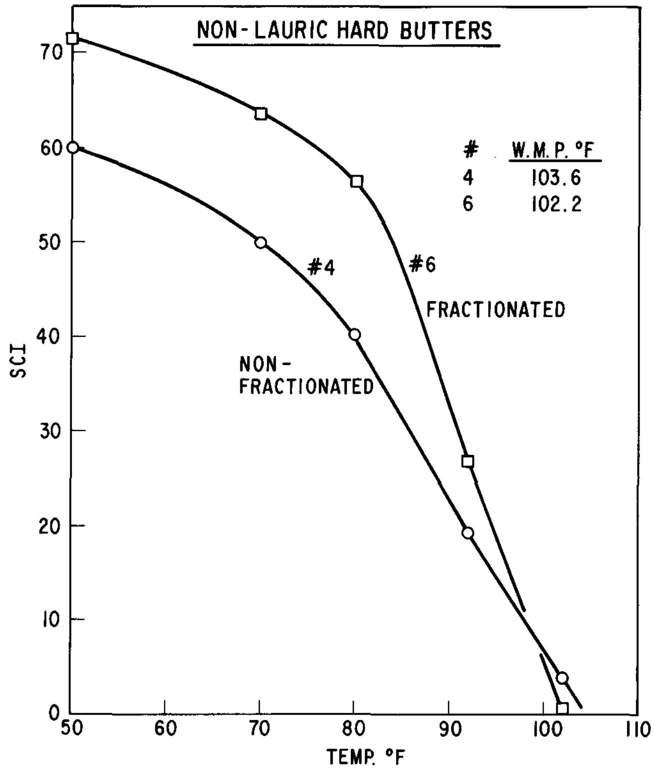

FIG. 1. Solid contents of typical nonlauric hard butters.

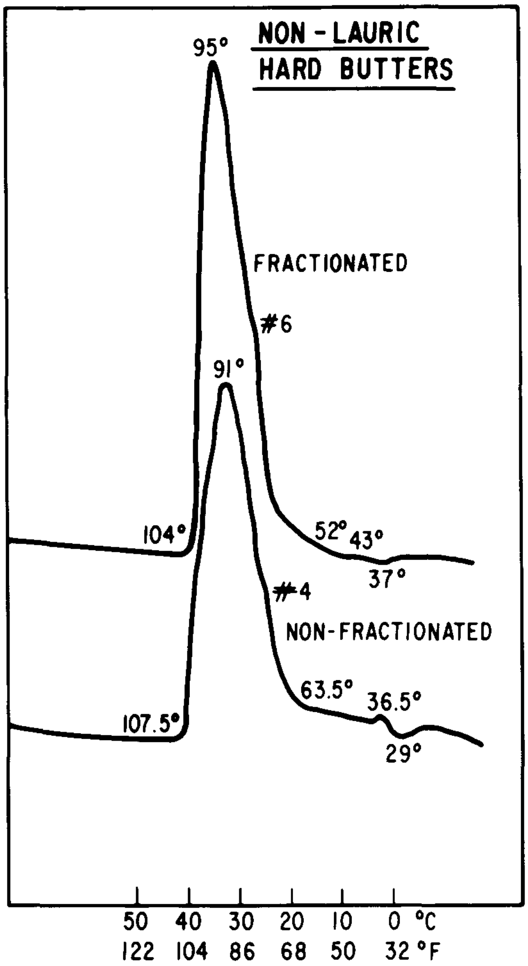

FIG. 2. DSC thermograms of typical nonlauric hard butters.

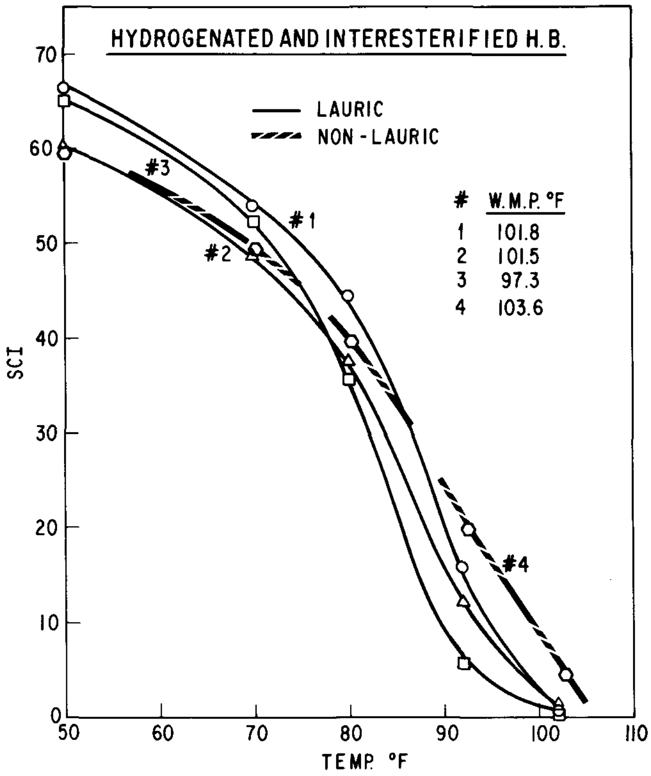

FIG. 3. Solid contents of typical hydrogenated and interesterified hard butters.

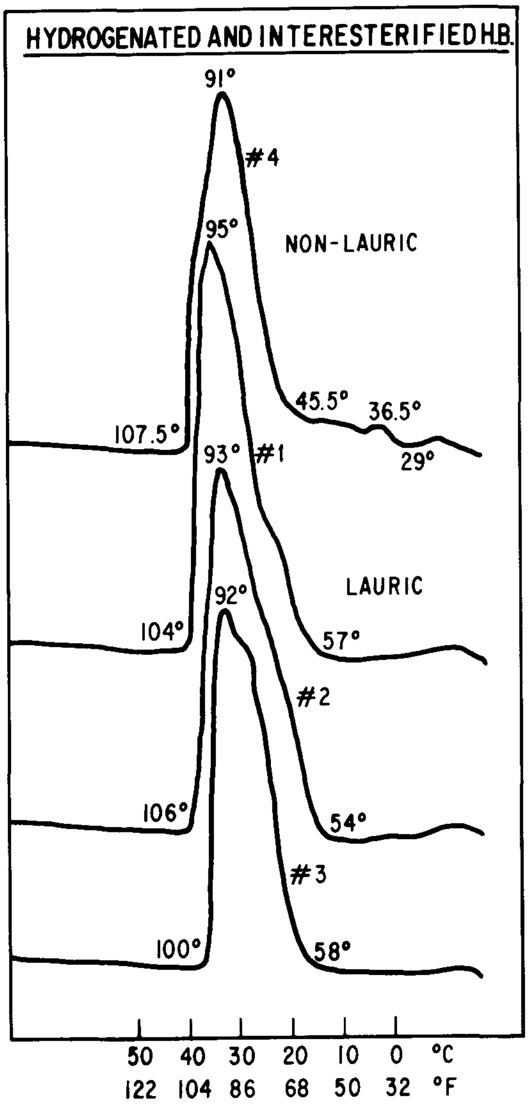

FIG. 4. DSC thermograms of typical hydrogenated and interesterified hard butters.

squeeze out the liquid oil or by dry fractionation. Hard butters with narrow melting ranges are made by eliminating both liquid fractions and high melting solid fractions. This is done either by dry or by solvent fractionation of the hard butters.

COMPARISON

The physical characteristics of various commercial hard butters are compared by determining their solid contents and melting thermograms. The dilatometric technique is used to determine SCI at different temperatures; the dilating fluid used is mercury. DSC thermograms are measured on 5-7 mg fat samples with a Perkin-Elmer DSC-2 instrument. The instrument is calibrated against standards of pure indium and diphenylamine. The verification of the calibration is done using pure methyl stearate. The normal method of determination is to heat the sample to 80 C and to hold it at this temperature for 10 min. The sample is then cooled at 10 C/min to a temperature of -20 C where it is kept for 10 min. The melting thermogram is obtained by heating this sample at 10 C/min.

Nonlauric, Hydrogenated Hard Butters

These are the least expensive and least sophisticated of the available domestic hard butters. They are made by selectively hydrogenating soya and/or other oils. These fats

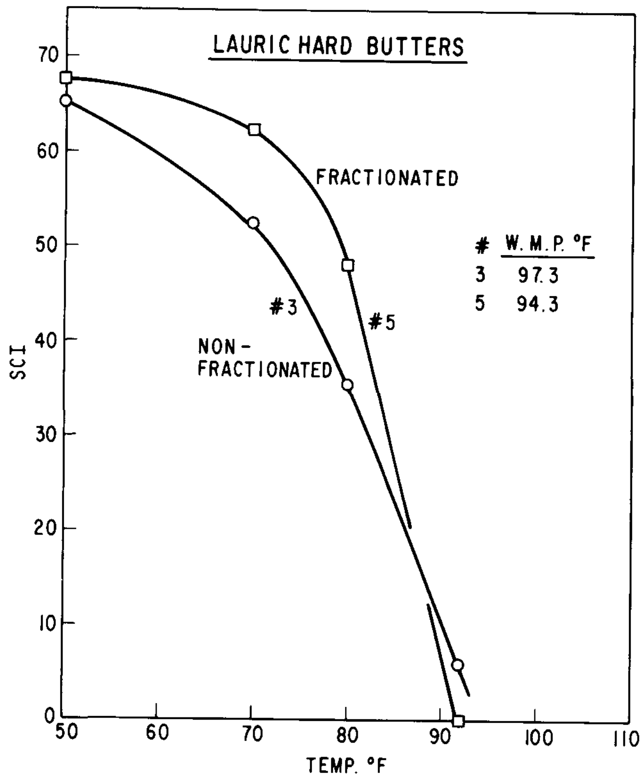

FIG. 5. Solid contents of typical lauric hard butters.

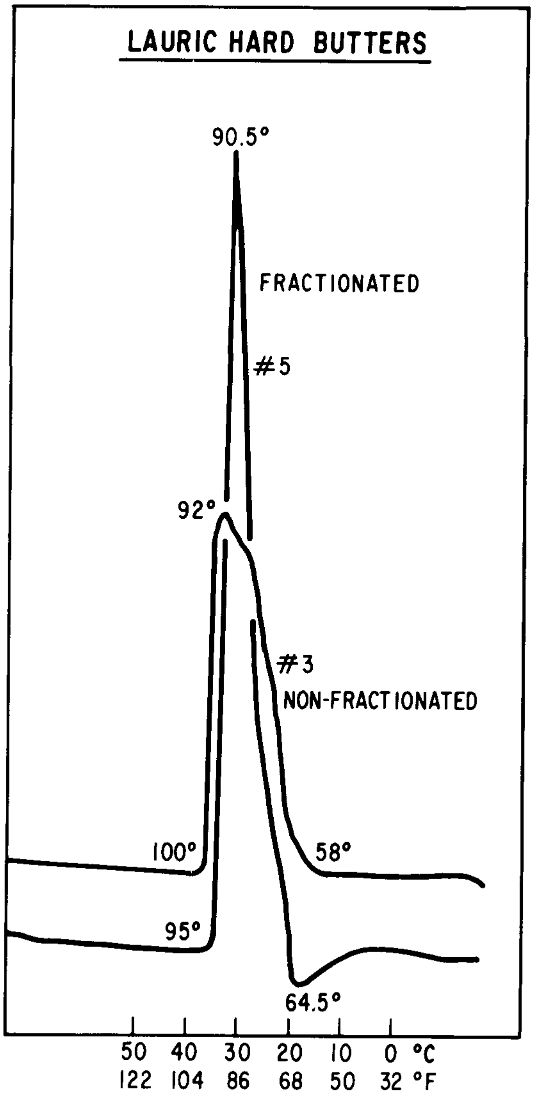

FIG. 6. DSC thermograms of typical lauric hard butters.

when used for confectionery coatings will produce a reasonably firm, nonbrittle, and relatively slow melting coating. The coating is less expensive and requires no tempering. These fats are used in bakery applications where properties of relatively plastic and slow melting coatings are acceptable. The SCI curve of a typical selectively hydrogenated domestic hard butter is shown in Figure 1. For comparison purposes, a corresponding fractionated nonlauric product is shown which offers high solids at low temperatures and has a relatively steep slope on the SCI curve. The melting thermograms of the two hard butters obtained by differential scanning calorimetry are shown in Figure 2. For the nonfractionated hard butter, the melting starts at a much lower temperature which causes a structural weakness in the resulting confectionary product. Also, the nonfractioanted product has a higher solids content at 38 C than the fractionated product which results in a waxy aftertaste.

Though fractionated hard butters are functionally superior to the nonfractionated, their usage in the confectionery industry is limited, due primarily to the relatively high costs involved in fractionation. They are thus limited to use as cocoa butter extenders or replacers. Nonfractionated hard butters, on the other hand, are used in almost any kind of confectionery application where their properties are acceptable.

Lauric Hard Butters, Hydrogenated and Interesterified

The hard butters produced by hydrogenation and interesterification of palm kernel oil meet the majority of the economic and functional requirements of confectionery coatings for bakery products and bar coveratures. The coatings made with these hard butters provide a firm, but not very brittle, texture at ambient temperature, good melting properties, and low cost. However, these coatings do require tempering. The solid contents of a few commercial palm kernel hard butters are shown in Figure 3. For comparison purposes, a typical nonlauric hard butter as discussed in the previous section is also shown. It is evident that the palm kernel hard butters have relatively high solids at low temperatures and have more rapid melting characteristics when compared with nonlauric hard butters. The DSC thermograms of these hard butters are shown in Figure 4. The melting behavior of all the palm kernel hard butters is almost identical; the differences in the thermograms are due to the different formulations consisting of the varied amounts of the unhydrogenated, hydrogenated and hydrogenated, and interesterified palm kernel oil in them. It should be pointed out that these hard butters do not start melting at low temperatures as can be seen in the case of a nonlauric, nonfractionated hard butter (Fig. 4, top plot).

In Figure 5 a fractionated and a nonfractionated lauric hard butter are compared. Their melting thermograms are shown in Figure 6. The fractionated lauric hard butter gives a sharp melting point as compared to the nonfractioanted hard butter. It thus provides a reasonably brittle and rapid melting fat and is suitable for the specific needs of the confectionery industry. A nonfractionated palm kernel hard butter, on the other hand, meets the needs of the confectionery industry at competitive prices.

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