SHORT COMMUNICATION

# Cocoa Butter Extenders from Kokum (*Garcinia indica*) and Phulwara (*Madhuca butyracea*) Butter

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**Cocoa butter extenders, suitable for use in chocolate and confectionery, were prepared from Kokum fat and a Phulwara butter fraction. The latter fraction was prepared from Phulwara butter by two-stage dry fractionation and blended with Kokum fat in selected proportions to obtain a series of hard butters with different melting profiles. The blends with higher proportions of Kokum fat were harder and hence may find application in warm climates. The blends had solidification properties, fatty acid and triacylglycerol compositions similar to those of cocoa butter. In addition, they had narrow melting ranges like cocoa butter, and they were compatible with cocoa butter and have tolerance toward milk fat.**

KEY WORDS: Cocoa butter extender, confectionery fat, Kokum fat, Phulwara butter fractionation.

Cocoa butter is an ideal fat that contributes to the desirable textural and sensory properties of chocolate and confectionery products but is inadequate for use in hot climates. The difficulties encountered by the chocolate manufacturers in countries with a hot climate or in countries with a moderate climate during summer are well known. Hence, fats with high-temperature resistance are required for use in such climatic regions. It has been reported that the incorporation of small amounts of SOS (S = stearic acid; O = oleic acid) triacylglycerols (TG) or SOS-rich fats into cocoa butter or chocolate increases the hardness, upgrades cocoa butter of inferior quality, inhibits fat bloom and decreases slightly the tempering time (1–3). Hence, stearic acid-rich fats are suitable for the preparation of high-temperature-resistant hard butters. There are a variety of stearic acid-rich fats in India, such as sal (*Shorea robusta*), dhupa (*Vateria indica*), Kokum (*Garcinia indica*) and mango (*Mangifera indica*), which have good potential for the preparation of hard butters. The preparation of cocoa butter substitutes of suitable heat resistance from sal fat has been reported earlier (4). In the present paper, another stearic acid-rich fat, Kokum, was chosen for the purpose.

Kokum (*G. indica*, fam: Guttiferae) is a small, slender evergreen tree found in several parts of India (5). The fruits are spherical (2.5–5.0 cm dia.) and dark purple in color (6), and the edible pulp is sour. The fruits consist of 3–8 large black ovoid seeds, and the kidney-shaped kernels contain about 40% hard and brittle fat with a m.p. of 42°C. The major fatty acids present are stearic (50–60%) and oleic (36–40%), and the major triacylglycerols are 2-oleodistearin (SOS), present to the extent of about 70% (7,8). Because of this composition, the fat is hard and solidifies with a rough surface (5); hence, it requires modification for use in chocolate and confectionery. In the present paper, the properties of this fat are shown to be suitably modified by incorporating a fraction of palmitic acid-rich Phulwara (*Madhuca butyracea*) butter.

## MATERIALS AND METHODS

Kokum seeds were collected locally, and the fat from the kernels was extracted with hexane and refined with alkali. Phulwara kernels were procured from Khadi and Village Industries Commission (Pithoragarh, India). The fat was extracted from the kernels with a Handler Baby Expeller (Mysore, India) washed with hot water and refined with alkali. The fat did not require bleaching as it is white in color.

*Dry fractionation.* Phulwara butter was heated to 50°C, cooled gradually to 30°C and held at this temperature for 4 h, and the partially crystallized mass was filtered to remove the stearin fraction (yield 20% by weight of fat). The olein thus obtained was further cooled to 20°C and was held at this temperature for 3 h and filtered to obtain middle fraction (St. 2, yield 60% by weight of olein). St. 2 was blended with Kokum fat at various proportions (60, 65, 70 and 75% levels and termed as BL. 1, 2, 3 and 4, respectively).

*Fatty acid composition.* Fatty acid compositions of the samples were determined by analyzing the fatty acid methyl esters (FAME) by gas chromatography. For the preparation of FAME, the samples were saponified with 1N alcoholic KOH on a boiling water bath for 3 h. The samples were cooled and, after removing the unsaponifiable matter by extracting with diethyl ether, neutralized with 1N HCl. The liberated fatty acids were extracted with diethyl ether and were converted into methyl esters with diazomethane (9). The FAME were analyzed on a Shimadzu gas chromatograph, GC-9A, equipped with flame-ionization detector (Shimadzu, Kyoto, Japan), operating under the following conditions: S.S. column (2.4 m × 0.3 cm) packed with 15% diethylene glycol succinate supported on Chromosorb W (60–80 mesh); column temperature, 180°C; carrier gas ($N_2$) at 15 mL/min; and hydrogen at 20 mL/min. The peaks were identified by comparing the retention times with those of authentic standards, and the results were expressed as relative percentages of the components in the sample.

*Analysis of TG.* The TG of normal-chain fatty acids of the samples were purified by silica gel column chromatography by following the procedure described in AOAC (10). The purified TG were analyzed by argentation thin-layer chromatography on 20 × 20 cm glass plates coated with 250 μ thick silica gel G, that contained 15% silver nitrate. The plates were activated at 130°C for 2 h. The samples dissolved in chloroform were applied, and the plates were developed with a mixture of benzene/chloroform (55:45, vol/vol). The chromatograms were air-dried and sprayed with 0.01% 2′,7′-dichlorofluorescein in methanol/water (90:10, vol/vol). The fluorescent spots were then scanned with a Camag T scanner equipped with a

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Fluorometer, model III and a Camag WW recorder (Camag, Muttenz, Switzerland) under the following conditions: Lamp, 110–851; primary filter, 110–810; secondary filter, 2A; and range selector at 3. The relative percentages of individual spots were calculated from the peak areas. For determining fatty acid composition of TG, individual spots from the chromatograms were eluted with diethyl ether. The FAME were prepared from the eluted samples and were analyzed by gas chromatography as described above.

*Cooling curve.* The cooling curves of the samples were obtained in a Shukoff's flask, according to the procedure described by Wilton and Wode (11).

*Dilatometry.* Dilatation studies were carried out according to the British Standard procedure, Method 2 (12), and the solid fat content was calculated from the dilatation values.

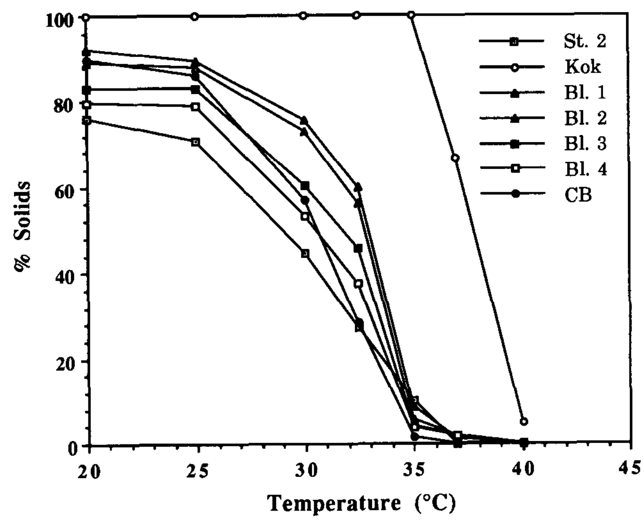


**FIG. 2. Melting profiles of blends of Phulwara butter middle fraction and Kokum fat: St. 2: Phulwara butter middle fraction; Kok.: Kokum fat; BL. 1: St. 2 + Kokum fat (60:40); BL. 2: St. 2 + Kokum fat (65:35); BL. 3: St. 2 + Kokum fat (70:30); BL. 4: St. 2 + Kokum fat (75:25); CB: cocoa butter.**

## RESULTS AND DISCUSSION

Both middle fraction (St. 2) of Phulwara butter and Kokum fat showed entirely different solidification properties and melting profiles when compared to those of cocoa butter (Figs. 1 and 2). They showed reduced supercooling and quick crystallization (Fig. 1), and Kokum fat showed high solids content at all temperatures (Fig. 2). These properties affect the quality and the manufacturing processes of chocolate products. The properties of Kokum fat are mainly due to a high proportion of SOS-TG. However, the properties of this fat are entirely altered by incorporating POP-rich (P = palmitic acid) Phulwara butter fraction (Figs. 1 and 2). Figures 1 and 2 show that the solidification properties and melting profiles of Kokum fat were improved considerably by incorporating Phulwara butter fraction. POP and SOS-TG are not fully compatible (13), and this property has been utilized to improve the properties of Kokum fat and to prepare value-added high-priced confectionery fat. Though the two individual fat/fat fractions are not fully compatible (Fig. 3), the blends of these two are compatible with cocoa butter (Fig. 4). The cooling curves of the blend (BL.1) and its mixture with cocoa butter at the 50% level are the same and superimposable on that of cocoa butter (Fig. 1). The blends with a series

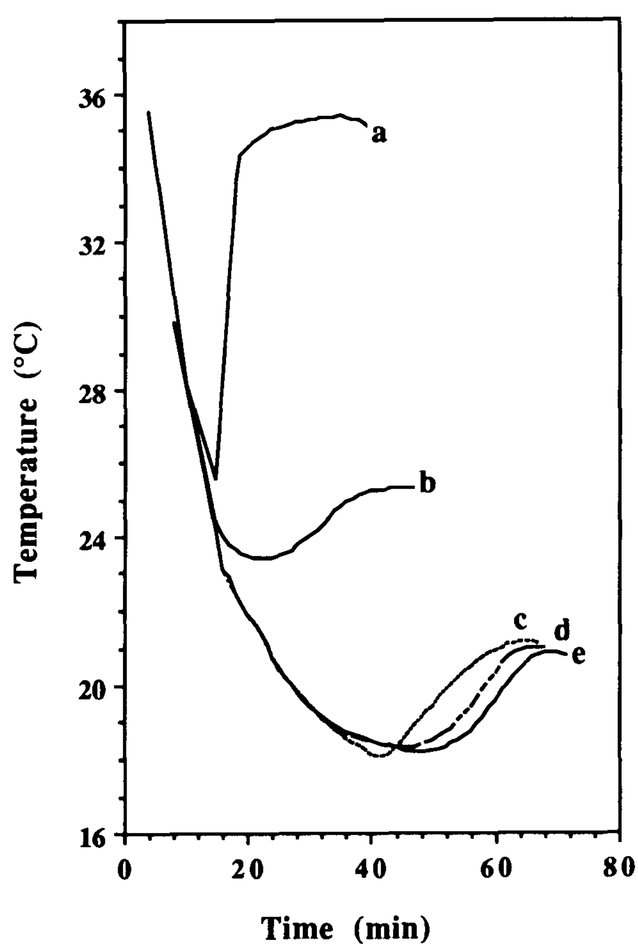


**FIG. 1. Shukoff's cooling curves of (a) Kokum fat; (b) St. 2 of Phulwara butter; (c) BL.1 (St. 2 + Kokum fat (60:40); (d) BL. 1 + cocoa butter (50:50) and (e) cocoa butter.**

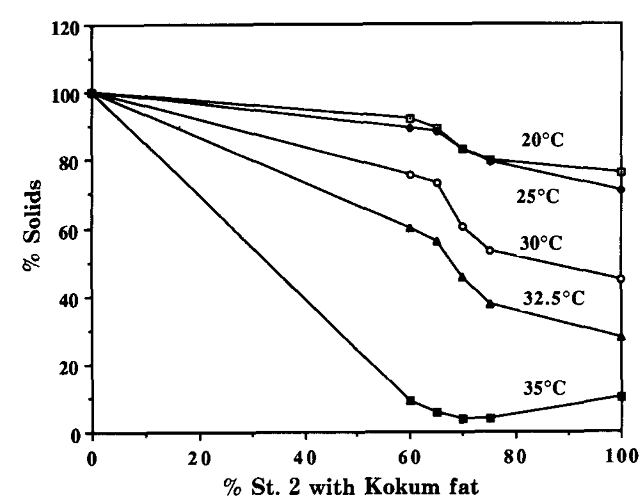


**FIG. 3. Isothermal solid diagrams of blends of Phulwara butter middle fraction (St. 2) and Kokum fat.**

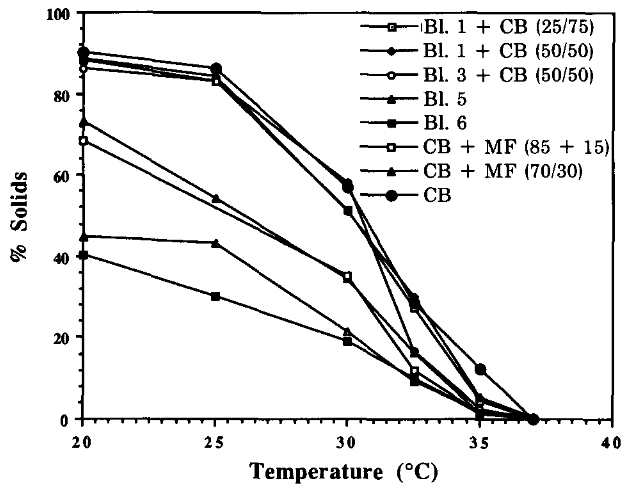


**FIG. 4. Melting profiles showing compatibility of the blends (BL) with cocoa butter and tolerance toward milk fat: BL. 5: BL. 1 + CB + milk fat (21.25:63.75:15.0); BL. 6: BL. 1 + CB + milk fat (17.5:52.5:30.0); BL. 1 and BL. 3 described in Figure 2; CB: cocoa butter; MF: milk fat.**

**TABLE 1**

**Fatty Acids and Triacylglycerol Compositions of Hard Butter from Kokum Fat and Phulwara Butter**

| | St. 2[a] | BL. 1 | CB | Kokum fat (7,8) |
|---|---|---|---|---|
| Fatty acid (%) | | | | |
| Palmitic | 66.3 | 34.4 | 31.0 | 2.5–5.3 |
| Stearic | 3.9 | 35.3 | 34.0 | 52–56 |
| Oleic | 27.7 | 30.0 | 35.0 | 39–41 |
| Linoleic | 0.6 | 0.2 | — | 1.7 |
| Triacylglycerols (%) | | | | |
| Trisaturated ($GS_3$) | 2.5 | 2.0 | — | 1.5 |
| Monounsaturated disaturated ($GS_2U$) | 85.0 | 89.0 | 90.0 | 80.0 |
| Diunsaturated monosaturated ($GSU_2$) | 12.0 | 7.8 | 10.0 | 18.0 |

[a]St. 2 = Phulwara butter middle fraction; BL.1 = blend of 60% St. 2 with 40% Kokum fat; CB = cocoa butter.

of melting profiles have been prepared by suitably altering the proportions of the two fats (Fig. 2). Figure 2 shows that the blends with higher levels of Kokum fat are harder than cocoa butter and had short melting ranges. The blends have higher solids contents at 32.5°C than those of cocoa butter and, hence, are resistant to higher temperatures and find applications in hot climates. The blends have slightly better tolerance toward milk fat compared to that of cocoa butter (Fig. 4). BL.1 has fatty acid and TG compositions similar to those of cocoa butter (Table 1). This blend is similar to Coberine prepared from palm, shea and illipe butter fractions (14). Hence, these results reveal that blends containing Kokum fat and Phulwara butter middle fraction are suitable for use in chocolate and confectionery and have advantages for use in hot climatic regions.

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