Effect of Oleo-Disaturated Triacylglycerol Content on Properties of Palm Mid Fraction, Sal Stearin and Borneo Tallow Blends

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Binary blends of palm mid fraction (PMF) with Borneo tallow (IP) and PMF with sal stearin (SLs) showed eutectic behavior. To produce a cocoa butter extender with steep melting profiles and containing not less than 70% solid fat at 20°C, the maximum amount of PMF1 (IV=49.2) and PMF2 (IV=39.8) that could be added to IP in PMF:IP binary systems were about 10% and 33%; whereas the amount of PMF2 that could be added to SLs1 (IV=33.4), SLs2 (IV=31.7) and SLs3 (IV=30.3) in PMF2:SLs binary systems were about 7%, 10% and 38%, respectively. Blends of any PMF with an iodine value of 37 or lower with IP could fulfill the above specifications at any blend ratio.

KEY WORDS: Cocoa butter extender, interaction between fats.

Palm mid fraction, sal stearin *(Shorea robusta)* and Borneo tallow *(S. stenoptera),* fats which contain high amounts of oleo-disaturated triacylglycerols, commonly are used in the production of cocoa butter extenders (CBE). Unlike Borneo tallow (IP) which is an intact fat, the physical chemical characteristics of commercial palm mid fraction (PMF) and sal stearin (SLs) are determined to a large extent by the fractionation process used in their preparation. Furthermore, it is well known that when fats are blended, the physical properties of the blends cannot be predicted in advance from a simple relationship, such as triacylglycerol or fatty acid composition. Therefore, in CBE formulation, it is important to understand how the properties and quantity of each fat used in a blend would affect the properties of the CBE produced. This paper reports a study of solid fat content of PMF:SLs and PMF:IP binary systems using PMF and SLs that differ in respect to their iodine value and oleo-disaturated triacylglycerol content.

MATERIALS AND METHODS

Preparation of component fats. A commercial sample of solvent fractionated palm mid fraction (PMF2) was purchased from Felda Oil Product (Pasir Gudang, Malaysia). The PMF was then refractionated in the laboratory using acetone (solvent to oil ratio of 4:1) to produce a more saturated fraction, abbreviated as PMF3 (Fig. 1). The liquid portion obtained from the fractionation process was then reblended in such a way with PMF2 to produce a softer fat (PMF1) with a liquid portion twice that of PMF2. In a similar procedure, a commercial refined sal fat sample was fractionated by using acetone at the same solvent to oil ratio as above to produce a hard fraction called SL3. The less saturated fraction (SLO) was then refractionated to produce a mid fraction called SLs1. Parts of the SLs1 and SLs3 were then reblended to produce SLs2. Refined Borneo tallow (IP) (P.T. Cahaya, Kalbar, Indonesia) was used in the CBE formulation without any pre-modification procedure.

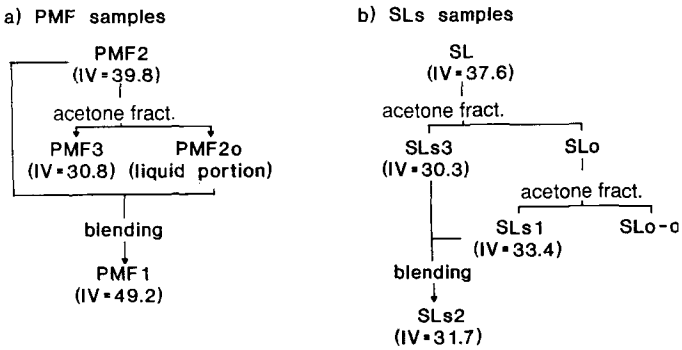

FIG. 1. Preparation of component fats.

Blending. PMF1, PMF2 and PMF3 were each blended with IP at ratios of 25%, 50% and 75%, respectively. In other systems, SLs1, SLs2 and SLs3 were blended separately with PMF2, also at the same ratios.

Analyses. Triacylglycerol composition of the oils and fractions was determined by using a modification of NARP-HPLC technique that had been reported previously (1,2). The HPLC instrument system employed was a Waters HPLC Pump 501 (Waters Associates, Milford, MA) a Rheodyne loop injector (Model 7125, Cotati, CA) equipped with a 20-μL sample loop, two commercially packed C-18 columns (Nucleosil ET, 3 μm, 125 mm × 4 mm i.d., Macherey Nagel, Düren, Germany) connected in series, and an RI Detector ERMA model ERC-7512 (ERMA, Inc., Tokyo, Japan). The columns were thermostated at 25°C. Triacylglycerol samples were dissolved in chloroform at the concentration of 10%. About 4 μL of these solutions were injected. The mobile phase was a mixture of acetone and acetonitrile at a ratio of 7:3 (v/v), with the flow rate of 1.0 mL/min. Separations were recorded with a Waters 740 Data Module.

The physical properties of fats were studied from their solid fat content (SFC) profile (3) on a Newport Analyzer Mark II continuous wave nuclear magnetic resonance (NMR) spectrometer. The sample in the NMR tube was first melted at 70°C for 30 min and then chilled at 0°C for 90 min. The tube was then transferred to a 26°C bath and kept for 40 ± .5 hr for stabilization. The stabilized sample was again chilled at 0°C for 90 min before being held at the measurement temperature for 60 min prior to measurement. The interaction between fats was monitored from isosolid diagrams constructed from the SFC profiles (4). Analysis of variance and surface responses were performed using a SASV5 Package on an IBM 4351/M12 computer.

RESULTS AND DISCUSSION

Component fats characteristics. The amount of liquid portion ($PMF2_o$) that could be removed in the preparation of PMF3 was 30%. To produce PMF1 with twice the liquid portion of PMF2 (2 × 30% = 60%), the

PMF2:PMF2$_0$ had to be blended at the ratio of 40:30. The IV difference between PMF2 (IV=39.8) and PMF1 (IV=49.2), and between PMF2 and PMF3 (IV=30.8) is equal. Thus, these fats were suitable for the 3 × 5 factorial blending study.

The initial fractionation of the sal fat sample produced 20% of a sal stearin fraction (SLs3) (IV=30.3) and 80% of sal olein (SLo). The amount of mid fraction (SLo-s, which is designated as SLs1) that could be removed from the fractionation of SLs3 was 56%. The IV of this mid fraction was 33.4. To produce a fraction suitable for the 3 × 5 factorial study, the SLs1 and SLs3 fractions were blended at the ratio of 1:1 to give fraction SLs2 (IV=31.7).

IP contains high amounts of POS and SOS, and relatively low IV (31.6) (Table 1). This fat resembles cocoa butter (CB) and can be used as is in a CBE formulation.

TABLE 1

Oleo-Disaturated Triacylglycerol Content of Fats and Fractions and Their Iodine Values[a]

	PMF1	PMF2	PMF3	SL	SLs1	SLs2	SLs3	IP	CB
POP	46.6	56.1	68.0	1.3	1.4	1.7	1.7	9.4	14.1
POS	9.7	12.6	15.2	9.1	10.0	11.0	12.2	36.0	39.3
SOS	1.1	1.3	2.2	45.6	50.3	56.8	61.9	40.4	30.5
SOA	—	—	—	10.4	11.7	12.6	13.3	4.7	—
Total	57.4	70.0	85.4	66.4	73.4	82.1	89.1	90.5	83.9
IV	49.2	39.8	30.8	37.6	33.4	31.7	30.3	31.6	32.2

[a]P, C16:0; O, C18:1; S, C18:0; A, C20:0; and CB, Malaysian cocoa butter.

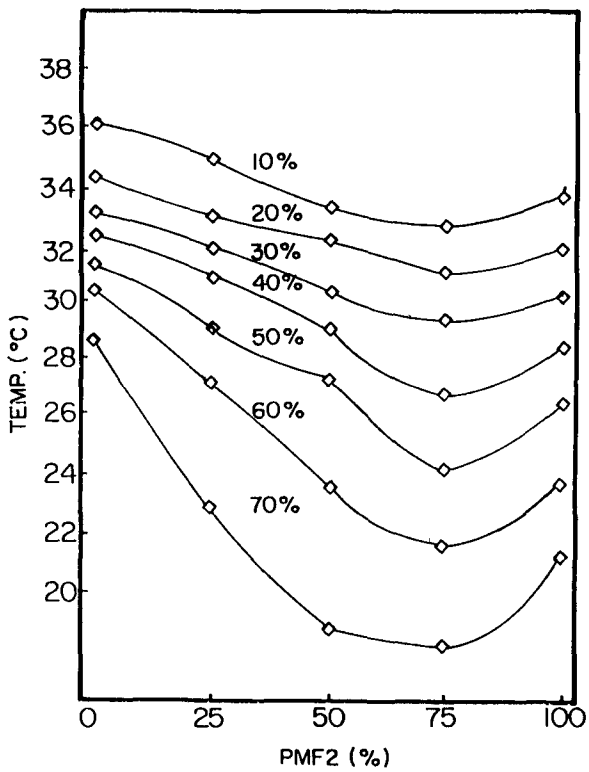

FIG. 3. Isosolid diagram of PMF2:IP blend.

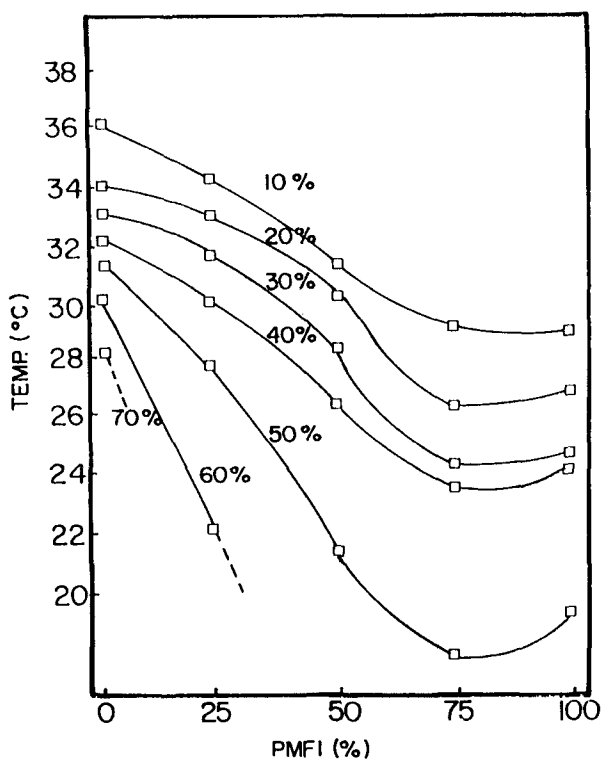

FIG. 2. Isosolid diagram of PMF1:IP blend.

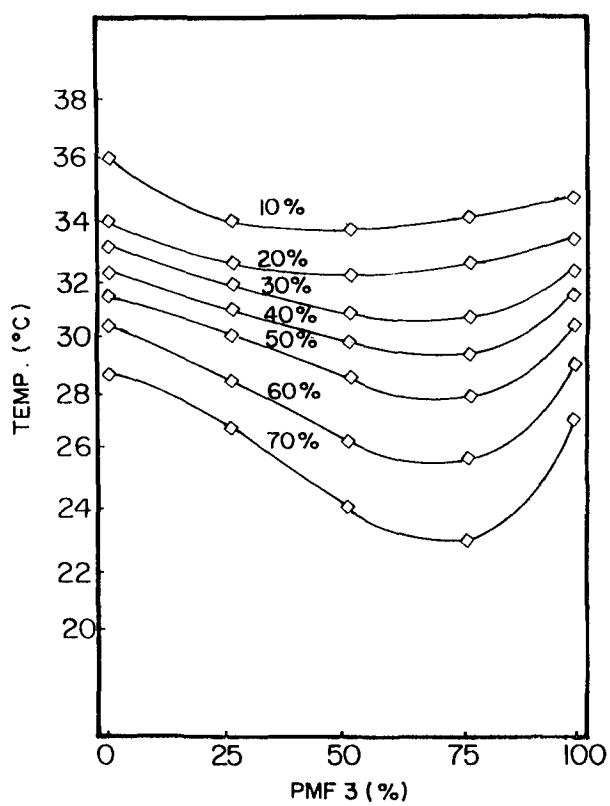

FIG. 4. Isosolid diagram of PMF3:IP blend.

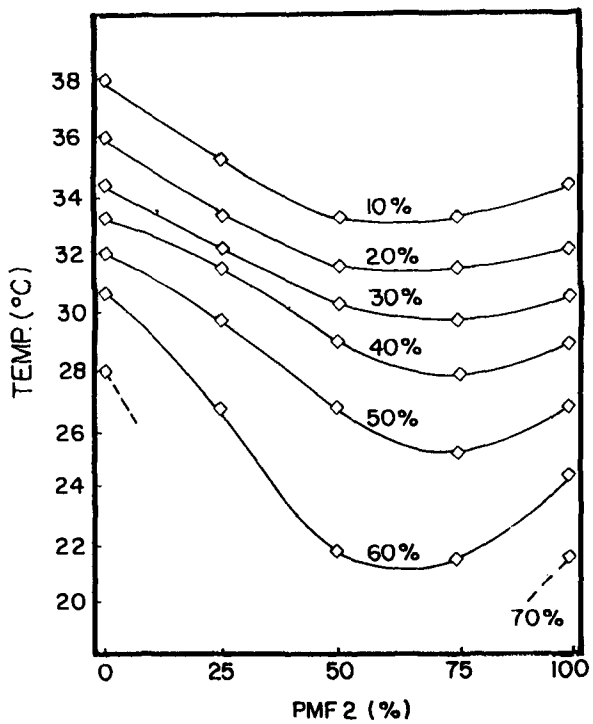

FIG. 5. Isosolid diagram of PMF2:SLs1 blend.

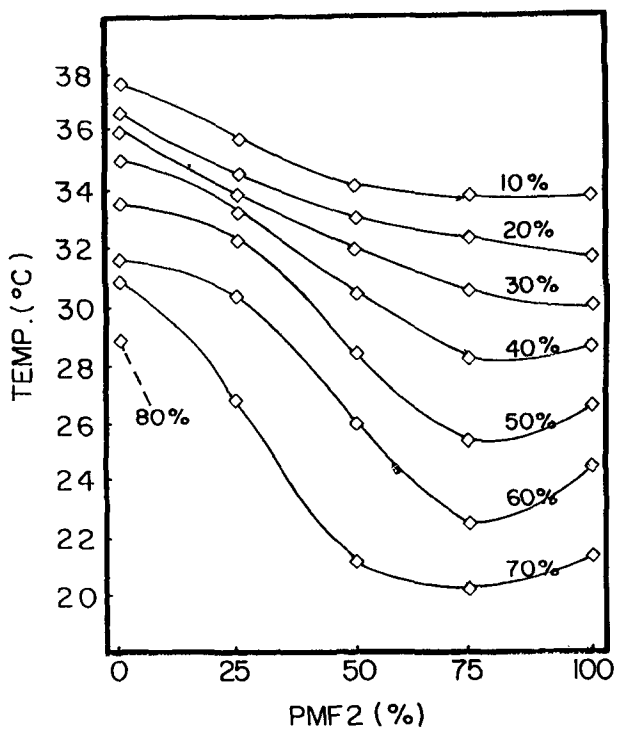

FIG. 7. Isosolid diagram of PMF2:SLs3 blend.

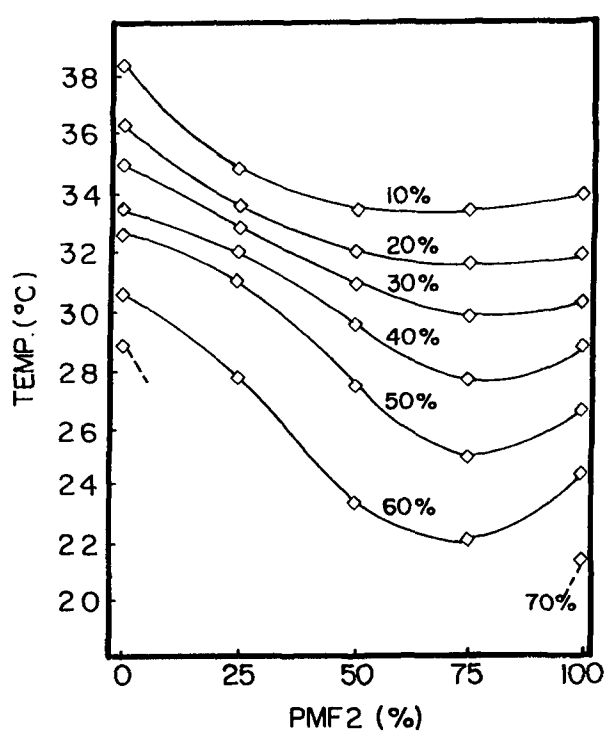

FIG. 6. Isosolid diagram of PMF2:SLs2 blend.

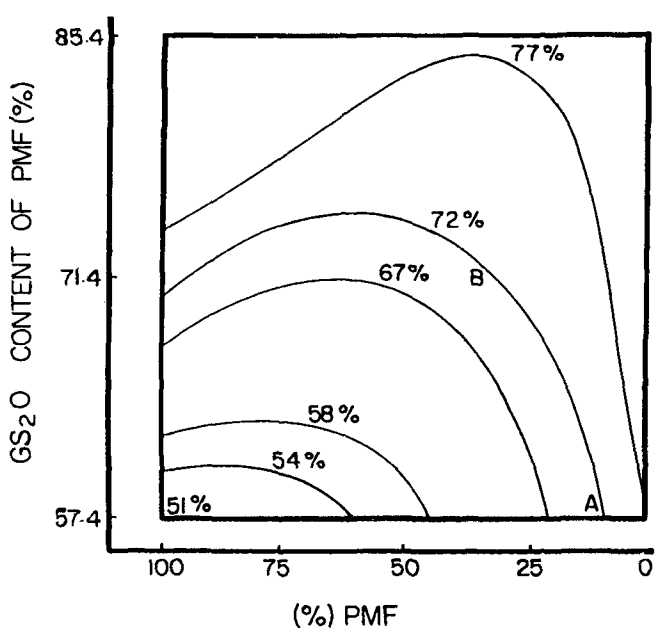

FIG. 8. SFC at 20°C of PMF:IP binary system.

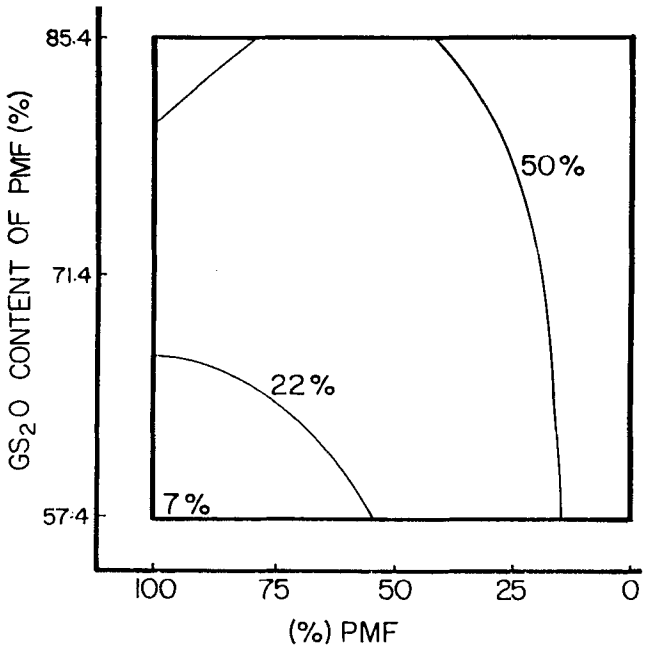

FIG. 9. SFC at 30°C of PMF:IP binary system.

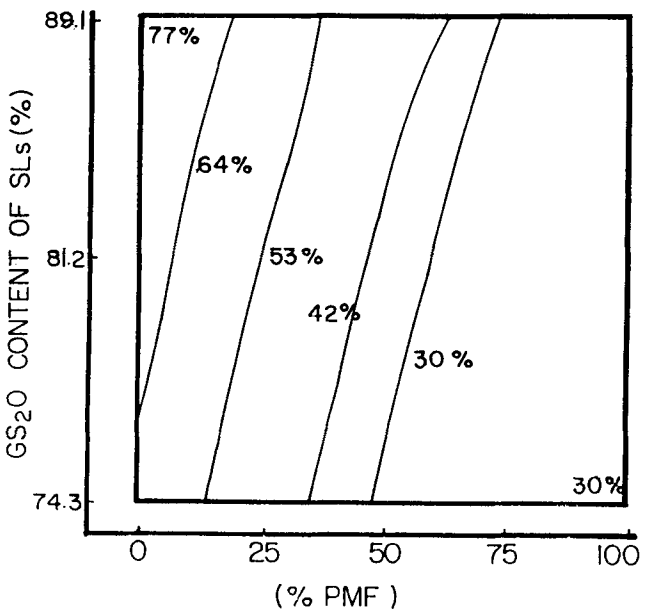

FIG. 11. SFC at 30°C of PMF:SLs binary system.

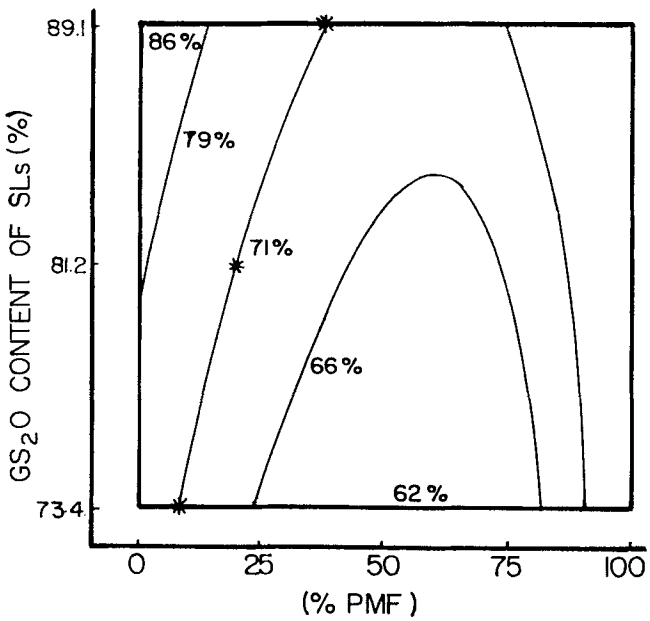

FIG. 10. SFC at 20°C of PMF:SLs binary system.

Table 1 also shows that reduction of PMF's IV causes an increase in POP and POS triacylglycerol content.

Interaction of component fats. Binary blends of PMF of lower IV with Borneo tallow (IP), or sal stearin of lower IV with PMF showed improved isosolid profiles. Nevertheless, all the blends showed eutectic interaction with the minimum point at about 75% PMF (Figs. 2–7). These results suggest that improving the quality of component fats could reduce the incompatibility between them, but this will not eliminate the eutectic behavior. It is believed that such interaction patterns were correlated with the interaction between POO, SOO, POP, POS and SOS. Interaction between these triacylglycerols was reviewed in 1967 by Rossell (5).

Figures 8 and 9 show that to produce PMF:IP blends with steep melting profiles and not less than 70% solid fat content at 20°C (one of the more important characteristics of CBE) (6), the amount of PMF1 and PMF2 that could be added were limited to about 10% (point A) and 33% (point B), respectively. Blends of PMF with iodine values of 37 or lower (with IP) fulfilled the above specification of 70% SFC at 20°C at any blend ratio. In the binary system of PMF2:SLs (Figs. 10 and 11), to fulfill such specification, the maximum amount of PMF2 that could be added to SLs1, SLs2 and SLs3 was 7%, 15% and 35%, respectively.

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