INTERACTION OF COCOA BUTTER EQUIVALENT COMPONENT FATS IN TERNARY BLENDS

Keywords: CBE; Interaction between Fats

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Date of Submission : 15 June 1991

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Selected commercial samples of palm mid-fraction (PMF), Borneo tallow (IP) and sal stearin (SLs) were blended in ternary systems. The compatibility of fats in the blends was monitored by measuring the changes in melting points and solid fat content. The results showed that the addition of the third component, IP or SLs, to binary blends of PMF:SLs or PMF:IP respectively, did not eliminate the eutectic behaviours which already existed.

INTRODUCTION

Cocoa Butter Equivalent (CBE) is used mainly in chocolate and related products. Normally CBE is produced by blending a high quality palm mid-fraction (PMF), with one or more other vegetable butters such as Borneo tallow (from *Shorea stenoptera*) (IP), sal stearin (from *Shorea robusta*) (SLs), shea stearin (from *Butyrospermum parkii*), *etc.* In practice, blends which incorporate more than two component fats are more important to the industry. Very little information is available in the literature regarding the compatibility of the component fats in multicomponent systems. Previous reports (Balinga and Shitole, 1981; Kalanithi, 1985; and Timme, 1984) only discussed the interactions of the component fats in a binary system, or the component fat with cocoa butter. The aim of the present research was to study the interaction between some of the most readily available CBE component fats, namely PMF, IP and SLs, in ternary blends.

EXPERIMENTAL

Selected commercial samples of PMF, IP, SLs and Malaysian cocoa butter (CB), each of which has a high content of oleo-disaturated triglycerides (72.4%, 90.5%, 82.4% and 85.7% respectively) were used. The triglyceride composition of the samples was determined using RP-HPLC according to the previously reported method (El-Hamdy and Perkins, 1981) with some modifications.

TABLE 1. CHARACTERISTICS OF FATS USED

Sample	PMF	IP	SLs	CB
TRIGLYCERIDE COMPOSITION (%)				
Trisaturated;				
PPP	1.5	—	—	—
PPS	tr	0.6	0.6	1.3
PSS/SSS	tr	1.3	0.3	1.4
Mono-unsaturated;				
POP	62.2	9.4	2.2	14.1
POS	9.0	36.0	9.1	39.3
SOS	1.2	40.4	53.2	30.5
SOA	—	4.7	17.9	1.8
(total)	(72.4)	(90.5)	(82.4)	(85.7)
Di-unsaturated;				
PLM/PLP	10.2	—	1.4	1.3
PLS	—	—	0.7	2.2
SLS	—	—	0.4	1.8
POO	10.2	2.8	1.3	1.7
SOO	—	2.8	1.3	1.7
SLA	—	—	0.4	—
AOO	—	—	2.7	—
Poly-unsaturated;				
OOL	tr	—	—	tr
OLL	0.4	—	0.6	0.7
PLL	2.9	—	—	—
PLO	1.0	0.2	0.2	—
OOO	0.5	0.7	—	—
SOLID FAT CONTENT (%) at,				
20°C	74.8	81.8	75.2	80.4
30°C	31.8	65.3	64.9	59.9
35°C	4.6	21.3	27.5	4.8
40°C	—	—	2.1	—

Abbreviations:
P = Palmitic
O = Oleic
L = Linoleic
S = Stearic
A = Arachidic

TABLE 2. MELTING POINT AND SOLID FAT CONTENT (%) OF BLENDS

PMF:IP:SLs	Melting Point (°C)	Solid Fat Content (%) 30°C	35°C
40:30:30	32.1	31.2	3.2
60:20:20	32.0	18.6	3.7
80:10:10	32.3	24.1	4.1
30:40:30	33.2	37.6	3.5
20:60:20	33.0	45.1	4.5
10:80:10	33.0	54.7	10.7
30:40:30	31.5	38.3	2.5
20:60:20	33.5	49.9	7.9
10:80:10	34.9	55.7	15.6
100:0:0	33.5	31.8	4.6
80:20:0	32.7	26.2	4.7
70:30:0	32.3	21.7	4.6
60:40:0	32.2	38.0	4.7
50:50:0	32.0	45.1	4.8
40:60:0	32.0	46.1	5.7
30:70:0	32.2	46.4	5.8
20:80:0	32.6	53.3	8.0
0:100:0	34.5	65.3	21.3
80:0:20	32.7	24.5	5.4
70:0:30	—	25.1	5.1
60:0:40	33.4	23.9	5.3
50:0:50	33.7	30.3	4.7
40:0:60	34.5	39.0	5.1
30:0:70	35.0	47.4	9.4
20:0:80	35.8	54.6	16.0
0:0:100	37.2	64.9	27.5
0:10:90	—	61.2	21.8
0:20:80	36.5	60.2	21.8
0:30:70	36.2	—	—
0:40:60	35.7	60.0	21.5
0:50:50	35.5	—	—
0:60:40	35.2	60.4	21.6
0:70:30	34.7	—	—
0:80:20	34.6	62.5	21.4
0:90:10	—	63.9	21.3

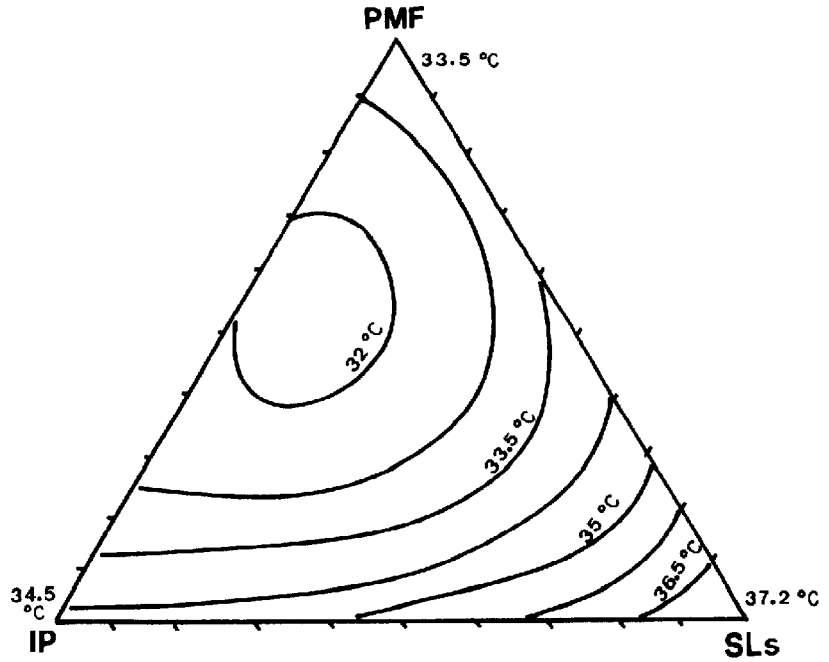

Figure 1. Isothermal diagram of melting points of blends of PMF:IP:SLs

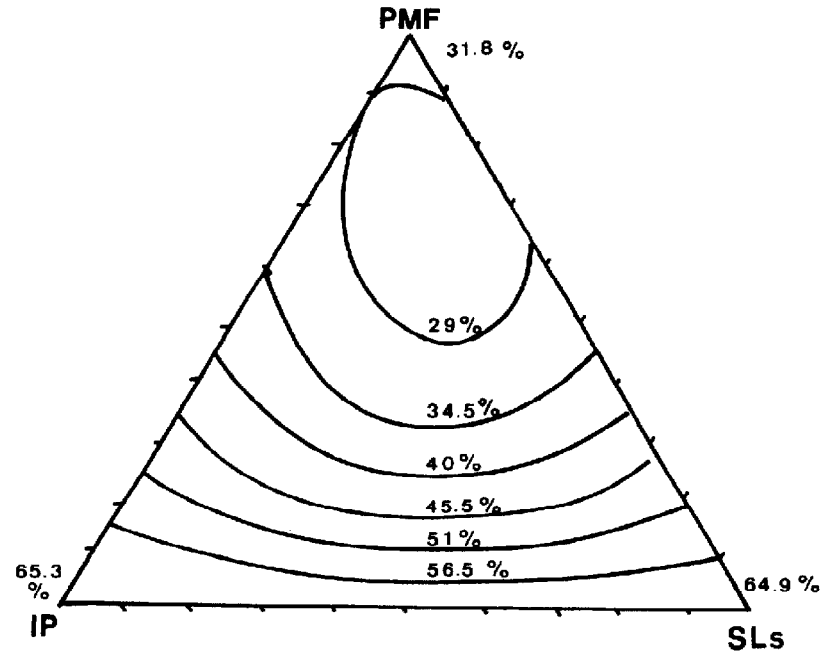

Figure 2. Isosolid diagram of SFC at 30°C for blends of PMF:IP:SLs

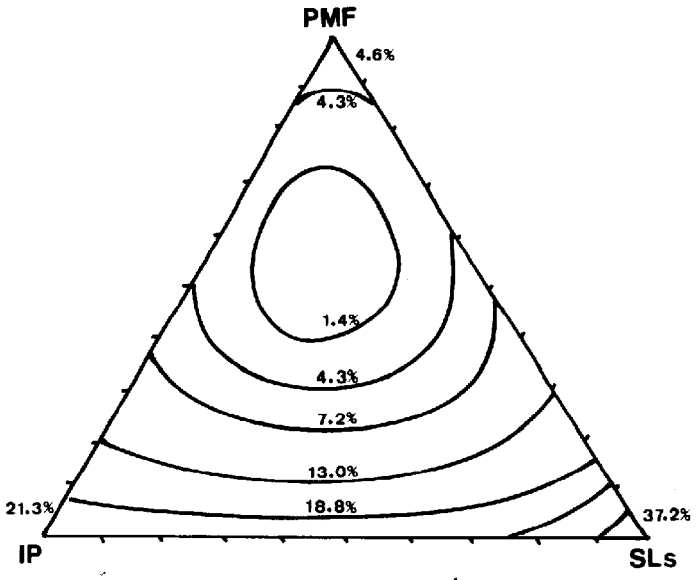

Figure 3. Isosolid diagram of SFC at 35°C for blends of PMF:IP:SLs

The HPLC system employed consisted of a Waters HPLC Pump 501, a Rheodyne loop injector (Model 7125) equipped with a 20- µL sample loop, two commercially packed C-18 columns (Nucleosil ET, 3µm, 125mm x 4mm i.d.) connected in series, and an RI Detector model ERMA ERC-7512. The columns were thermostatted at 25°C. Triglyceride samples were dissolved in chloroform at a concentration of 10% (w/v). About 4µL of solution were injected. The mobile phase was a mixture of acetone and acetonitrile at a ratio of 7:3 (v/v), with a flow rate of 1.0ml/minute. Separations were recorded with a Waters 740 Data Module.

The physical properties of fats were assessed by their solid fat content (SFC) profile (Flingoh, 1983) on a Newport Analyzer Mark II continuous wave 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 ± 0.5 hr for stabilization. The stabilized sample was then again chilled at 0°C for 90 min before being held at the measuring temperature for 60 min prior to measurement.

The component fats were blended at various ratios as shown in *Table 2*, and contour lines of solid fat content and melting point for the blends were constructed. Analysis of variance and surface responses were performed using a SASV5 Package on IBM 4341/M12 (SAS, 1985).

RESULTS AND DISCUSSION

Table 1 shows that the PMF, IP and SLs have oleopalmitostearin (POS) content lower than CB (39.3%). Thus none of the possible ternary blends of PMF:IP:SLs could have an oleo-disaturated triglyceride composition exactly like that of CB. This indicates that no blend would have physical properties exactly like those of CB.

Figures 1 to *3* are isothermal and isosolid diagrams of melting point and solid fat content for ternary blends constructed from the data shown in *Table 2*. All three diagrams have a very good model fit, with R-square values not less than 0.9.

Figure 1 shows eutectic interaction in all binary systems except IP:SLs blends. Thus, the addition of a small amount of either PMF or IP to the binary blends of IP:SLs or PMF:SLs would reduce the melting point of the binary blends. A quite similar pattern of interaction can also be seen in *Figure 3*. However, the patterns of melting point and SFC at 35°C, might not give an exact picture of the interactions between the major triglycerides (POP, POS and SOS) in the blends (P = C16:0; O = C18:1; S = C18:0), because of the possibility that the interactions between these major triglycerides were less prominent at the melting points of the blends. In addition, at 35°C, the range of SFC deviations was small, since some of the blends, notably those containing about 50%-75% PMF, were already completely melted.

Maintaining a high solid fat content at 30°C is particularly important in CBE formulations to be used in tropical regions. *Figure 2* shows that the addition of PMF tends to reduce the SFC of the IP:SLs blends at 30°C. On the other hand, the addition of IP and SLs to PMF:SLs and PMF:IP respectively, increases the solid fat content. Eutectic mixtures formed with the addition of PMF at between 50% and 90%, giving curves close to the binary line of PMF:SLs.

CONCLUSION

Palm mid fraction, Borneo tallow and sal stearin showed eutectic interaction in ternary blends The eutectic mixtures formed on the addition o between 50% and 90% PMF, giving curves close t the binary line of PMF:SLs.

ACKNOWLEDGEMENT

We would like to express our sincere thanks to the National Science Council — MPKSN, and the International Foundation for Science, Sweden, for research grants, and to the Palm Oil Research Institute of Malaysia (PORIM) for providing research facilities.

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