Specialty Fats from Palm and Palm Kernel Oils - A Review of PORIM's Activities

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Specialty fats can be defined as fats for specific edible end use applications other than shortenings and margarines.

In PORIM studies on specialty fats concentrate upon increasing the end use applications of palm and palm kernel oils and upon solving particular problems encountered by local and foreign companies.

The four main areas of this research are:-

- Cocoa butter equivalents } Hard Butters
- Cocoa butter substitutes } Hard Butters
- Savoury coatings
- Toffee fats, coffee whiteners, whipped cream

COCOA BUTTER EQUIVALENTS (CBE)

Cocoa Butter Equivalents are fats which are similar in physical and chemical properties to cocoa butter and are therefore compatible with it. The major triglycerides-present in such fats (making up about 75% of the total) are palmito-oleostearin (POST), stearo-oleostearin (StO St) and palmito-oleo-palmitin (POP). Collectively they are referred to as SOS triglycerides, where S indicates a saturated fatty acid.

Palm mid-fraction (PMF) has physical and chemical properties similar to those of cocoa butter (*Table 1*), (*Figures 1 and 2*) but not close enough for it to be used as CBE in the manufacture of chocolate. Certain exotic fats (*Figure 3*) such as illipe (engkabang), sal stearin and shea fat are therefore blended with it in order to bring the properties of the mixture closer to those of cocoa butter and simultaneously achieve a better degree of compatibility with cocoa butter. Formulation work carried out at PORIM has produced several promising blends (*Table 2*) that have performed well in chocolate. These blends were used as extenders up to the permitted legal maximum of 5% in chocolate.

COCOA BUTTER SUBSTITUTES (CBS)

These are fats which are similar to cocoa butter in physical but not in chemical properties, and therefore only compatible with it in limited amounts. The degree of compatibility of these fats with cocoa butter and their melting characteristics determine quality. A good quality CBS is hard at ambient temperature and has sharp melting characteristics similar to those of cocoa butter. Cocoa butter substitutes are divided into lauric-based substitutes and non-lauric-based substitutes. In general lauric-based substitutes are less compatible with cocoa butter than the non-lauric substitutes.

This report highlights the lauric-based substitutes particularly the fractionated palm kernel stearins, but also deals with some aspects of non-lauric CBS.

LAURIC CBS FATS

Imitation chocolate or coatings made from lauric stearins have excellent melt-away with no waxy after-taste. Because lauric-based fats have a low tolerance for cocoa butter they must be used in chocolate formulations with cocoa powder (instead of the cocoa liquor), such as the following:

Cocoa powder (10 - 12%)	–	6%
CBS fat	–	32%
Sugar	–	45%
Skim milk powder	–	17%

In this formulation the CBS amounts to 97% of the total fat phase while the milk fat adds 1% and the cocoa fat 2 per cent.

TABLE 1. COMPARISON OF PALM MID-FRACTION (PMF) AND COCOA BUTTER (CB)

Characteristics	PMF 895 a	PMF Ab	CB
Slip melting point (SMP, °C)	33.0	33.2	34.4
Iodine value (IV)	35.9	33.6	37.5
Solid fat content (SFC) % by NMR at			
20°C	78.3	83.0	74.0
25°C	62.6	69.0	66.6
30°C	34.8	44.0	37.9
32.5°C	10.3	14.0	10.5
35°C	5.0	6.0	1.9
37°C	2.4	–	–
40°C	–	–	–
Jensen cooling curve (JCC)			
T max (°C)	27.7	28.0	29.2
T min (°C)	23.7	21.9	24.0
ΔT	4.0	6.1	5.2
t max (min)	87	64.0	47
t min (min)	57	32.0	24
Δt	30	32.0	23
Q = ΔT/Δt	0.13	0.19	0.23

a. PMF 895 : local PMF

b. PMF A: commercial PMF (imported from Europe)

TABLE 2. COMPOSITION AND PROPERTIES OF COCOA BUTTER EQUIVALENT FATS (CBE)

Composition (%)	(1)	(2)
PMF	70	50
Illipe (Engkabang)	30	40
Sal stearin		10
Properties		
Solid fat content (SFC, %)		
20°C	72.4	63.2
25°C	60.0	56.0
30°C	29.7	39.9
32.5°C	29.7	39.9
35°C	2.4	12.0
37°C	1.6	3.0
40°C	–	1.8
Jensen cooling curve		
T max °C	27.2	26.8
T min °C	22.7	22.8
ΔT	4.5	4.0
t max (min)	61	57
t min (min)	35	37
Δt	26	20
Q = ΔT/Δt	0.17	0.2
Tempering Time (min)	44	34

(Note: CB Tempering Time 33 min)

We have investigated the properties of imported commercial CBS fats and compared them with local CBS fats and found that there were no significant differences in their physico-chemical properties (*Tables 3 and 4*).

We are currently investigating the causes of fat bloom in chocolates containing lauric fats: This is a problem in warm climates because of the poor conditions during storage and transportation. Emulsifiers such as sorbitan tristearate are normally used to inhibit fat bloom formation.

NON-LAURIC CBS FATS

The non-lauric CBS have a marginally higher level of compatibility with cocoa butter than palm kernel stearins. These stearins normally have a high content of *trans* acids and will tolerate approximately 2-3% cocoa butter in milk chocolate formulations, and 5-6% in dark chocolate formulations. Non-lauric CBS do not require tempering, produce excellent gloss, and have good shelf life.
Non-lauric CBS are prepared by selective hydrogenation of liquid oils such as soyabean, cottonseed and rapeseed oils, and palm olein.

SAVOURY COATINGS

Coatings prepared from cocoa butter substitutes have long been used in the confectionery and in the biscuit and cracker industries to coat and enhance the flavour of a variety of centres.

Generally, confectionery coatings contain a matrix of coating fat and other ingredients consisting of cocoa mass, sugar and non-fat dry milk. Savoury coatings on the other hand replace the cocoa mass portions of a typical confectionery coating with specially formulated protein-carbohydrate bases, spray-dried cheese powders, seasoning and spice blends, and natural or artificial flavours. As with confectionery coatings, hard butters prepared by hydrogenation, fractionation and interesterification are preferred for savoury coatings.

The following is a typical recipe:

Hard butter	–	40%
Cheese powder	–	30%
Skim milk powder	–	10%
Lactose	–	20%

It will be noted that the main ingredient is hard butter; it is possible to replace 50% of this with palm olein. The processing of savoury coatings is similar to that of substitute chocolate coating, where the particle size of the solid portion is reduced by refining to achieve a smooth mouthfeel. Savoury coatings may be sprayed, coated on a single surface or used to completely enrobe the surface of the snack. PORIM has developed a potential formulation and it can be seen from *Table 5* that the physical and chemical properties are almost identical with those of some commercial fats.

FATS FOR TOFFEES, COFFEE CREAMERS AND WHIPPED CREAM

Some of the work we are doing in this area is as follows:

Hydrogenated palm kernel oil or olein is now largely used as a cheaper alternative to butter fat in toffees. The physical properties of hydrogenated palm kernel-oil and olein that could be used as toffee fats are shown in *Table 6*. Fats are necessary ingredients in toffees, caramels and other boiled sugar confectionery to provide texture, richness and character. We are currently formulating blends using various palm oil products to achieve physical properties similar to those of butter fat.

Coffee Creamers

At present the fat in some coffee creamers comes from coconut oil. PORIM has been able to develop excellent fats for this purpose also, using palm oil products mainly hydrogenated palm kernel oil and palm kernel olein. In coffee creamers, the main function of the fat is to add viscosity, body and whitening power to the beverage. In these applications the fat must be quick melting and oxidatively very stable. Hydrogenated palm kernel oil has been found to be an excellent ingredient for this purpose. Some of the fats indicated in *Table 6* are also suitable for powdered coffee whiteners.

Some general specifications for fats used in coffee creamers and a typical recipe are given below.

Slip melting point (SMP°C): 30-39°C

TABLE 3. IODINE VALUES, SLIP MELTING POINT AND SOLID FAT CONTENTS OF IMPORTED AND LOCAL COCOA BUTTER SUBSTITUTES (CBS)

Sample code A	**I1**	**I2**	**L1**	**L2**	**L3**	**L4**
Slip melting point (SMF°C)	34.5	33.5	32.0	34.5	35.5	34.5
Iodine value (IV)	0.4	0.8	7.4	0.8	0.4	0.8
Solid fat content (SFC, %)						
20°C	94.4	94.6	80.3	93.3	93.7	93.8
25°C	87.0	86.7	64.9	83.7	84.2	83.8
30°C	48.9	48.5	33.2	48.9	48.4	48.9
35°C	4.8	4.5	–	6.5	6.4	4.5
37°C	1.2	1.8	–	2.8	2.3	1.8
40°C	–	–	–	1.3	0.3	

a. I1, I2 : Imported fats.

L1, L2, L3, L4 : Local fats.

TABLE 4. FATTY ACID AND TRIGLYCERIDE COMPOSITION OF CBS

Sample code A	**I1**	**I2**	**L1**	**L2**	**L3**	**L4**
Fatty acid composition						
C 6 : 0	0.1	0.1	0.2	0.2	0.2	0.1
C 8 : 0	2.1	2.7	2.7	2.6	2.9	3.0
C 10 : 0	2.8	3.3	3.1	3.1	3.2	3.5
C 12 : 0	53.4	55.7	56.9	55.3	57.4	56.6
C 14 : 0	21.6	19.1	20.3	20.8	20.3	19.4
C 16 : 0	9.0	8.1	7.6	7.9	6.9	7.6
C 16 : 1	0.1	–	–	–	–	–
C 18 : 0	10.2	9.5	2.6	8.6	8.1	9.0
C 18 : 1	0.1	0.1	5.2	0.9	0.3	0.2
C 18 : 2	0.1	0.1	0.7	–	0.1	–
C 20 : 0	0.2	0.3	–	0.1	0.1	0.2
Triglyceride composition						
C 28	0.5	0.3	0.3	0.4	0.4	0.6
C 30	0.6	0.6	0.6	0.6	0.7	0.7
C 32	3.3	3.6	3.4	3.6	3.7	3.3
C 34	6.5	6.6	6.3	6.5	6.6	6.4
C 36	26.2	26.5	26.8	25.8	27.0	26.0
C 38	23.3	23.3	23.7	22.4	23.1	22.7
C 40	14.3	13.9	14.0	13.4	13.4	13.5
C 42	9.2	9.1	8.8	9.0	8.6	9.1
C 44	5.3	5.3	4.9	5.3	5.0	5.4
C 46	3.4	3.4	3.1	3.6	3.2	3.6
C 48	2.8	3.0	2.9	3.3	3.1	3.2
C 50	1.3	1.3	1.6	1.9	1.3	1.3
C 52	1.2	1.2	1.5	1.8	1.3	1.3
C 54	1.2	1.2	1.3	1.5	1.3	1.4

a. Samples as in Table 3

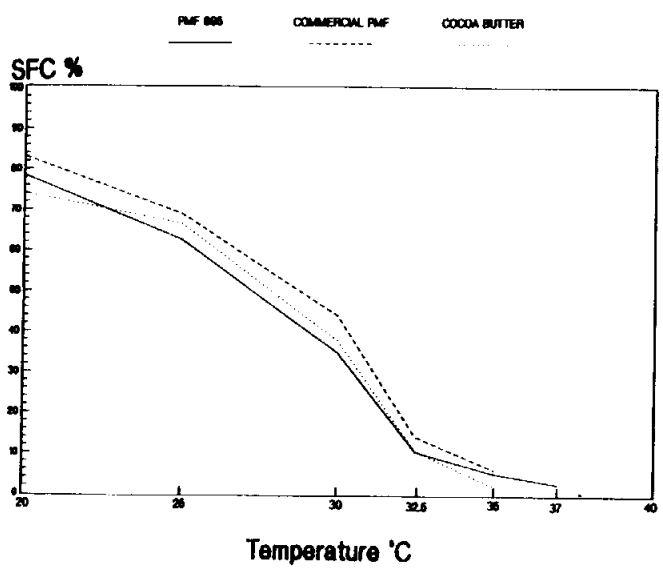

Figure 1: Solid Fat Contents of PMF and Cocoa Butter

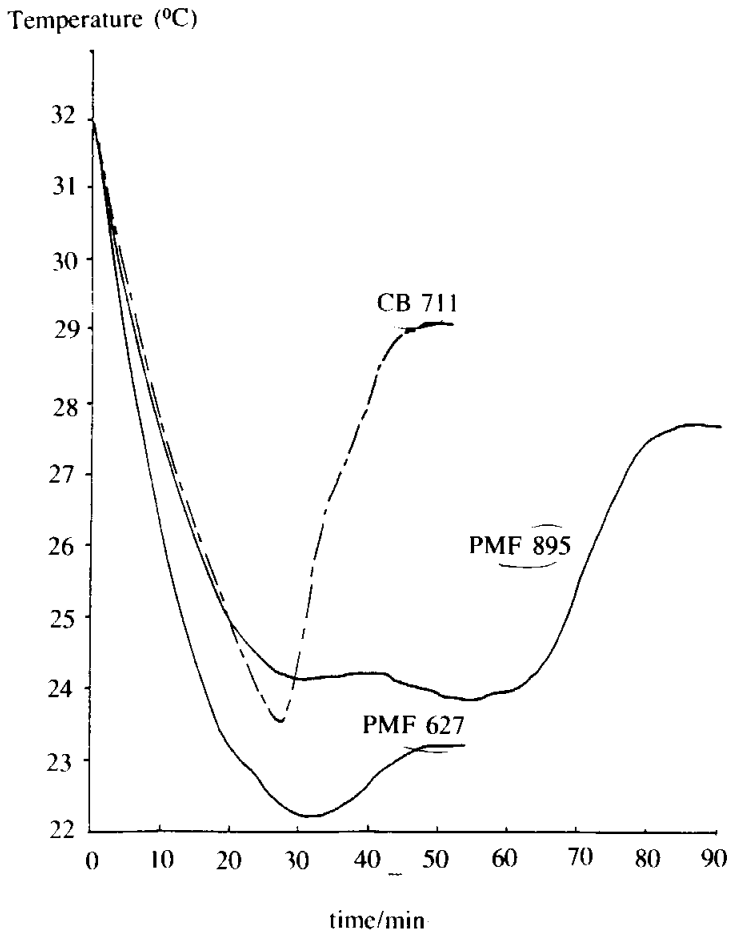

Figure 2: Cooling Curve

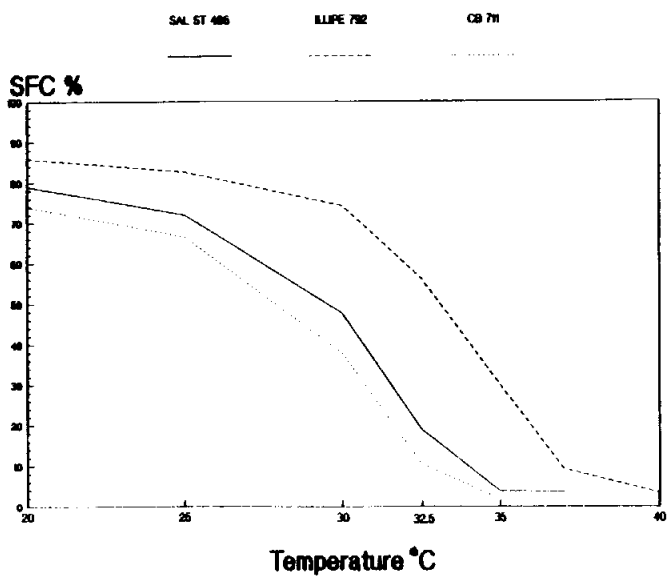

Figure 3: Solid Fat Content of Sos Type Fats

Solid fat content (SFC):

20°C	:	50 - 60%
30°C	:	5 - 10%
40°C	:	1 - 2%

Recipe

Fat	35%
Corn syrup	55%
Sodium caseinate	4.5%
Emulsifier	0.3%

Whipped Cream

Hardened palm kernel oil has been used successfully for the complete replacement of milk fat in imitation whipping cream in Europe and other areas with temperate climates. In a general recipe for whipped cream, hardened palm kernel is present at a level of about 20-30% of the total ingredients.

TABLE 5. SAVOURY COATING FATS

Sample code A	**C1**	**C2**	**POo: SBO (50: 50)**
Slip melting point (SMP, °C)	36.8	38.2	38.0
Iodine value (IV)	61.0	63.7	62.6
Solid fat content (SFC, %)			
5°C	93.7	ND	89.0
10°C	92.6	ND	86.5
15°C	91.7	ND	79.6
20°C	84.0	60.9	69.8
25°C	70.2	50.9	54.6
30°C	46.8	44.2	37.7
35°C	18.8	24.8	19.0
40°C	–	4.0	4.3

a. C1, C2 : Commercial fats

POo: SBO = Palm olein : Soyabean oil

ND - Not determined

TABLE 6. PHYSICAL CHARACTERISTICS OF TOFFEE FATS

	HPKOa	**HPKOa**	**HPKOob**	**HPKOob**	**Butter Fat**
Slip melting point °C	37	41	37	41	34
Solid fat content (SFC, %)					
20°C	64	77	63	73	22
25°C	39	58	37	53	13
30°C	14	31	12	28	7
35°C	7	15	4	14	4
40°C	2	7	0	6	0

a. Hydrogenated palm kernel oil.

b. Hydrogenated palm kernel olein.