Elaeis Vol. 9, No. 1, June 1977, pp. 17-24

EFFECT OF FIRST STAGE DRY FRACTIONATION ON THE QUALITY OF CBE BASED ON PALM OIL AND SAL FAT

Keywords: cocoa butter extender; fractionation; palm oil; sal fat

MD. ALI, A. R., TAN, S.Y., AND AZMAN, K.*

Palm oil (PO) and sal fat (SL) were dry fractionated separately at 30-33°C to remove the high melting constituents, yielding palm olein (POo), and sal olein (SLo). Acetone fractionation was then conducted on a blend of POo+SL(7:3) to produce CBE1, and on a blend of POo+SLo(7:3) to produce CBE2. Changes in the composition of the fractionated products were monitored from the triacylglycerol profiles and polar lipid content, while physical changes were observed from the DSC melting profile and Jensen cooling curve. The dry fractionation reduced the trisaturated triacylglycerol content of palm oil, but had no profound effect on the triacylglycerol composition of sal fat. Nevertheless, dry fractionation reduced the polar constituents of sal fat, and improved the physical characteristics of the CBE produced.

INTRODUCTION

Cocoa butter is the main fat used in chocolate. However in Europe, the addition of other vegetable fats which are compatible with cocoa butter is normally allowed up to 5% (w/w) of the final product, *i.e.* about 15% of the total fat content. The reasons for using these fats include reducing the production cost, and improving the quality of the final product. Fats that are commonly used are palm mid fraction, Borneo tallow (from *Shorea stenoptera*), sal stearin (from *S. robusta*), shea stearin (from *Butyrospermum parkii*), and blends of these. Recently Md. Ali (1996) reported a method of producing cocoa butter extender (CBE) by co-fractionating a blend of palm olein and sal fat. This technique was found to increase the compatibility between the component acylglycerols of the CBE. Reddy and Prabhakar (1985) reported a significant effect of sal fat

*Department of Food Science & Nutrition,
Universiti Kebangsaan Malaysia,
43600, Bangi, Selangor, MALAYSIA.
(Aali @pkrisc. cc: ukm. my)

pre-fractionation on the removal of a polar material identified as dihydroxystearic triacylglycerols (DHS-TGs). This improved the physical characteristics of the sal fat required for confectionery. It is well known, however, that the melting and crystallization behaviour of fats and oils can be significantly affected by the presence of other polar lipids including free fatty acids and partial acylglycerols which migrate to the olein portion during dry or acetone fractionation (Timms, 1985; Deffense, 1985). The presence of these polar lipids may induce early crystallization and adversely affect the order of fractional crystallization. The objective of this study was to determine the effect of dry pre-fractionation of sal fat on the content of the polar components and on triacylglycerol composition, as well as on the physical characteristics of cocoa butter extender (CBE) produced using the co-fractionation method mentioned.

EXPERIMENTAL

Samples of refined, bleached palm oil (PO) and sal fat (SL) were obtained from FELDA Oil Refinery (Klang, Malaysia) and Foods Fats & Fertiliser Ltd. (India) respectively. The palm oil was dry-fractionated in the laboratory at 30°C and 33°C to produce palm olein (POo_{dy30} and POo_{dy33}, respectively) based on technique reported by Pike et al. (1980). POo_{dy30} was found to contain a smaller amount of trisaturated triacylglycerol and was chosen in preparing cocoa butter extender (CBE). To produce CBE1 (*Figure 1A*), a blend containing three parts of SL and seven parts of POo_{dy30} (v/v) (Md. Ali, 1996) was dissolved in acetone (1:6 oil to solvent ratio) by warming it to about 45°C. The solution was cooled gradually to 10°C and held at that temperature fo three hours. Then it was filtered, and the solid was washed with one part of chilled acetone at 10°C. The solid fraction was

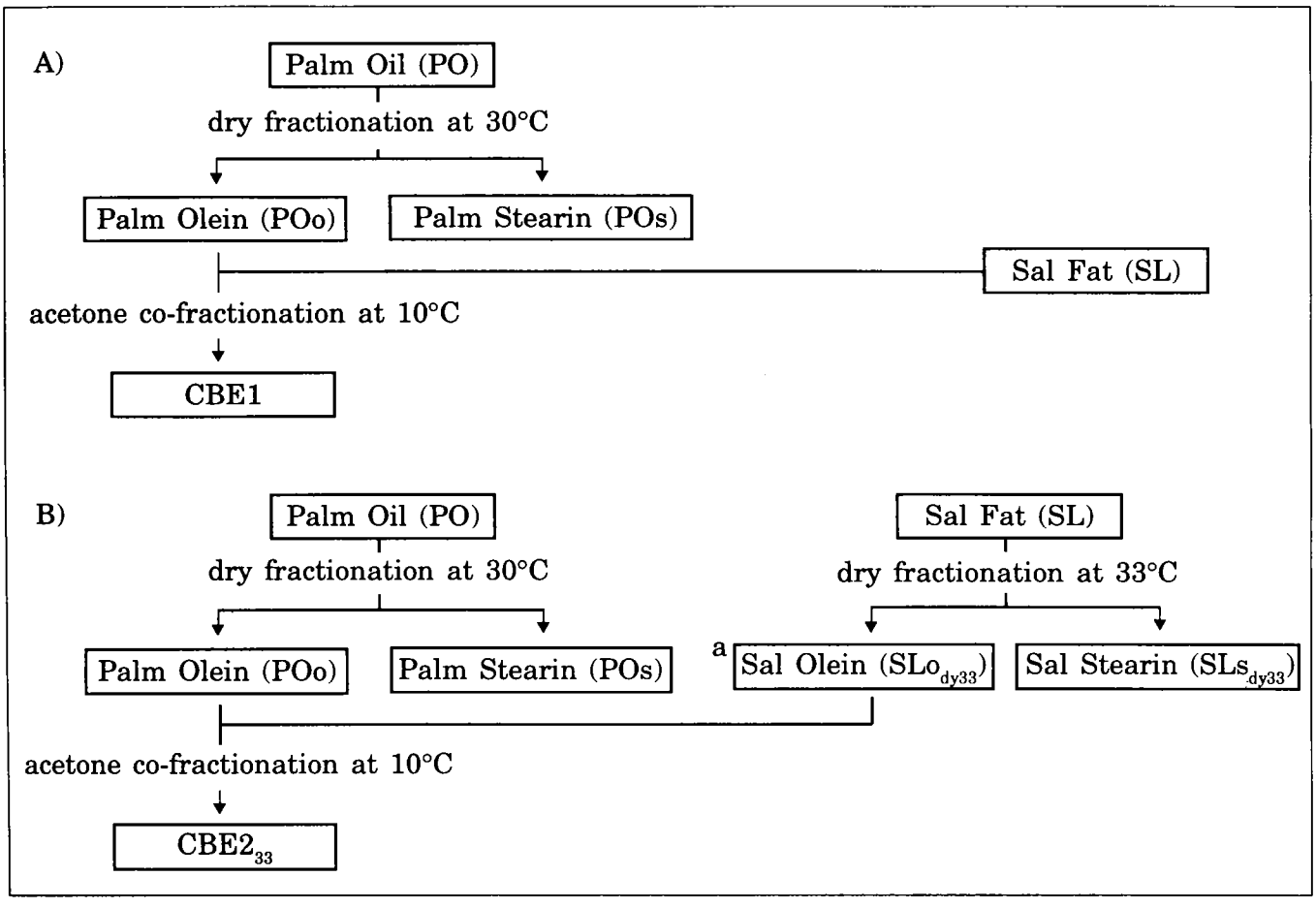

Figure 1. Preparation of cocoa butter extenders (CBE1 and CBE2) from palm oil and sal fat ([a]Replacing with SLo_{dy30} produces $CBE2_{30}$).

freed of solvent in a rotary evaporator under reduced pressure. $CBE2_{30}$ and $CBE2_{33}$ were produced using a similar procedure, except that the SL was replaced with sal olein dry-fractionated at 30°C (SLo_{dy30}) and 33°C (SLo_{dy33}) respectively (*Figure 1B*).

Estimation of the level of polar lipids was done according to the IUPAC method 2.507 (1984) by adsorption on silica gel. Normal triacylglycerol eluted was analysed on HPLC (Waters Associates, Milford, MA) according to the method reported earlier (Md.Ali *et al.*, 1991). The solidification performance was assessed from the Jensen Cooling Curve (Williams, 1966). Each sample was melted at 65°C and filled into a glass tube. It was then cooled in the tube to about 40°C. The cork and fitting were placed in position and the assembly was allowed to cool to 33°C, then placed in the air jacket. The temperature was plotted every minute from the standard temperature of 32°C when stirring was started. This stirring (one stroke at each quarter of a minute) was kept up until the fat become too stiff for it to be continued. The one-minute temperature readings were plotted down to the minimum and then up to the maximum (solidification point). The melting profile was studied by using a Mettler DSC Model FP80 (Switzerland), equipped with a Mettler FP84 TA microscopy cell and Mettler FP89AT System Software running on an IBM PC. About 5 mg of fat sample was precisely weighed (±0.005mg) into the DSC pan and melted at 65°C for 30 minutes before cooling to 0°C and holding there for 90 minutes. The pan was then transferred to a 26°C incubator and held for 7 d for stabilization. The stabilized sample was again cooled to 0°C and held there for 90 minutes before being held at 10°C for 5 minutes on the DSC head prior to measurement. The DSC melting thermogram was recorded at a heating rate of 10°C / minute from 10°C to 50°C.

RESULTS AND DISCUSSION

Dry fractionation of palm oil: The data in *Table 1* indicate that dry fractionation of palm oil (PO) at 30°C and 33°C produces palm oleins (POo_{dy30} and POo_{dy33}) with quite similar triacylglycerol compositions. Major triacylglycerols present were oleo-dipalmitin (POP) and palmito-diolein (POO). The trisaturated acylglycerol content (8.3%, mainly tripalmitin) in palm oil was reduced significantly to < 1%, with a good olein yield (79%). The presence in palm olein of a trisaturated acylglycerol with a high melting point, like tripalmitin is undesirable since it would accumulate in the solid fraction during the further solvent fractionation used to produce CBE. Since POo_{dy30} was found to contain less trisaturated triacylglycerol (0.5%) than POo_{dy33} it was chosen in the preparation of cocoa butter extender. The results show that the palm oil used contained 5.7% polar lipids, while the oleins contained 7.4 percent. The occurence of appreciable amounts of polar lipids such diacylglycerols (5-8%) in palm oil, which during fractionation migrate predominantly to the olein, has been reported by other researchers (Timms, 1985; Deffense, 1985).

Dry fractionation of sal fat: The data in *Table 2* show that fractionation of sal fat (SL) at 30°C and 33°C gave higher yields of olein (91% SLo_{dy30} and 95% SLo_{dy33}) than the fractionation of palm oil at the same temperature. In addition, by contrast with the case of palm oil, the triacylglycerol compositions of sal fat, sal stearin and sal olein were more or less the same. However, dry fractionation reduced the polar lipid content of sal olein (from 4.5% to 1.2-2.2%) and concentrated them in the stearin portion (31.1% in SLs_{dy30} and 35.8% in SLs_{dy33}). This is similar to the results of Reddy and Prabhakar (1985) which showed that when sal fat was subjected to dry fractionation at 35°C, polar lipids such as DHS-TGs and diacylglycerols, because of their high melting nature, were removed to a greater extent in the form of stearin. These findings showed that dry fractionation of sal fat at 30°C and 33°C only had a prominent effect on the polar lipids and not on the normal triacylglycerols.

Acetone fractionation of palm olein and sal fat blends: The results in *Table 3* show that acetone fractionation reduced the amount of polar components in the cocoa butter extender fractions. The effect was more prominent in $CBE2_{30}$ (1.3% polar constituents) and $CBE2_{33}$ (1.6%), which also had a higher content of total monounsaturated triacylglycerols (86.1%) than

TABLE 1. LIPID COMPOSITION OF PALM OIL (PO) AND PALM OLEIN (POo)

Triacylglycerol	PO	[a]PO_{dy30}	[b]POo_{dy33}
trisaturated;			
PPP	6.9	0.5	0.9
PPS	1.4	-	-
monounsatutared;			
POP	29.5	30.4	30.6
POS	5.2	5.5	5.3
SOS	0.2	-	-
diunsaturated;			
PLM	0.9	0.6	0.6
PLP	11.2	10.1	9.3
PLS	-	0.7	0.5
POO	21.7	26.4	26.2
SOO	2.9	2.7	2.6
polyunsaturated;			
OLL	0.3	0.6	0.8
OOL	1.6	2.0	2.7
PLL	2.8	3.1	2.2
PLO	11.6	12.0	12.2
OOO	3.8	4.3	4.7
Polarlipid	5.7	7.4	7.4
Yield%		79	84

[a]dry fractionated at 30°C; [b]dry fractionated at 33°C; M = myristic; P = palmitic; S = stearic; O = oleic; L = linoleic.

TABLE 2. LIPID COMPOSITION OF SAL FAT (SL) AND FRACTIONS.

Triacylglycerol	SL	$^{a}SLo_{dy30}$	$^{b}SLo_{dy33}$	$^{a}SLs_{dy30}$	$^{b}SLs_{dy33}$
trisaturated;					
PPS	tr.	tr.	tr.	tr.	tr.
monounsatutared;					
POP	1.0	0.8	0.9	1.0	1.1
POS	11.3	11.0	11.2	12.0	11.5
SOS	42.4	42.2	41.8	41.3	42.2
SOA	10.9	11.2	10.9	11.2	11.1
AOA	1.8	2.0	1.8	1.8	1.9
diunsaturated;					
PLS	1.0	1.0	1.0	1.1	0.9
SLS	tr.	1.1	0.9	tr.	tr.
POO	3.8	3.8	4.0	3.9	3.9
SOO	16.1	16.1	16.5	16.3	16.6
AOO	3.4	3.7	3.5	3.4	3.3
polyunsaturated;					
OOL	1.6	1.7	1.6	1.7	1.6
PLL	1.2	1.2	1.3	1.0	1.2
PLO	1.4	1.3	1.5	1.2	1.5
SLO	3.1	2.9	3.0	3.2	3.1
Polarlipid	4.5	1.2	2.2	31.1	35.8
Yield%		91	95	9	5

[a]dry fractionated at 30°C; [b]dry fractionated at 33°C; tr = trace;
M = myristic; P = palmitic; S = stearic; A = arachidic;
O = oleic; L = linoleic.

TABLE 3. LIPID COMPOSITION OF SAL FAT (SL) AND FRACTIONS.

Triacylglycerol	CBE1	[a]CBE2$_{30}$	[b]CBE2$_{33}$	CB
trisaturated;				
PPP	1.1	1.1	1.6	-
PPS	0.5	0.4	0.9	tr.
monounsatutared;				
POP	20.5	26.2	20.4	14.1
POS	11.1	12.6	12.1	39.3
SOS	32.1	35.9	40.4	30.4
SOA	8.7	9.8	11.5	1.8
AOA	1.4	1.6	1.7	-
diunsaturated;				
PLP	4.8	2.6	2.5	1.3
PLS	-	-	-	2.2
SLS	tr.	tr.	tr.	1.8
POO	7.5	4.6	3.9	1.7
SOO	3.7	1.6	1.7	3.9
polyunsaturated;				
OOL	2.1	0.6	0.6	0.1
PLL	2.1	0.6	0.6	0.7
PLO	3.5	1.5	1.7	-
SLO	0.9	0.3	0.3	-
Polarlipid	3.0	1.3	1.6	1.3
Yield%	41	38	39	-

[a]dry fractionated at 30°C; [b]dry fractionated at 33°C; tr = trace;
M = myristic; P = palmitic; S = stearic; A = arachidic; O = oleic; L = linoleic.
CBE1 = produced from blend of POo and SL; CBE2 = produced from blend of POo and SLo; CB = Malaysian cocoa butter.

Malaysian cocoa butter (85.6%). It is believed that this composition was responsible for their improved melting and solidification characteristics as shown in *Figures 2* and *3*. According to Timms (1981) diacylglycerols tend to be more soluble in polar and hydrogen bonding solvents like acetone. This facilitates their migration to the olein fraction. Acetone is thus the preferred solvent when the crystallization is to produce a confectionery fat where the diacylglycerol content has to be as low as possible. A similar effect on DHS-TGs

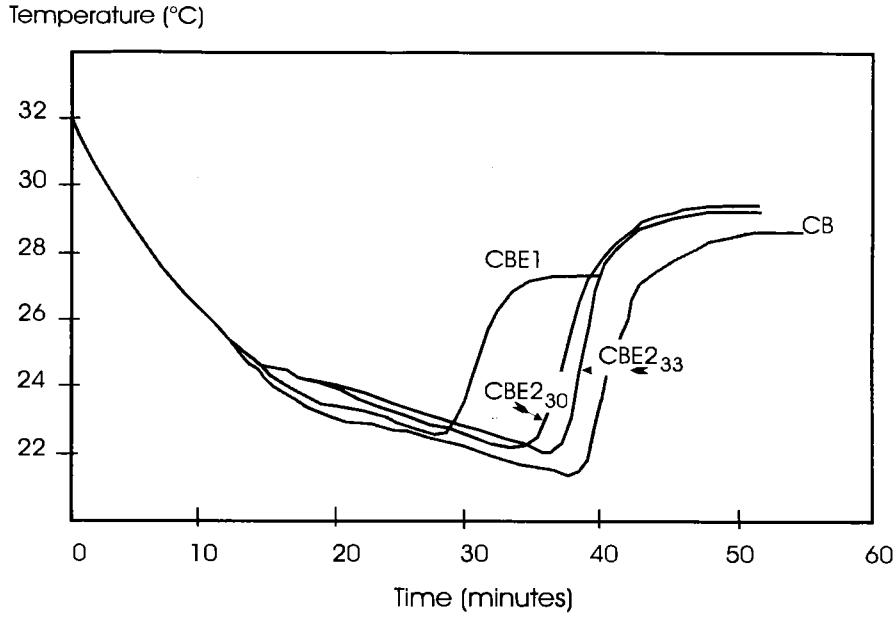

Figure 2. Jensen cooling curve of CBE and cocoa butter

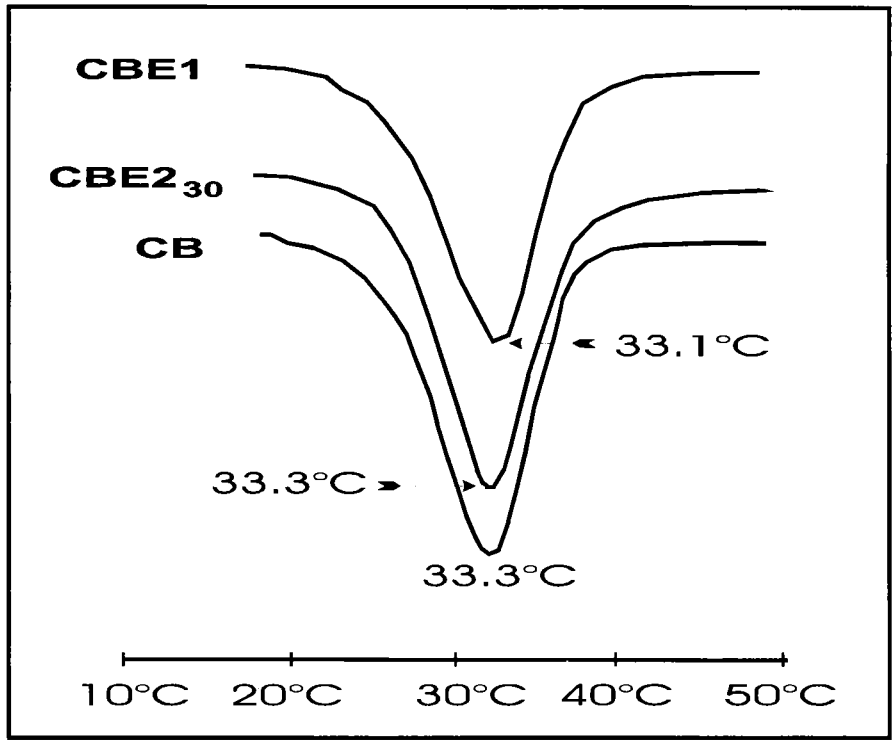

Figure 3. DSC melting curve of CBE and cocoa butter

had also been reported by Reddy and Prabhakar (1985).

The results given above show that dry fractionation of sal fat, followed by acetone co-fractionation of sal olein and palm olein blends, provides efficient removal of polar components and thereby gives a cocoa butter extender with better physico-chemical characteristics.

ACKNOWLEDGEMENTS

The research was sponsored in parts by the International Foundation for Science, Sweden, (IFS E 1281) and the Malaysian National Science Council-MPKSN, under the IRPA 01-07-03-016 programme.

REFERENCES

DEFFENSE, E. (1985). Fractionation of palm oil. *J. Amer. Oil Chem. Soc., 62,* 376-385.

IUPAC (1984). *Standard methods for the analysis of oils, fats and derivatives. 7th revised and enlarged.* International Union of Pure and Applied Chemistry, 216-218.

MD. ALI, A R (1996). Effect of co-fractionation technique in the preparation of palm oil and sal fat based CBE. *International Journal of Food Science and Nutrition., 47,* 15-22.

MD. ALI, A R; EMBONG, M S; OMAR, H and FLINGOH, C H OH (1991). Effect of oleo-disaturated triacylglycerol content on properties of palm mid fraction, sal stearin, and Borneo tallow blends. *J. Amer. Oil Chem. Soc., 68,* 328-31.

PIKE, M; BARR, I and TIRTIAUX, F (1980). Improvments relating to cocoa butter substitute. *British Patent; BP 1,573,210.*

REDDY,S Y and PRABHAKAR, J V (1985). Effect of triacylglycerols containing 9,10-dihydroxystearic acid on the solidification properties of sal *(Shorea robusta) fat. J. Amer. Oil Chem. Soc., 62,* 1126-1130.

TIMMS, R E (1981). Choice of solvent for fractional crystallization of palm oil. *The palm oil product technology in the eighties.* Pushparajah, E. & Rajadurai, M. The Incorporate Society of Planters, Kuala Lumpur, 227-291.

TIMMS, R E. (1985). Physical properties of oils and mixtures of oils. *J. Amer. Oil Chem. Soc., 62,* 241-248.

WILLIAMS, K A (1966). *Oils, Fats and Fatty Foods.* American Elsevier Publishing Co. Inc. New York, pp. 85-88.