Low-Fat Chocolate Spread Based on Palm Oil

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INTRODUCTION

A wide variety of chocolate-related products are currently available. One of them is chocolate spread, also known as breakfast chocolate with, some containing nut pastes such as hazel nut or almond. Chocolate spreads are usually consumed with sandwiches and are very popular with children. In Malaysia, an increasing volume of chocolate spreads is seen on supermarket shelves.

At ambient temperature, the ideal spread should have a creamy, light consistency and there should be no oil separation during its shelf-life of 6-12 months. The consistency of the product can be adjusted by the balance of liquid oil and solid fats. Sufficient solid fat in the fat system will ensure product stability and good shelf-life. The product should have solid appearance and yet be spreadable from the refrigerator. It also should not become oily or greasy from oil separation over time at room temperature (30°C).

A typical fat used as the continuous phase in chocolate spread is partially hydrogenated soyabean oil with a melting range of 32°C-38°C. The product requires a fat system that contains low solids at room temperature but resists oil separation (Finchum and Gunnerdal, 1994). The continuous phase, or fat content, varies from 40%-44% for ordinary chocolate spreads to 28%-35% for low-fat spreads. Palm-based fats for high-fat chocolate spreads are commercially available from specialty fat producers. In addition, fats for low-fat chocolate spreads have also been developed.

MATERIALS AND METHODS

Raw Materials

The raw materials used for production of low-fat chocolate spread include sugars, cocoa powder, skim milk powder, fats, water, lecithin and food stabilizer. Fats and oils were selected from palm-based modified fats. Commercial products for comparison study were purchased from local supermarket and they carried brand names such as *Nutella Scokomac, J W Nuts* and *Winny*. The products were all imported either from Italy, Germany or Belgium.

Production of Low-Fat Chocolate Spread

The flow chart for processing chocolate spread is shown in *Figure 1*. Proteinous ingredients like milk products, cocoa powder and salt were mixed in water before the fat phase was added. The mass was then mixed with other ingredients such as sugars and food stabilizer. Then the mixture was cooked and dispersed through a high speed shear mixer at 72°C-90°C. This process was important to produce a tight emulsion with small water globules finely dispersed in the fat phase. The emulsion was further homogenized using a colloid mill or dairy homogenizer to improve the quality and smoothness of the product. It was then hot-filled into plastic tubs, cooled to 17°C and kept at 10°C for 48 hr for stabilization. Different samples were then stored at 10°C, 20°C and 30°C for eight weeks, and their properties evaluated regularly.

Physical and Chemical Analyses of Fats and Oils

Fats and oils were analysed for their solid fat contents (SFC) using a Nuclear Magnetic Resonance Bruker NMS 120 Minispec (Bruker analytische, Meβtechnik, Germany). The samples were melted at 70°C for 30 min, cooled at 0°C for 90 min and kept at the measuring temperature for at least 30 min before taking the reading. The SFC was measured at 5°C, 10°C, 15°C, 20°C, 25°C, 30°C, 35°C and 37°C. The fatty acid compositions of the fats were analysed by Gas Liquid

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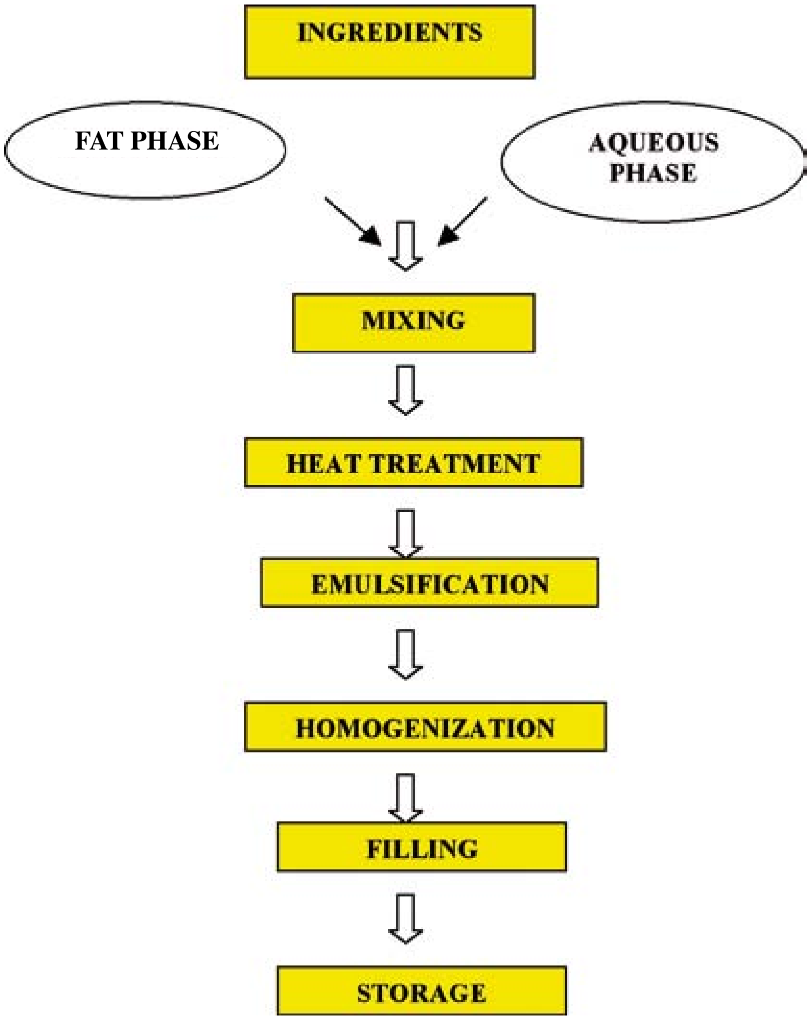


Figure 1. Flow chart for processing low-fat chocolate spread.

Chromatography according to MPOB Test Methods (2005).

Product Evaluation

Analyses on the palm-based chocolate spreads stored at 10°C, 20°C and 30°C were carried out on their spreadability. The test was performed using a texture analyser, TA-TX3 (Stable Micro Systems).

The melting temperature of each chocolate spread was measured by differential scanning calorimetry (DSC), using a Perkin-Elmer DSC 7 calorimeter. A sample of 10-13 mg was weighed accurately into an aluminium pan, sealed and placed on the DSC head. The melting profile was then plotted by heating the sample from 0°C to 60°C at 5°C per minute.

The water activity (a_w) was measured using a Novasina ms1 (a_w) meter (Novasina of Axair Ltd., PFaffikon, Switzerland).

RESULTS AND DISCUSSION

Physical and Chemical Characteristics of the Oils and Fats Used for Chocolate Spread

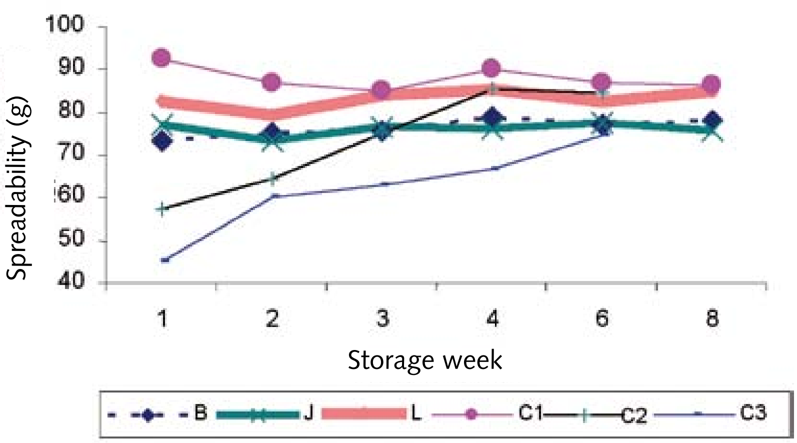
The physical properties of the oils and fats used are important for identification and characterization of the product. *Table 1* shows the SFCs of chocolate spread fats at different temperatures for the experimental samples and the commercial products. The low-fat product required water as an additional liquid phase to compensate for part of the *missing* fats. It also needed a higher solid fat profile for the purpose.

The experimental fats developed for chocolate spread contained no *trans* fatty acids while the commercial products contained 0.3%-3.8% (*Table 2*). *Trans* fatty acids are formed during partial hydrogenation process. A survey in Germany showed that the average *trans* fatty acid content in chocolate spreads was 5.5% with a range of 0.7%-11.1% (Demmelmair *et al.*, 1996). Since chocolate spreads are consumed by children in large quantities, they can be a major source of undesirable *trans* fatty acids and any measure to reduce the *trans* intake will a step towards a healthier diet.

Product Characteristics

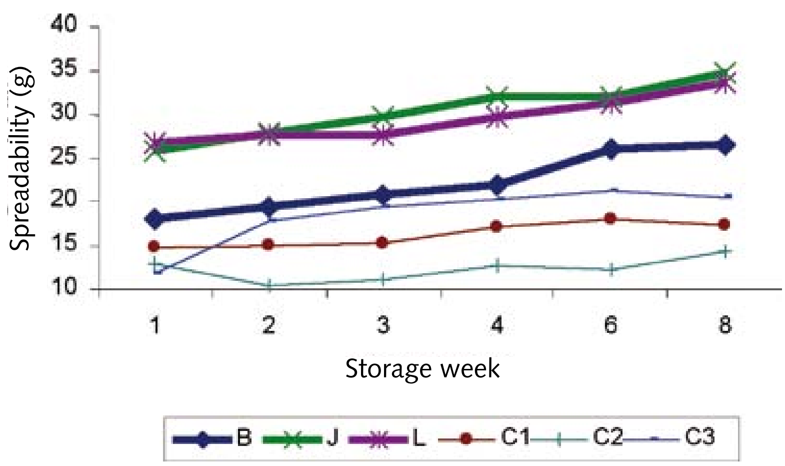
The spreadability of the products after storage for up to eight weeks at 10°C and 20°C are shown in *Figures 1a* and *b.*

Spreadability is a measure of ease of spreading the product into a thin, even layer on bread. Spreadability of the products at 10°C was 77-85 g for the experimental spreads and 70-88 g for the commercial samples after eight weeks' storage. At 20°C storage, the spreadability of the experimental products was 26.5-34.7 g and for the commercial samples, 17.3-20.6 g. The results were slightly higher for the experimental products as a food stabilizer was incorporated. The experimental products were still stable at 30°C after eight weeks storage with no oil separation whereas the commercial samples became very soft and oily. The



Note: B, J, L = palm-based chocolate spread.
C1, C2, C3 = commercial samples.

Figure 2a. Spreadability of palm-based chocolate spreads at 10°C.



Note: B, J, L = palm-based chocolate spread.
C1, C2, C3 = commercial samples.

Figure 2b. Spreadability of palm-based chocolate spreads at 20°C.

experimental samples also did not show post-hardening effect with no significant increase in hardness from the first week of storage. Other parameters monitored in the products are shown in *Table 3*.

The experimental palm-based chocolate spreads (which contained food stabilizer) melted in the same temperature range as the commercial samples. The melting temperatures of the experimental products were 39.3°C -42.6°C while the commercial samples melted at 39.7°C -42.6°C.

Foods with a high a_w have a juicy, moist, tender and chewy texture whereas those with lower a_w a tend to have a hard, dry and tough texture. The experimental products had a_w of 0.76-0.79 and resisted bacterial and mouldy growth for more than six month with the use of potassium sorbate and adequate pasteurization, and having a small particle size (< 5 µm). Water activity in the commercial products was lower because the product was based on full fat chocolate spread. There was no water being added for this type of commercial formulation.

CONCLUSION

The study has shown that low-fat chocolate spread can be produced

TABLE 1. COMPARISON OF THE SOLID FAT CONTENTS OF COMMERCIAL AND EXPERIMENTAL SPREADS AT 10°C-30°C

Spread	Solid fat content (%)		
	10°C	20°C	30°C
Commercial product*	6.3-15.0	1.3-6.8	0.0-2.0
Experimental products*	23.1 – 46.6	8.4-25.2	2.5-8.4

Note: * Commercial products contained 35%-40% fat in formulation.
Experimental products contained < than 30% fat in formulation.

TABLE 2. FATTY ACID COMPOSITIONS OF FATS FROM COMMERCIAL AND EXPERIMENTAL BLENDS (%)

Fatty acid	Fat blend (exp)			Commercial sample			
	1	2	3	a	b	c	d
C16:0	22.9	25.6	26.5	9.8	15.0	18.0	17.9
C18:0	4.0	4.1	3.9	4.5	5.4	5.7	3.3
C18:1	28.1	29.0	29.6	55.0	51.4	31.1	54.2
C18:2	43.8	35.7	38.5	20.8	15.2	37.2	15.9
C18:3	0.2	3.9	0.3	0.4	6.3	4.2	5.6
Unsaturated	72.1	68.7	68.5	81.4	76.7	75.0	77.1
Saturated	27.9	31.1	31.5	18.5	22.6	24.8	22.4
Ratio of unsat:sat	2.6	2.2	2.2	4.4	3.4	3.0	3.4
Trans fatty acid content	none	none	none	3.8	2.3	1.8	0.3

TABLE 3. MELTING TEMPERATURES AND WATER ACTIVITY OF CHOCOLATE SPREADS

Sample	Melting temp. (°C)	Water activity (a_w)
B	39.3 $\pm$ 1.9	0.78 $\pm$ 0.02
J	42.6 $\pm$ 2.7	0.79 $\pm$ 0.01
L	41.2 $\pm$ 1.2	0.78 $\pm$ 0.01
C1	40.1 $\pm$ 2.3	0.48 $\pm$ 0.03
C2	42.6 $\pm$ 1.3	0.52 $\pm$ 0.03
C3	39.7 $\pm$ 3.1	0.47 $\pm$ 0.03

Notes: B, J, L : experimental samples.
C1, C2, C3: commercial samples.

using palm-based fats. The advantage of using palm-based fats is that they are *trans*-free and can be used in the formulation without affecting the characteristics of the finished product. The experimental products were found to be comparable to commercial high-fat chocolate spreads in terms of spreadability and melting profile. The low-fat palm-based chocolate spreads were more stable against oil separation at room temperature (30°C) than the commercial products. Longer shelf-life can be achieved with an adequate manufacturing procedure and the use of anti-moulds.

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