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Physical Properties of Red Palm-based Ice Cream

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ABSTRACT

Ice cream was formulated using a blend of non-fat milk solids and red palm olein. The purpose of adding red palm olein was to maximize the use of red palm oil in dairy products. Ice cream was produced using different percentages of red palm olein, namely, 10%, 8% and 5%. The samples were coded as S1, S2 and S3, respectively. The other samples were prepared using 10% fat from red palm olein:palm oil blends at 20:80, 50:50 and 80:20 ratios. The samples were coded as S4, S5 and S6, respectively. Physical and chemical characteristics of the ice cream mixes and ice cream such as viscosity, colour, overrun, meltability and structure were analysed. All the ice creams produced were yellowish in colour due to the presence of carotenoids. Overrun of the ice creams ranged from 35% to 50%, meltability was 95% to 99% and viscosity ranged from 450 to 500 centipoise (cPs). Red palm olein ice creams received higher scores compared to the control sample in terms of appearance, flavour, body and texture, and meltability.

ABSTRAK

Ais krim telah diformulasi dengan menggunakan campuran pepejal susu tanpa lemak dan minyak olein sawit merah. Tujuan penambahan minyak olein sawit merah ialah untuk memaksimumkan penggunaan minyak ini dalam hasil tenusu. Ais krim dihasilkan dengan menggunakan peratusan minyak olein sawit merah yang berbeza, iaitu 10%, 8% and 5%. Sampel ini masing-masing dikodkan sebagai S1, S2 dan S3. Sampel seterusnya disediakan dengan menggunakan 10% lemak daripada campuran minyak olein sawit merah:minyak sawit pada nisbah 20:80, 50:50 dan 80:20. Sampel masing-masing dikodkan sebagai S4, S5 dan S6. Sifat fizikal dan kimia campuran ais krim dan ais krim seperti kelikatan, warna, isi padu udara dan kecairan telah dianalisis. Kesemua ais krim yang dihasilkan menunjukkan warna kekuningan disebabkan oleh kandungan karotenoid. Ais krim yang dihasilkan mempunyai isi padu udara 35% hingga 50%, kecairan 95% hingga 99% dan kelikatan 450 hingga 500 centipoise *(cPs). Ais krim daripada minyak olein sawit merah menerima pencapaian yang tinggi berbanding dengan ais krim kawalan dari segi rupa bentuk, cita rasa, struktur dan tekstur, serta sifat kecairannya.*

Keywords: red palm olein, ice cream, physical characteristics.

INTRODUCTION

The basic ingredients in ice cream include fat, non-fat milk solids (NMS), sweetener, emulsifiers and stabilizers. Most of these ingredients are multi-functional, contributing to different aspects of ice cream manufacture, product quality and stability. For various reasons, whether financial, functional, or consumer preference, manufacturers must explore alternatives to the traditional sources of the basic ice cream ingredients. The products of current interest aim to reduce the fat contribution from milk fat by incorporating red palm olein or its blends with palm oil. Palm kernel oil and palm oil are alternative fats to replace milk fat in ice cream formulation. Palm products are abundantly available, less expensive and have the added advantage of being cholesterol-free. In ice cream fat, content is usually at the level of 10% (Wan Rosnani and Nor Aini, 2000).

Red palm olein is another alternative fat which may be suitable to replace milk fat in the manufacturing of ice cream. Red palm olein is the liquid fraction of red palm oil obtained by fractionation of oil under controlled conditions. Red palm olein is available in the market. It has a bland flavour and contains less than 0.1% free fatty acids. It also contains high amount of carotene (not less than 500 ppm) and vitamin E (more than 800 ppm). Carotene (precursor of vitamin A) and vitamin E are important natural antioxidants (Choo *et al*., 1993).

Red palm olein is fully liquid at temperatures above 25ºC, but tends to form crystals at low temperatures or during prolonged storage under fluctuating temperatures. Solid fat content (SFC) of nor-

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mal palm olein is high at 5ºC and 10ºC. Super oleins with iodine values (IV) of 60 to 64, also have considerably high solid content at 5ºC and 10ºC. These solids are considerably reduced in oleins with IV greater than 65 (Siew, 2000).

Food products using red palm olein can be considered as value-added products as their high β-carotene content makes them more nutritious. Ice creams produced from red palm olein, or its blends with other palm fractions, have a potential market because of their natural pro-vitamin A content. The colour of ice cream can be either natural or synthetic to suit its flavour and appearance. The present study was conducted to investigate the physico-chemical properties of red palm-based ice cream.

MATERIALS AND METHODS

Materials

Red palm olein (RPOo) was obtained from Carotino (M) Sdn Bhd (Pasir Gudang, Johor, Malaysia) and palm oil (PO) was obtained from Jomalina (M) Sdn Bhd (Banting, Selangor, Malaysia). Milk fat and spray-dried skimmed milk powder were purchased from New Zealand Dairy Board, Wellington, New Zealand. Emulsifiers-stabilizers were obtained from Danisco (Denmark) and flavouring from Damah Trading, Kuala Lumpur. Sucrose and glucose syrup were purchased from local supermarkets.

Ice Cream Preparation

A standardized procedure for the production of ice cream was used (Wan Rosnani and Nor Aini, 2000). Reconstituted skimmed milk powder was heated to 40ºC in a jacketed vessel (Armfield Ltd, UK) before a pre-determined amount of red palm olein or its blend was added. The mixture was heated while being agitated before it was homogenized at 200 bar (Niro Soavi, Italy). The mixture was then pasteurized at 72ºC for 30 min, and then rapidly cooled to 4ºC and aged overnight prior to freezing. Different ice cream mixes were prepared using formulations as shown in *Table 1*, and processed according to the flow chart as shown in *Figure 1*.

Slip Melting Point

The slip melting point (SMP) was determined according to MPOB Test Method, p. 4.2 (MPOB, 2005).

Solid Fat Content

The solid fat content (SFC) was determined by pulse nuclear magnetic resonance (NMR), using a Bruker NMS 120 Mini Spec NMR analyser (Karlsruhe, Germany), according to MPOB Test Method, p. 4.9 (MPOB, 2005).

Viscosity

Viscosity was measured using a Brookfield viscometer Model DV11 (Brookfield, USA). The speed was set at 100 rpm and spindle No.# 1 was used. The spindle was dipped into the sample for 25 s before taking the readings.

Overrun

Overrun was calculated using the following formula:

$$\text{Overrun (\%, w/w)} = \frac{W_1 - W_2}{W_2} \times 100$$

where W_1 is the weight of unit volume of mix and W_2 is the weight of unit volume of ice cream.

Meltability

Meltability of ice cream was measured by using a separating funnel. A 30 g sample was placed in a 50 mm diameter separating funnel and tempered at -18°C for 1 hr. The funnel was then placed over a 100 ml measuring cylinder. The melted materials were measured after 45 min.

Colour

Colour was measured using a Minolta Chroma meter, model CR- 300. Each sample was analyse in duplicate. Readings were interpreted as *L*, *a* and *b* values.

Ice Cream Structure

The ice cream mix was warmed to 15ºC after ageing at 4ºC, and combined with a 2% agarose solution (Sea Prep Agarose, FMC, Bio Products, USA), at a ratio of three parts of sample to one part of agarose (Wan Rosnani, 2006). The structure of the ice cream mix was analysed using a Hitachi 7100 Transmission Electron Microscopy (TEM).

Sensory Evaluation

A sensory evaluation of the ice creams was conducted using a multiple comparison test. Ten MPOB staff members were trained as panellists. Samples were coded using three-digit random numbers, and stored in the freezer. Samples were taken out and presented to the panellists just before evaluation. Data were analysed by the analysis of variance (ANOVA) using Microsoft Excel 2000. The significance level was set at 95%.

TABLE 1. COMPOSITION OF PALM-BASED ICE CREAMS

Ingredient (%)	Formulation					
	Red palm olein			Red POo:PO		
	S1	S2	S3	S4	S5	S6
				20:80	50:50	80:20
Fat	10	8	5	10	10	10
Skimmed milk powder	11.15	11.30	13.85	11.15	11.15	11.15
Sugar	12.0	12.0	12.0	12	12	12
Glucose syrup	5.35	5.35	5.35	5.35	5.35	5.35
Emulsifier-stabilizer	0.5	0.5	0.6	0.5	0.5	0.5
Water	61	62.85	63.2	61	61	61

Note: Fat in S1, S2 and S3 were from red palm olein at 10%, 8% and 5%, respectively. Fat in S4, S5 and S6 were at 10% each from red palm olein: palm oil blends at ratios 20:80, 50:50 and 80:20, respectively.

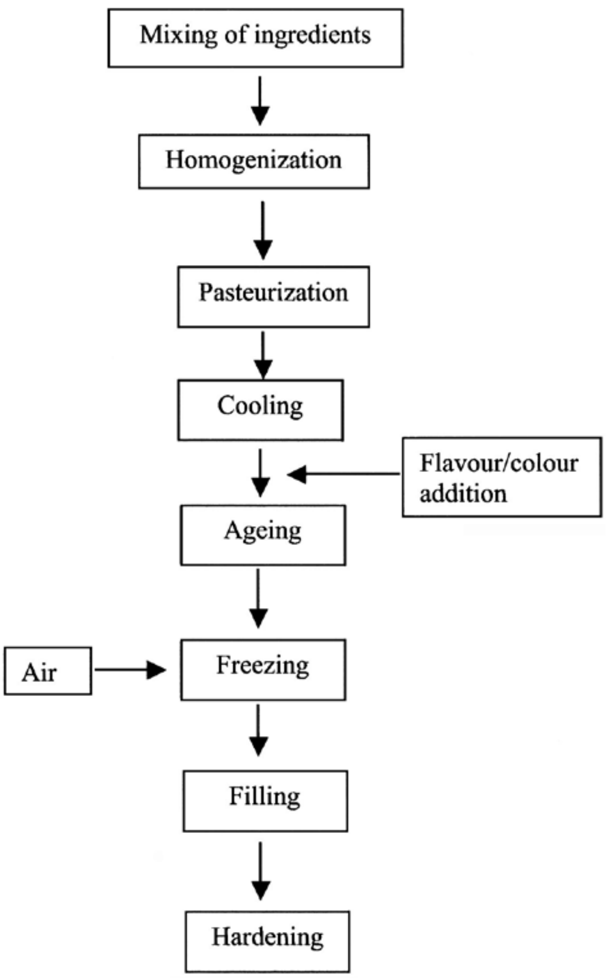


Figure 1. Flow chart for the production of red palm-based ice-cream.

RESULTS AND DISCUSSION

Analyses of the raw materials used showed that all the oils and fats used had a melting point in the range of 20ºC-38ºC. The low slip melting point of palm kernel oil (PKO) was characterized by a high content of triglycerides containing C12. On the other hand, PO had a high content of long-chain triglycerides (LCTs). Fifty percent red palm olein (RPOo) had a melting point around 26ºC. According to Madsen (1984), the best result for fats/oils used in ice cream is achieved with hardened coconut oil or PKO having melting points in the range of 30ºC-33ºC. The melting point of fats is largely determined by the melting points of their constituent fatty acids which in turn are dependent on chain length and degree of unsaturation.

Figure 2 shows the solid fat profile of ice cream fats. PKO with a higher solids content at 5ºC (70%) had a very steep solid fat profile compared to PO (65% solids at 5ºC) and anhydrous milk fat (AMF) (60% solids at 5ºC), while the blend of 50% RPOo with PO had 50% solids at 5ºC. PO had a similar solid fat profile but with a much flatter solid fat curve than AMF. PO exhibited a much wider plasticity and higher solids content at lower temperatures. AMF had lower solids content at all temperatures compared to PKO. At 35ºC, PO and AMF had about 4% solids while PKO was totally liquid. All these fats/oils were suitable for ice cream as they exhibited narrow plastic ranges and low solids content at body temperature. The characteristics of these oils are similar to those reported by Berger (1994), who postulated that the fats for ice cream should be partially solid at 5ºC and substantially liquid at 37ºC with good melting property in the mouth.

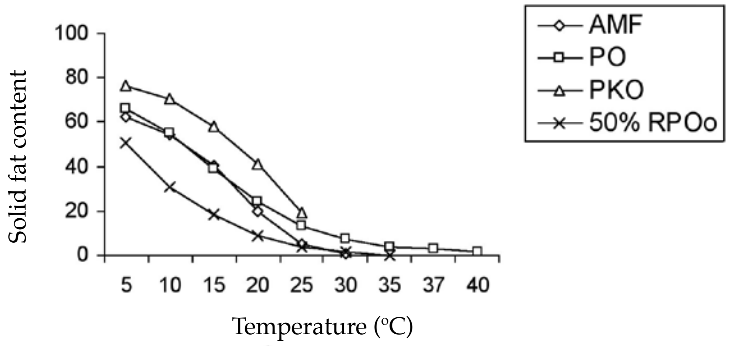


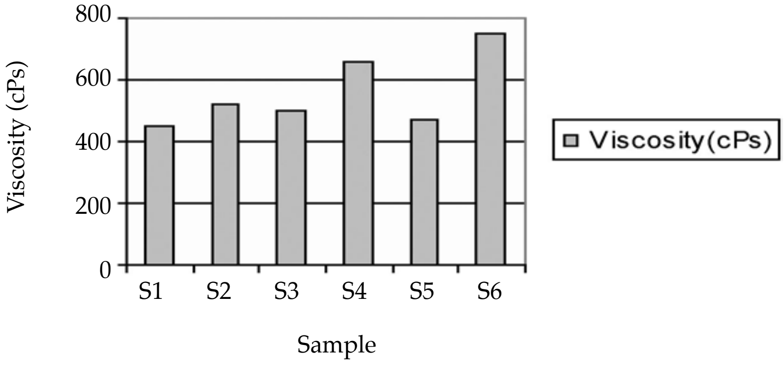
Figure 2. Solid fat content of anhydrous milk fat (AMF), palm oil (PO), palm kernel oil (PKO) and 50% red palm olein (RPOo) blends.

Figure 3 shows the viscosity of the ice cream mixes. The ice cream mix prepared with 20% of RPOo blends (S6) had the highest viscosity, followed by 80% RPOo blends (S4). The formulation containing 100% RPOo (S1) and 50% of RPOo blends (S5) had similar values. A high viscosity value is a function of the stickiness of the mixture. The higher viscosity values of the mixture contributed to higher overruns in the end products.

Overrun is the term used to indicate the volume of air incorporated during the freezing operation. There was not much difference in overruns of ice creams containing blends of RPOo at 20%, 80% and 50% in combination with PO (*Figure 4*). On the other hand, S2 showed the lowest overrun. The amount of air in the ice cream is important because it has to meet legal standards besides affecting profits. Maintaining a uniform amount of air is essential in controlling both quality and quantity.

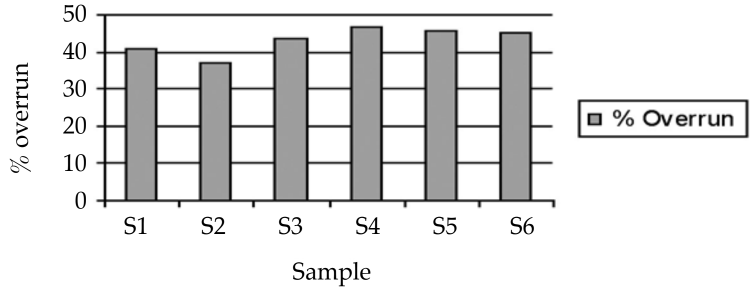
Meltability of ice cream is influenced by the type and amount of fats and the amount of fat incorporated in the ice cream formulation. Ice cream made from binary blends of 50% RPOo: 50% PO had the best melting resistance compared to the other samples (*Figure 5*). After 45 min, 95% of all the ice creams had melted. A faster meltability was noticed by increasing the percentage of RPOo.

Colour is an important quality attribute in marketing, and affects consumers decision on whether or not to buy a product. Colour measurements are reported in the form of *L, a* and *b* values. *L* denotes lightness, *a* shows redness or greenness, and *b* measures yellowness or blueness. The *a* value can take a positive or a negative value, whereby the positive value measures redness and the negative value measures greenness of the samples. A positive *b* value denotes yellowness whereas a negative value denotes blueness. *Table 2* shows that there were only slight differences in the *L, a* and *b* values among the samples. However, it was noted that the *L* values for the formulation S4 were considerably higher than those of the other samples while those of formulation S2 were considerable lower, formulation S1 showed higher *b* values and formulation S4 recorded a lower *b* value than most of the experimental ice cream samples. In terms of *L* values, the experimental ice creams were comparable.



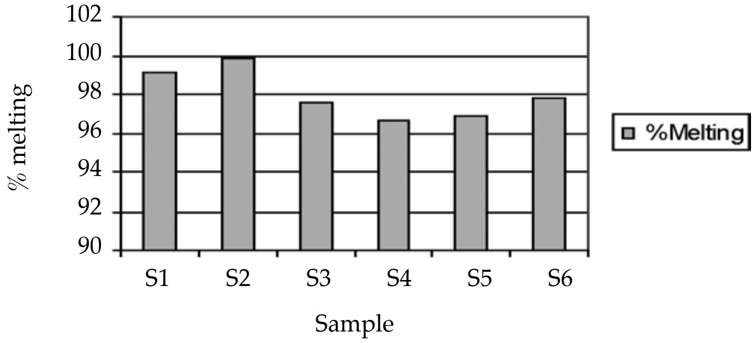
Note: Fat in S1, S2 and S3 were from red palm olein at 10%, 8% and 5%, respectively. Fat in S4, S5 and S6 were at 10% each from red palm olein: palm oil blends at ratios 20:80, 50:50 and 80:20, respectively.

Figure 3. Viscosity of red palm-based ice cream.



Note: Fat in S1, S2 and S3 were from red palm olein at 10%, 8% and 5%, respectively. Fat in S4, S5 and S6 were at 10% each from red palm olein: palm oil blends at ratios 20:80, 50:50 and 80:20, respectively.

Figure 4. Percentage of overrun of red palm-based ice cream.

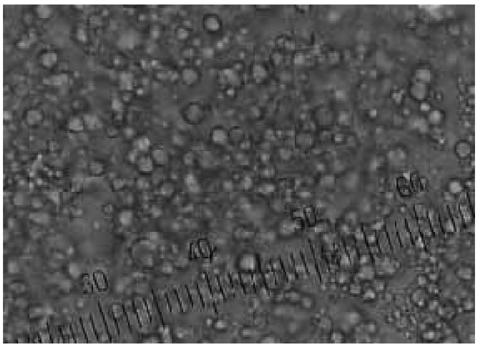


Note: Fat in S1, S2 and S3 were from red palm olein at 10%, 8% and 5%, respectively.
Fat in S4, S5 and S6 were at 10% each from red palm olein: palm oil blends at ratios 20:80, 50:50 and 80:20, respectively.

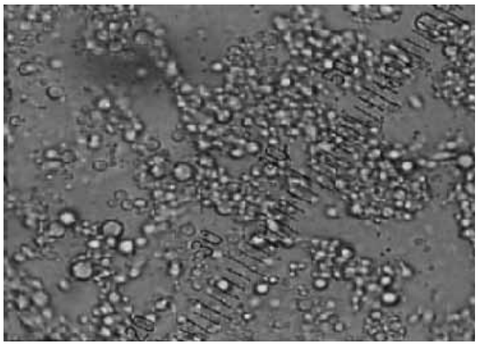
Figure 5. Percentage of melting of red palm-based ice cream.

The colour of the ice cream in this study was mainly contributed by the carotene in the RPOo. Carotene causes the yellow colour of the ice creams. This yellowish colour in red palm olein ice cream is compatible to vanilla or tropical fruit flavours.

The microstructure of ice cream mixes are shown in *Figures 6* and *7*. The fat globules and air cells were visible under optical (light) microscopy (*Figure 6*), but the dimensions of the casein micelles were below the resolution limits of light microscopy. However, casein micelles could be seen using an electron microscope (*Figure 7*), which has higher resolution than optical microscopy. Casein micelles are protein particles approximately 100 nm in diameter, while fat globules range from 500 nm to 10 μm. Casein

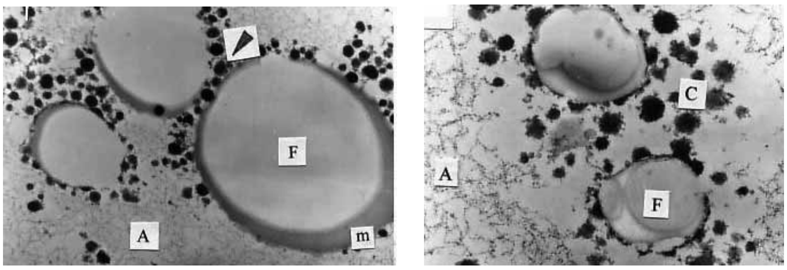


(a)



(b)

Figure 6. Photomicrographs (magnification 40 x 10) of ice cream mixes prepared from (a) dairy-based fat and (b) palm-based fat. 1 cm = 100 μm.



(a) (b)

Note: F = fat globule.
C = casein micelle.
A = agarose matrix.
m = membrane.

Figure 7. Transmission electron micrograph (magnification 20 x 1000) of ice cream mixes prepared from (a) dairy-based fat and (b) palm-based fat. Arrow points to two fat globules joined together by the adsorption of a casein micelle onto each globule. Bar = 10 μm.

TABLE 2. APPEARANCE OF RED PALM-BASED ICE CREAM

Sample	*L*	*a*	*b*	Colour description
S1	82.33	+4.97	+65.02	orange
S2	79.83	+5.44	+62.94	orange
S3	85.85	+0.90	+56.70	yellow
S4	88.52	+3.05	+36.80	corn
S5	83.80	+2.77	+57.25	egg yolk
S6	85.82	+4.31	+60.35	orange

Note: *-a*: green; *+a*: redness; *+b*: yellowness; *-b*: blueness; *L*: lightness

Fat in S1, S2 and S3 were from red palm olein at 10%, 8% and 5%, respectively. Fat in S4, S5 and S6 were at 10% each from red palm olein: palm oil blends at ratios 20:80, 50:50 and 80:20, respectively.

TABLE 3. SENSORY EVALUATION OF RED PALM-BASED ICE CREAM

Sample	Appearance	Flavour	Body and texture	Meltability
RPOo	8.2 ± 1.03	7.6 ± 2.17	8.1 ± 1.28	8.7 ± 0.82
PO	7.7 ± 1.35	7.3 ± 1.33	7.2 ± 1.09	7.2 ± 1.32
PKO	7.7 ± 1.17	6.1 ± 1.94	6.8 ± 1.01	6.6 ± 1.39
RPOo:PO (20:80)	8.0 ± 1.25	6.9 ± 1.45	7.5 ± 1.72	8.2 ± 1.03
RPOo:PO (50:50)	7.7 ± 1.70	7.5 ± 1.84	7.7 ± 1.34	7.9 ± 1.20
RPOo:PO (80:20)	8.7 ± 0.82	8.6 ± 1.51	8.6 ± 0.70	8.2 ± 1.32
Control	7.3 ± 1.61	6.3 ± 1.94	6.2 ± 1.64	6.6 ± 1.57

Note: RPOo : red palm olein.
PO : palm oil.
PKO : palm kernel oil.
Control : anhydrous milk fat.

micelles adhering to the fat globules were observed in *Figure 7*. The number of casein micelles adsorbed to the fat globules increased after 24 hr of ageing. The membrane of the fat globules appeared darker and thicker in the mix containing dairy-based fat compared to palm-based fat. The membrane of palm-based fat was weakly bound and was easily stripped off to expose a crystalline liquid. Liquid fat escaping from these ruptured membranes, thus, became the cementing agent in fat destabilization during freezing.

Results of the sensory evaluation of red palm-based ice creams are shown in *Table 3*. Red palm olein ice creams received higher scores compared to the control sample in terms of appearance, flavour, body, texture and meltability. The control sample was prepared with AMF. Ice cream prepared with the RPOo:PO (80:20) blend had better sensory scores compared to palm oil itself. This indicates that good quality ice cream can be produced using red palm olein, either singly or as blends with other palm oil fractions.

CONCLUSION

This investigation demonstrated that red palm olein and their blends with palm oil at different ratios are suitable as alternative fats in ice cream production. Physical characteristics of the ice creams produced with red palm olein and their blends showed good quality characteristics. This new potential application will certainly provide an opportunity to expand the usage of red palm olein in ice cream manufacture.

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REFERENCES

BERGER, K G (1994). The use of palm and palm kernel oils in ice cream and whipped cream products. *PORIM Information Series.* p. 1-4.

CHOO, Y M; MA, A N; YAP, S C; OOI, C K and YUSOF BASIRON (1993). Production and application of deacidified and deodorized red palm oil. *Palm Oil Developments No. 19*: 30-34.

MADSEN, J (1984). The used of vegetable fats in dairy products. *Lipid Forum Symposium*. Swedish Food Institute, Goteborg, Sweden. p. 45-48.

MPOB (2005). *MPOB Test Method*. MPOB, Bangi. p. 4.2 , 4.9.

SIEW, W L (2000). Characteristics of palm olein from *Elaeis guineensis* palm oil. *MPOB Technology No. 23*: 1-12.

WAN ROSNANI, A I and NOR AINI, I (2000). Application of palm products in ice cream. *Palm Oil Developments No. 33*: 8-12.

WAN ROSNANI, A I (2006). Effect of ageing on rheological behaviour of non-dairy ice cream mix. *MPOB Viva Report No.* 356/2006(08). p. 1-27.