Composition and Thermal Characteristics of Madhuca longifolia Seed Fat and Its Solid and Liquid Fractions

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Abstract: This study was to characterize the seed fat from Madhuca longifolia known as Mee fat and its solid and liquid fractions with the objective of distinguishing them. A sample of Mee fat was partitioned into solid and liquid fractions using acetone as the solvent medium. The isolated fractions were compared to the native Mee fat sample with respect to various physico-chemical parameters using standard chemical methods as well as instrumental techniques such as, gas liquid chromatography (GLC), reversed-phase high performance liquid chromatography (RP-HPLC), and differential scanning calorimetry (DSC). Basic analyses indicated that there were wide variations between the native sample and its fractions with respect to iodine value (IV), and slip melting point (SMP). The cloud point (CP) of the liquid fraction was found to be 10.5°C. Fatty acid compositional analyses showed that the proportion of saturated fatty acids (SFA) such as palmitic and stearic went up in the high-melting fraction (HMF) while in low-melting fraction (LMF) the proportion of unsaturated fatty acid (USFA) such as oleic and linoleic increased. According to the HPLC analyses, Mee fat had a triacyl glycerol (TAG) sequence similar to that of palm oil. After fractionation, the solid and liquid fractions obtained were found to have TAG profiles very much different from the native sample. Thermal analyses by DSC showed that Mee fat had two-widely separated high and low melting thermal transitions, a feature which was beneficial for the effective separation of solid and liquid fractions. The thermal profiles displayed by the fractions were clearly distinguishable from that of the native sample.

Key words: cocoa butter substitute, confectionery fat, DSC, fractional crystallization, Madhuca longifolia, Mee fat, seed fat

1 INTODUCTION

Madhuca longifolia is a large-grown, woody tree distributed in the North-Central part of Sri Lanka. Belonging to the family Sapotaceae, the tree is reported to have its origin from South-east Asia. Being known for its medicinal value, several parts of the tree find uses in the folk medicine of Sri Lanka1. Likewise, its uses in the Indian folk medicine are described elsewhere in the literature2. Madhuca longifolia flowers seasonally and produces green-fleshy fruits containing three to four seeds which are ellipsoidal in shape. Unlike many other tropical fruit seeds, the seeds of Madhuca longifolia show a good commercial potential as a source of vegetable fat. According to past reports, the fruit seeds may have 50 to 58% oil (w/w, db)3 and hence, a high possibility exists for oil recovery from the seed via commercial screw-press expellers. The crude oil extracted from the seeds is locally known as Mee fat, which is pale yellow in color and remains as a semi-solid under the tropical temperature conditions.

As common with many other tropical fruit seeds, seed of Madhuca longifolia is also among the under-utilized for oil production. This could probably be due to the lack of technical information with regard to its properties and potential uses. However, a few reports already appeared in the literature highlighted the compositional characteristics of the Indian Mahua seed fat and indicated its potential uses as confectionery fat4,5. As the Sri Lankan Mee fat usually exists in the semi-solid form, under tropical conditions, there may be a possibility for its separation into solid and liquid fractions. This may eventually provide opportu-
nities to enhance its utilization in many food applications. Hence, the objective of this study was to compare Mee fat and its solid and liquid fractions in terms of different physico-chemical characteristics.

2 EXPERIMENTAL

2.1 Materials

Dried fruit seeds of *Madhuca longifolia* were collected from three different locations in the North Central Province of Sri Lanka. A sample of palm oil (Slip Melting Point: 30.5°C; Iodine Value: 54) was purchased from a local refinery in Malaysia while a sample of cocoa butter was obtained as a generous gift from the Malaysian Cocoa Board. All chemicals used in this experiment were of analytical or HPLC grade.

2.2 Methods

2.2.1 Extraction of Mee fat

Dried kernels of *Madhuca longifolia* seeds were fed into a micro-oil expeller (Komet oil press, Oekotec, Germany) for oil extraction. Extracted oil sample was collected in plastic buckets and kept for one hour in an oven at 60°C prior to filtration using Whatman No. 1 filter paper. The filtered oil samples were bottled into 500 mL plastic bottles for further studies.

2.2.2 Fractional crystallization of Mee fat

Fractional crystallization was carried out according to the following procedure using acetone as solvent medium: A portion of native sample of Mee fat was melted at 60°C and mixed with acetone in 12 (w/v) ratio. The solution was boiled at 60°C until become uniformly dissolved and left at 7±1°C for 2 h to crystallize. The precipitated fat was filtered off to give a high melting fat fraction. The filtrated mother-liquor was re-crystallized in the same condition for another 2 h and a second fat fraction was collected. It was boiled at 70°C for 2 h to crystallize. The precipitated fat was filtered off to give a low melting fat fraction. The filtrated mother-liquor was again left at 5±1°C for 24 h to allow the remaining solid to precipitate. After removing the precipitate the mother-liquor was evaporated under reduced pressure to yield a liquid called low-melting fraction (LMF).

2.2.3 Determination of cloud point (CP), slip melting point (SMP) and iodine value (IV)

CP, SMP and IV of the fat samples were determined according to AOCS method Cc.6.25, AOCS method Cc.3.25, and AOCS method Cd Id–92, respectively (AOCS 1993)4).

2.2.4 GLC analysis of fatty acid methyl esters (FAME)

FAME were prepared using 14% BF3/methanol solution (Shimazu GC-14 A) fitted with a FID detector. A polar capillary column BPX70 (0.32 mm internal diameter, 30 m length and 0.25 lm film thickness; SGE International Pty, Ltd., Victoria, Australia) was used at a column pressure of 10 psi. The temperature of the column was 90°C, programmed to increase to 220°C at 15°C/min (for 5 min), 2°C/min (for 20 min) and 15°C/min (for 1 min). The temperatures of the injector and detector were maintained at 240°C 5).

2.2.5 HPLC analysis of TAG composition

The system used was a Waters Model 510 liquid chromatograph equipped with a differential refractometer Model 410 as the detector (Waters Associates, Milford, MA). The analysis of TAG was performed on a Merck Lichrosphere RP-18 Column (5 µm) column (12.5 cm × 4 mm i.d.; Merck, Darmstadt, Germany). The mobile phase was a mixture of acetone-acetonitrile (63.5:36.5) and the flow rate was 1 mL/min at 30°C. The injector volume was 10 µL of 5% (w/w) oil in chloroform. Each sample was chromatographed two times, and the data were reported as percentage areas 5).

2.2.6 DSC Thermal analysis

Thermal analysis was carried out on a Perkin-Elmer differential scanning calorimeter (Pyris-Diamond Model) equipped with a thermal analysis data station (Perkin-Elmer Corp., Norwalk, CT). Nitrogen (99.999% purity) was used as the purge gas at a rate of ~20 mL/min. Approximately 6-8 mg of melted sample was placed in a standard DSC aluminum pan and then hermetically sealed. An empty, hermetically-sealed DSC aluminum pan was used as the reference. The oil/fat samples were subjected to the following temperature program: 70°C isotherm for 1 min, cooled at 5°C/min to ~70°C. The samples were held at ~70°C isotherm for 1 min, and heated at 5°C/min to reach 70°C 5).

2.2.7 Solid fat content (SFC) analysis by pulse NMR

SFC was measured using a Bruker Minispec (Model Mq 20) pulse Nuclear Magnetic Resonance (pNMR) spectrometer (Karlsruhe, Germany). Measurements were taken according to PORIM parallel method: the sample in the NMR tube was melted at 70°C for 15 min, followed by chilling at 0°C for 60 min, and then held at each measuring temperature for 30 min prior to measurement. Melting, chilling and holding of the samples were carried out in pre-equilibrated thermostatted glycol containing baths, accurate to 0.1°C. SFC measurements were taken at 5°C intervals over the range of 0–40°C 5).

3 RESULTS AND DISCUSSION

3.1 Cloud point, slip melting point and iodine value

CP, SMP and IV are important parameters related to the nature of fatty acid and TAG distribution of oils and fats. The data presented in Table 1 shows that the average SMP of Mee fat is 35.5°C, which is comparable to those of Malaysian Cocoa butter, as well as Borneo Illipe butter 36.
Characteristics of Mee Fat and Its Fractions

The SMP value being below the physiological temperature indicates its suitability for edible applications, such as fat substitute in confectionery industry. Upon fractionation, the SMP of the solid component, HMF, is found to exceed the physiological temperature. However, its value is within the range of the commercially available palm sterine samples. According to past survey studies, the SMPs of commercial stearines are found to range from 44.4 to 56.2\(^{\circ}\text{C}\). Hence, it may be useful as a raw-material for preparing fat blends that could be used as commercial shortenings. On the other hand, the low-melting fraction, LMF remains as a liquid in all temperatures above 10\(^{\circ}\text{C}\). The CP value of LMF is within the range found in most of the commercially available palm olein samples\(^9\). Thus, it may have some resistance to clouding effect, particularly, if its intended use is as cooking oil for temperate climatic regions. The data presented in Table 1, also compares the iodine value of Mee fat with those of its fractions. According to the data, the IV of Mee fat is well-above from those reported for Malaysian cocoa butter or Borneo Illipe butter\(^7\,^8\). With respect to the native sample, the IV of LMF was increased by 3 units while the corresponding decrease in IV of HMF was by 14 units. Although the IV of HMF does not come closer to the two plant-derived fats such as cocoa butter and Borneo Illipe butter, it is found to be in the IV range of commercial stearines\(^9\). On the other hand, the IV of LMF is slightly higher than those of the commercially available palm olein samples\(^9\,^{10}\).

### Table 1 Cloud Point, Slip Melting Point, and Iodine Values of Mee Fat and Its Fractions\(^1\).

<table>
<thead>
<tr>
<th>Sample</th>
<th>Cloud point ((^{\circ}\text{C}))</th>
<th>Iodine value (g I(_2/100) g)</th>
<th>Slip melting point ((^{\circ}\text{C}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>(^a)MF</td>
<td>–</td>
<td>61.1±0.35</td>
<td>35.5±0.5</td>
</tr>
<tr>
<td>(^b)HMF (Solid)</td>
<td>–</td>
<td>47.05±0.05</td>
<td>46.5±0.7</td>
</tr>
<tr>
<td>(^c)LMF (Liquid)</td>
<td>10.5±0.5</td>
<td>64.4±0.45</td>
<td>–</td>
</tr>
</tbody>
</table>

\(^1\)Each value in the table represents the mean of two determinations.

\(^a\)MF, Mee fat.

\(^b\)HMF, high-melting fractions.

\(^c\)LMF, low-melting fraction.

### Table 2 Fatty Acid Composition of Mee Fat and Its Fractions\(^1\).

<table>
<thead>
<tr>
<th>Sample</th>
<th>C16:0</th>
<th>C18:0</th>
<th>C18:1</th>
<th>C18:2</th>
<th>(^a)SFA</th>
<th>(^b)USFA</th>
</tr>
</thead>
<tbody>
<tr>
<td>MF</td>
<td>20.88±1.51</td>
<td>22.05±0.9</td>
<td>44.02±1.1</td>
<td>7.85±0.77</td>
<td>43.4±2.15</td>
<td>51.85±2.55</td>
</tr>
<tr>
<td>HMF (Solid)</td>
<td>25.28±1.33</td>
<td>29.01±0.84</td>
<td>38.38±1.6</td>
<td>5.72±0.56</td>
<td>54.28±2.46</td>
<td>44.1±2.86</td>
</tr>
<tr>
<td>LMF (Liquid)</td>
<td>19.28±1.2</td>
<td>16.2±0.67</td>
<td>53.12±0.95</td>
<td>9.61±0.88</td>
<td>35.48±2.6</td>
<td>62.73±2.58</td>
</tr>
</tbody>
</table>

\(^1\)Each value in the table represents the mean of two determinations.

\(^a\)SFA, saturated fatty acids.

\(^b\)USFA, unsaturated fatty acids.

3.2 Fatty acid composition

Fatty acid profiles of Mee fat and its fractions are compared in Table 2. The major fatty acids of Mee fat are oleic, stearic, palmitic, and linoleic. Although oleic is the most dominant FA of Mee fat, its high contents of stearic and palmitic acids displays its closer resemblance to other plant derived fats such as Malaysian cocoa butter, Borneo Illipe butter, etc\(^7\,^8\). This characteristic feature seemed to have been affected by fractionation as there were considerable deviations in the fatty acid profiles of the fractions. In HMF, the SFA content increased with a concurrent decrease in its USFA content (Table 2). Its fatty acid profile showed closer comparison to that of Malaysian cocoa butter with regard to the proportion of palmitic and oleic acids, but did not show much comparison to that of commercial palm stearine\(^9\,^{11}\). This shows that there could be considerable amount of palmitic and steric acids migrating into the solid phase during crystallization. In the meantime, the SFA content of LMF fraction decreased with a concurrent increase in the USFA content. Naturally, with the departure of more palmitic and steric acids into the solid phase, the liquid phase becomes enriched with oleic acid (Table 2). The liquid fraction becoming rich in oleic acid is beneficial for its use as cooking oil for temperate climatic regions. These changes in the fatty acid compositions of the fractions are also found to tally with the change in the degree of unsaturation of fractions as indicated by the IV (Table 1).
Comparative TAG profiles of Mee fat and its fraction are presented in Fig. 1. Owing to the non-availability of individual standards, TAG peak identification of Mee fat was made with reference to the TAG profiles of palm oil and Malaysian cocoa butter samples (Table 3\textsuperscript{8,12}). According to Table 3, the TAG profile of Mee fat shows closer comparison to that of palm oil. Hence, it can be deduced that the combination of TAG molecules formed by palmitic, oleic and steric acids could be responsible for the semi-solid nature displayed by Mee fat. It is because the combined effect of both palmitic and stearic acids in TAG molecules may tend to elevate the melting points of fatty materials\textsuperscript{13}. Among the TAG molecules of Mee fat, OOP is the most dominant followed by POS and OOS. A fingerprint comparison with the TAG profile of Malaysian cocoa butter showed that Mee fat also had considerable amount of POP, POS, and SOS molecules. But, the proportional distribution of POP, POS, and SOS in Mee fat is not comparable to either Malaysian cocoa butter or Borneo Illipe butter\textsuperscript{8,14}. It could be a probable reason for the soft nature of Mee fat as against the usual brittle nature displayed by the other two plant-derived fats. The TAG profiles of the liquid and solid fractions obtained after fractionation show considerable

Table 3 Triacylglycerol Composition of Mee Fat and Its Fractions\textsuperscript{1}.

<table>
<thead>
<tr>
<th>Peak no.</th>
<th>TAG</th>
<th>MF</th>
<th>LMF</th>
<th>HMF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>OOL</td>
<td>3.0±0.26</td>
<td>2.60±0.1</td>
<td>1.45±0.00</td>
</tr>
<tr>
<td>2</td>
<td>PLO</td>
<td>4.26±0.37</td>
<td>2.59±0.15</td>
<td>1.77±0.00</td>
</tr>
<tr>
<td>3</td>
<td>PPL</td>
<td>1.19±0.04</td>
<td>Tr.</td>
<td>0.35±0.03</td>
</tr>
<tr>
<td>4</td>
<td>OOO</td>
<td>9.85±0.22</td>
<td>12.56±0.05</td>
<td>3.47±0.04</td>
</tr>
<tr>
<td>5</td>
<td>OOP</td>
<td>22.92±0.88</td>
<td>28.65±0.06</td>
<td>9.00±0.01</td>
</tr>
<tr>
<td>6</td>
<td>PPO+POP</td>
<td>11.92±0.66</td>
<td>12.07±0.02</td>
<td>13.95±0.06</td>
</tr>
<tr>
<td>7</td>
<td>PPP</td>
<td>Tr.</td>
<td>Tr.</td>
<td>0.2±0.1</td>
</tr>
<tr>
<td>8</td>
<td>OOS</td>
<td>17.80±0.00</td>
<td>24.05±0.07</td>
<td>7.42±0.02</td>
</tr>
<tr>
<td>9</td>
<td>POS</td>
<td>19.34±0.44</td>
<td>14.05±0.00</td>
<td>35.09±0.04</td>
</tr>
<tr>
<td>10</td>
<td>PPS</td>
<td>Tr.</td>
<td>Tr.</td>
<td>1.76±0.04</td>
</tr>
<tr>
<td>11</td>
<td>SOS</td>
<td>9.74±0.58</td>
<td>3.45±0.2</td>
<td>23.78±0.04</td>
</tr>
<tr>
<td>12</td>
<td>UK</td>
<td>–</td>
<td>–</td>
<td>1.86±0.1</td>
</tr>
</tbody>
</table>

\textsuperscript{1}Each value in the table represents the mean of two determinations.

\textsuperscript{2}Abbreviations: O, oleic; P, palmitic; L, linoleic; S, stearic; TAG, triacylglycerol; Tr, trace level; UK, unknown.
deviations from that of the native Mee fat sample (Fig. 1). In the liquid fraction, the TAG molecular species such as OOO, OOP and OOS experienced increments while TAG species such as POS and SOS undergone decreases. The relative increase in the proportion of diunsaturates and triunsaturates would have lead to the increase of oleic acid content as seen in Table 2 and, hence the elevation of IV of LMF (Table 1). In the solid fraction, TAG molecular species such as POP, POS, and SOS experienced increments while there were considerable decreases in the proportion of PLO, OOO, OOP, and OOS. This would make HMF, a potential cocoa butter substitute. Due to the drop in the proportion of triunsaturates and diunsaturated TAG molecules, the SMP of the HMF was found to increase while its IV tended to decrease (Table 1) 13).

3.4 Solid fat content profiles
The SFC of Mee fat and its fractions measured as a function of temperature is given in Fig. 2. The solid fat content of Mee fat at 0°C is 33% (Fig. 2) while that of Malaysian cocoa butter is 94% (unpublished data). This wider difference may support the presumption that the physical nature of Mee fat is softer when compared to Malaysian cocoa butter, which is hard and brittle. It is due to the fact that high SFC means the firmness of fat as it is the solid component that imparts the plasticity and rigidity to fatty materials15). After fractionation, the SFC profile of solid fraction is found to have a pattern similar to that of Mee fat, but the values are always higher than those of the native sample. For example, the SFC value of HMF at 0°C is 48% and it could be probably due to the fact that the HMF becomes enriched with more disaturated TAG molecules (Table 3) which may crystallize at higher temperatures13). On the other hand, the liquid fraction always had a lower SFC than the native sample, and tended to become zero even just below 10°C. This could be a direct result of the enrichment of unsaturated TAG molecules in LMF as noticed in Table 3. In this case, having a lower SFC for LMF would be advantageous, if its intended use is cooking oil.

3.5 Thermal behavior by DSC
3.5.1 Cooling profiles
The DSC cooling thermograms of Mee fat and its fractions are presented in Fig. 3. The cooling profile of the
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Table 4 Thermal Transitions in the Cooling and Melting Curves of Mee Fat and Its Fractions.

<table>
<thead>
<tr>
<th>DSC Curve</th>
<th>Sample</th>
<th>Thermal transition (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Crystallization</td>
<td>MF</td>
<td>25.4±0.2</td>
</tr>
<tr>
<td></td>
<td>HMF</td>
<td>40.15±0.1</td>
</tr>
<tr>
<td></td>
<td>LMF</td>
<td>-</td>
</tr>
<tr>
<td>Melting</td>
<td>MF</td>
<td>-1.50±0.1</td>
</tr>
<tr>
<td></td>
<td>HMF</td>
<td>-3.65±0.1</td>
</tr>
<tr>
<td></td>
<td>LMF</td>
<td>-5.40±0.1</td>
</tr>
</tbody>
</table>

1Each value in the table represents the mean of duplicate analyses. Abbreviations: See Table 1.

Fig. 4 DSC Melting Profiles of Mee Fat (Curve B) and Its Solid (Curve A) and Liquid (Curve C) Fractions.

native sample [curve (B)] displayed three exothermic transitions. The exothermic peak at 25.4°C (b1) represented the high-melting TAG group (HMG), which appear to crystallize first while the two peaks at 1.05°C (b2) and -21.4°C (b3) represented the low-melting TAG group (LMG), which undergo crystallization later. In fact, the high and low-melting transitions existing in wider separation could be an indication of a better fractionation in Mee fat. In Fig. 3, the cooling profiles of the fractions LMF and HMF are represented by the curves (A) and (C), respectively. Clearly, they demonstrated features that were distinctly different from those of the native sample. As the curve (C) had its major exothermic transition (c1) in the higher temperature region with two minor peaks (c2) and (c3) in the lower temperature region, it can be assumed to have emerged from the high-melting TAG component of the native Mee fat sample. According to the data presented in Table 4, the major transition of solid fraction was at 40.15°C, with two minor transitions appearing at -2.40°C, and -23.15°C. With respect to the cooling profile of the native sample as represented by curve (B) in Fig. 3, the major transitions of this fraction showed a relative increase in the enthalpy change with a concurrent shift in its peak position towards the higher temperature region. In fact, the enthalpy change of the major thermal transition was increased by 133%. These changes in DSC parameters of HMF could be attributed to the enrichment of the disaturated (PPL, FPO, POP, and POS) and trisaturated (PPP and PPS) TAG molecules during crystallization. According to Table 3, the increase in the content of disaturates in the HMF fraction was 73.45%. The co-existence of two smaller low-melting peaks, (c2) and (c3) along the major high-melting transition was a characteristic feature noticed in this fraction. This could be due to the fact that some amounts of the diunsaturated and triunsaturated TAG groups, tended to co-crystallize with the disaturated TAG during crystallization. According to Table 3, 18.19% diunsaturates (OOS, OOP, and PLO) and 4.92% triunsaturates (OOL and OOO) were present in the TAG.
composition of HMF.

The low-melting fraction represented by curve (A) in Fig. 3 displayed a different profile from that of the high melting fraction. It had its major exothermic transitions at 0°C (a₁) and ~30.0°C (a₂) (Table 4). The absence of any thermal transition above 5°C was an indicative feature, which could be used to establish its identity as the liquid fraction. With respect to the cooling profile of the native sample [curve (B) of Fig. 3], the enthalpy change of its thermal transition was increased by 71.7%. Hence, it could be assumed to have emerged from the low-melting TAG component of the native sample. Based on the HPLC analysis, LMF was found to have 55.29% of diunsaturated (OOS, OOP, and PLO) and 15.16% triunsaturated (OOL, and OOO) TAG molecules. These were TAG molecules tend to crystallize at relatively lower temperatures [13]. Due to this reason, the thermal transitions of LMF were found to have shifted into the low-temperature region of the DSC curve (Table 4).

3.5.2 Melting profiles

DSC melting profile of Mee fat and its two fractions are compared in Fig. 4. As seen previously with the cooling profile, here also, the native sample had two well-separated endothermic transitions, which could be identified as the low and high melting regions [curve (B)]. The low-melting region consisted of a major sharp peak at ~1.5°C (b₁) with a shoulder-peak at 5.6°C (b₂) while the high-melting transition was a broad peak with a maxima at 37.7°C (b₃) (Table 4). The curve (A) representing HMF is distinguishable from that of the native sample, as its high-melting thermal transition becomes more dominant than the low-melting transition. It had its major transition at 46.25°C (a₂) with a minor transition at ~3.5°C (a₁). With respect to the curve (B) of the native sample, the enthalpy change of the major transition was increased by 150.8% and the peak positions were also found to have shifted towards the higher temperature region. As already discussed, these changes could be due to the increasing proportion of disaturated TAGs, which are generally found to have higher melting points [13].

Curve (C) in Fig. 4 representing LMF differed remarkably from those of the HFM as well as of the native Mee fat sample. It had its major thermal transition in the low-temperature region at ~5.4°C (c₁) and a minor transition at 23.8°C (c₂). With respect to the native sample, the enthalpy change of the high-melting transition was reduced by 76.15% while the relative proportional increase in the enthalpy change of the low-melting transition was 71.3%. In addition, the shifting peak maxima of thermal transitions of LMF toward the low-temperature region indicated the changing proportional distribution of different TAG molecules. As already explained in crystallization profiles, here too, the reason for these changes could be attributable to the increasing proportion of diunsaturated and triunsaturated TAG groups in the liquid fraction (Table 3).

4 CONCLUSIONS

Mee fat and its solid and liquid components separated in acetone were characterized and compared. Generally, the native Mee fat sample and its solid and liquid fractions are distinguishable based on the basic physico-chemical characteristics and fatty acid profiles. HPLC analyses showed that the liquid fraction becomes enriched with triunsaturated and diunsaturated TAG molecules while the solid fraction showed more increases with respect to the disaturated TAG molecules such as POP, POS, and SOS. Thermal analyses indicated that a more direct and rapid distinction between the native sample and its fractions could be made through the DSC thermograms. As such, they can be used as finger prints to identify the solid and liquid component emerging from fractionation of Mee fat.

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References

9. PORIM technology. No. 4, Palm Oil Research Institute of Malaysia (PORIM). Ministry of Primary Industries.


