Palm Oil & Fractions: Characteristics and Properties

Nor Aini Idris, Siew Wai Lin
and Mohd. Fairus Hizir

OFI Middle East 2008, 14-16 April, Abu Dhabi
Palm Oil Industry - RM45.1b, planted area of 4.3m hectares, production of 15.8 m tonnes oil.
Oil Palm Bunch

Oil per bunch
20-30%

Bunch weight 20-30 kg

Fruit spiklets

15.8m tonne CPO

1.95m tonne PKO

Kernels
Why PALM OIL?

- Versatility
- Cost effectiveness
- Wide range of products
- 20% solids at 20°C-suited for formulation of plastic fat products
- Nutritive value
PALM OIL- A BALANCED OIL

- 50% UNSATURATED
- 50% SATURATED
Fractionation of palm oil

PO

St 33 → OI 56

Soft pmf 45 → Sp ol 64-65

Hard Pmf 36 → Mid ol 54

PO

St 40 ← OI 62

st25 ← pmf48

PO

St 30-45 ← OI 56-64

St 33 ← OI 56

Soft pmf 42-50 → Sp ol 63-70

Hard st 15-25 → Soft pmf 42-50

Hard pmf 34-42 → Mid ol 54-56

Mid ol 54-56 → Sp ol 63-70

Source: Kellen, M.
<table>
<thead>
<tr>
<th>FAC</th>
<th>Palm Oil</th>
<th>Palm Olein</th>
<th>Super Olein</th>
<th>Palm Stearin</th>
</tr>
</thead>
<tbody>
<tr>
<td>C12:0</td>
<td>0.2</td>
<td>0.2</td>
<td>0.3</td>
<td>0.1-0.3</td>
</tr>
<tr>
<td>C14:0</td>
<td>1.1</td>
<td>1.1</td>
<td>1.0</td>
<td>1.1-1.7</td>
</tr>
<tr>
<td>C16:0</td>
<td>44.0</td>
<td>40.9</td>
<td>35.4</td>
<td>49.8-68.1</td>
</tr>
<tr>
<td>C18:0</td>
<td>4.5</td>
<td>4.2</td>
<td>3.8</td>
<td>3.9-5.6</td>
</tr>
<tr>
<td>C18:1</td>
<td>39.2</td>
<td>41.5</td>
<td>45.1</td>
<td>20.4-34.4</td>
</tr>
<tr>
<td>C18:2</td>
<td>10.1</td>
<td>11.6</td>
<td>13.4</td>
<td>5.0-8.9</td>
</tr>
<tr>
<td>C18:3</td>
<td>0.4</td>
<td>0.3</td>
<td>0.3</td>
<td>0.1-0.5</td>
</tr>
<tr>
<td>C20:0</td>
<td>0.4</td>
<td>0.2</td>
<td>0.3</td>
<td>0.3-0.6</td>
</tr>
</tbody>
</table>
## Triacylglycerol composition of palm oil

<table>
<thead>
<tr>
<th>TAG</th>
<th>wt%</th>
<th>TAG</th>
<th>wt%</th>
<th>TAG</th>
<th>wt%</th>
<th>TAG</th>
<th>wt%</th>
<th>TAG</th>
<th>wt%</th>
</tr>
</thead>
<tbody>
<tr>
<td>All 0 db</td>
<td>7.4</td>
<td>All 1 db</td>
<td>36.8</td>
<td>All 2 db</td>
<td>34</td>
<td>All 3 db</td>
<td>16.1</td>
<td>All&gt;3 db</td>
<td>5.6</td>
</tr>
<tr>
<td>PPP</td>
<td>5.1</td>
<td>MOP</td>
<td>0.9</td>
<td>POO</td>
<td>20.3</td>
<td>OOO</td>
<td>4.4</td>
<td>LOO</td>
<td>1.8</td>
</tr>
<tr>
<td>PPSt</td>
<td>1.2</td>
<td>POP</td>
<td>23.7</td>
<td>StOO</td>
<td>2.4</td>
<td>POL</td>
<td>4.1</td>
<td>OLO</td>
<td>1.2</td>
</tr>
<tr>
<td>PStP</td>
<td>0.3</td>
<td>PSt</td>
<td>5.7</td>
<td>OPO</td>
<td>1</td>
<td>PLO</td>
<td>5.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>PPO</td>
<td>4.4</td>
<td>PLP</td>
<td>6.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>PStO</td>
<td>0.2</td>
<td>StLP</td>
<td>1.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## TRIGLYCERIDES OF PALM OIL PRODUCTS (C No.)

<table>
<thead>
<tr>
<th>C. No</th>
<th>Palm Oil</th>
<th>Palm Olein</th>
<th>Super Olein</th>
<th>Palm Stearin</th>
</tr>
</thead>
<tbody>
<tr>
<td>C46</td>
<td>0.8</td>
<td>0.8</td>
<td>0.2</td>
<td>3.1</td>
</tr>
<tr>
<td>C48</td>
<td>7.4</td>
<td>3.3</td>
<td>1.9</td>
<td>23.7</td>
</tr>
<tr>
<td>C50</td>
<td>42.6</td>
<td>39.5</td>
<td>30.8</td>
<td>40.3</td>
</tr>
<tr>
<td>C52</td>
<td>40.5</td>
<td>42.7</td>
<td>53.4</td>
<td>25.3</td>
</tr>
<tr>
<td>C54</td>
<td>8.8</td>
<td>12.8</td>
<td>13.6</td>
<td>6.9</td>
</tr>
<tr>
<td>C56</td>
<td>-</td>
<td>0.7</td>
<td>0.2</td>
<td>0.5</td>
</tr>
</tbody>
</table>
Two important physical properties of palm oil

SOLID FAT CONTENTS

POLYMORPHISM
Solid fat contents of palm oil products

- Palm oil
- Stearin
- Hpo(43)
- Olein
- Hard stearin
- Shortening
Morphology of Crystals

\[ \alpha \text{ Small} \]

\[ \beta' \text{ Small, } \approx 5 \ \mu m, \text{ needle-like} \]

\[ \beta \text{ large, course, as large as 50 } \mu m \text{ or more, dense, flat} \]
Palm oleins

TWO TYPES

• IV 56 – 60

• IV >60
Fatty acid composition (wt%) of palm olein

<table>
<thead>
<tr>
<th>IV</th>
<th>C14</th>
<th>C16</th>
<th>C18</th>
<th>C18-1</th>
<th>C18-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;60</td>
<td>1.0</td>
<td>37.9</td>
<td>4.1</td>
<td>43.4</td>
<td>12.5</td>
</tr>
<tr>
<td>60-64</td>
<td>1.0</td>
<td>34.8</td>
<td>3.8</td>
<td>45.5</td>
<td>14.2</td>
</tr>
<tr>
<td>&gt;65</td>
<td>1.0</td>
<td>30.8</td>
<td>3.6</td>
<td>47.9</td>
<td>15.4</td>
</tr>
</tbody>
</table>
SFC AT 2.5 AND 5°C

Super olein
SFC of palm oil and oleins

![Graph showing SFC of palm oil and oleins vs temperature]

- Palm oil
- Palm olein
- Super olein

Temperature C:
- 10
- 15
- 20
- 25
- 30
- 35
- 40
- 45
- 50
- 55
Palm olein

- An excellent choice for food applications.
- Has good oxidative stability.
- Limited use in temperate countries - tends to crystallize and becomes cloudy at low temperature.
- Blending of palm olein with other liquid oils increase the degree of unsaturation (IV) of palm olein.
Binary and ternary blends of palm olein with other liquid vegetable oils, alternatives to partially hydrogenated oils which contain \textit{trans} fatty acids.

Oil blends stay clear in temperate climate.

Excellent choice for food applications, e.g. as frying, cooking and salad oils.
Typical specifications of palm olein for snack food frying

- FFA <0.05%
- PV <1
- M&I <0.1%
- COLOUR <3R
- FLAVOUR BLAND
- SMOKE POINT 220-240C
Frying performance of palm-based solid shortening vs. palm olein.

![Graph 1: FFA value](image1)

![Graph 2: Polar content of frying oil](image2)
ADVANTAGES OF USING PALM-BASED PRODUCTS AS A FRYING MEDIUM

- Abundant supply
- Good heat transfer
- Excellent oxidative and flavour stabilities
- Less foam, polymers and polar compounds compared to soft oils
Palm stearins

Fatty acid composition of commercially available palm stearins

<table>
<thead>
<tr>
<th>Fatty acids</th>
<th>Range (wt%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16:0</td>
<td>47-82</td>
</tr>
<tr>
<td>18:0</td>
<td>4 - 6</td>
</tr>
<tr>
<td>18:1</td>
<td>11-37</td>
</tr>
<tr>
<td>18:2</td>
<td>1-10</td>
</tr>
</tbody>
</table>
# Characteristics of Palm Stearin

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slip Melting Point °C</td>
<td>44 - 60</td>
</tr>
<tr>
<td>Iodine Value</td>
<td>14 - 49</td>
</tr>
</tbody>
</table>
SFC of palm stearins

SFC profiles of POs

Solid fat content %

Temperatures (°C)

POsIV14
POsIV20
POsIV30
POsIV40
### Fatty Acid Composition of Cocoa Butter, Palm, Illipe and Shea Fat

<table>
<thead>
<tr>
<th>Fatty Acid</th>
<th>Cocoa butter</th>
<th>PMF</th>
<th>Illipe</th>
<th>Shea</th>
</tr>
</thead>
<tbody>
<tr>
<td>C12:0</td>
<td>Trace</td>
<td>0.1</td>
<td>Trace</td>
<td>0.5</td>
</tr>
<tr>
<td>C14:0</td>
<td>0.7</td>
<td>1.2</td>
<td>0.3</td>
<td>0.6</td>
</tr>
<tr>
<td>C16:0</td>
<td>25.2</td>
<td>46.8</td>
<td>17.5</td>
<td>4.2</td>
</tr>
<tr>
<td>C18:0</td>
<td>35.5</td>
<td>3.8</td>
<td>45.8</td>
<td>40.6</td>
</tr>
<tr>
<td>C18:1</td>
<td>35.2</td>
<td>37.6</td>
<td>35.2</td>
<td>47.3</td>
</tr>
<tr>
<td>C18:2</td>
<td>3.2</td>
<td>10.0</td>
<td>0.7</td>
<td>5.4</td>
</tr>
<tr>
<td>Total saturated</td>
<td>61.4</td>
<td>51.9</td>
<td>63.6</td>
<td>45.4</td>
</tr>
</tbody>
</table>

**POP, POS, SOS**  **POP**  **POS & SOS**  **SOS**
SFC of PMF

![SFC of PMF Graph]

SFC (%)

Temperature(°C)

- PMF IV34
- PMF IV 45
TOCOPHEROLS/ TOCOTRIENOLS IN OILS

TOCOPHEROL - RICHEDE

SOY, CORN COTTONSEED, SUNFLOWER, RAPESEED

TOCOTRIENOL-RICHED

PALM, WHEATGERM, RICEBRAN
**TOCOPHEROLS/ TOCOTRIENOLS IN PALM OIL PRODUCTS**

<table>
<thead>
<tr>
<th>Type</th>
<th>mg/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude palm oil</td>
<td>600 - 1000</td>
</tr>
<tr>
<td>Crude palm olein</td>
<td>800 - 1000</td>
</tr>
<tr>
<td>Refined palm oil</td>
<td>350 - 630</td>
</tr>
<tr>
<td>Refined palm olein</td>
<td>468 - 673</td>
</tr>
</tbody>
</table>
A 20% palm oil (PO) diet was protective and comparable to a 5% corn oil (CO) diet. It was also better than a 20% lard and a 20% beef fat (BF) diets.
# Carotenoid Composition in Crude Palm Oil

<table>
<thead>
<tr>
<th>Type</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phytoene</td>
<td>1.3</td>
</tr>
<tr>
<td>β Carotene</td>
<td>56</td>
</tr>
<tr>
<td>α Carotene</td>
<td>35</td>
</tr>
<tr>
<td>Lycopene</td>
<td>1.3</td>
</tr>
<tr>
<td>Others</td>
<td>6.4</td>
</tr>
</tbody>
</table>

Vitamin A precursor
Novel palm products - nutrolein

- A nutritious cooking oil, extracted from selected palms and processed under stringent QC to retain carotenoids and tocopherols.

<table>
<thead>
<tr>
<th>specifications</th>
<th>0.10%</th>
<th>64 min</th>
<th>4C</th>
<th>16C</th>
<th>400ppm min</th>
<th>800ppm min</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cloud point</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>carotene</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tocols</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Advantages of palm oil

- Versatility
- Unique in composition
- Functionality
- Healthy, natural oil
- Trans-free formulations
- Stability
- Abundance
- Consistent supply