QUALITY DETERMINATION
OF PALM OILS

Prepared by:
Asosiasi Independent Surveyor Indonesia (AISI)
BASIC CONSIDERATIONS

A. Quality of Palm Oil produced by each Palm Oil Refinery is different, it depends on:
   * Variety of Oil Palm
   * Level of fruit ripening & smoothness of fruit transportation to the Refinery

B. Chemical components in Palm Oils are reactive with the surroundings & other substances

C. Quality of Palm Oils from the Plantation, Refinery, Storage and Sea or Land Transportation gradually change
CHEMICAL COMPONENTS OF CPO

MAIN COMPONENT (TRIGLYCERIDE ESTERS):
* Saturated medium & long chain fatty acids.
* Un-saturated medium & long chain fatty acids
* Majority of fatty acids: Palmitic, C₁₆; Oleic, C₁₈= and Linoleic, C₁₈=₂

MINOR COMPONENTS
* Tocopherols: anti-oxidant (Pro-vit. E)
* Beta carotene (Pro-vit. A = Anti cancer)

IMPURITIES
* Metals: Fe, Cu, Zn.
* Water & FFA.
* Various types of Solid particles.
<table>
<thead>
<tr>
<th>TYPE OF FATTY ACID</th>
<th>CPO</th>
<th>CPKO</th>
<th>COCONUT OIL</th>
<th>SOYABEAN OIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Octanoic, C8</td>
<td>2 - 4</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Decanoic, C10</td>
<td>3 - 7</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Lauric, C12</td>
<td>1</td>
<td>41 - 55</td>
<td>48 - 56</td>
<td></td>
</tr>
<tr>
<td>4. Myristic, C14</td>
<td>1 - 12</td>
<td>14 - 19</td>
<td>17</td>
<td>0.1</td>
</tr>
<tr>
<td>5. Palmitic, C16</td>
<td>32 - 47</td>
<td>6 - 10</td>
<td>9</td>
<td>10.5</td>
</tr>
<tr>
<td>6. Stearic, C18</td>
<td>4 - 10</td>
<td>1 - 4</td>
<td>2</td>
<td>3.2</td>
</tr>
<tr>
<td>7. Oleic, C18=1</td>
<td>38 - 50</td>
<td>10 - 20</td>
<td>6</td>
<td>22.3</td>
</tr>
<tr>
<td>8. Linoleic, C18=2</td>
<td>5 -14</td>
<td>1 - 5</td>
<td>3</td>
<td>54.5</td>
</tr>
<tr>
<td>9. Linolenic, C18=3</td>
<td>1</td>
<td>1 - 5</td>
<td>8.3</td>
<td></td>
</tr>
</tbody>
</table>
# CHEMISTRY OF TRIGLYCERIDE ESTER

## 1. SATURATED FATTY ACIDS (R-COOH)

<table>
<thead>
<tr>
<th>No.</th>
<th>Number of C</th>
<th>Formal name</th>
<th>Trivial name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>C1</td>
<td>Methanoic acid</td>
<td>Formic acid</td>
</tr>
<tr>
<td>2.</td>
<td>C2</td>
<td>Ethanoic acid</td>
<td>Acetic acid</td>
</tr>
<tr>
<td>3.</td>
<td>C3</td>
<td>Propanoic acid</td>
<td>Propionic acid</td>
</tr>
<tr>
<td>4.</td>
<td>C4</td>
<td>Butanoic acid</td>
<td>Butyric acid</td>
</tr>
<tr>
<td>5.</td>
<td>C5</td>
<td>Pentanoic acid</td>
<td>Valeric acid</td>
</tr>
<tr>
<td>6.</td>
<td>C6</td>
<td>Hexanoic acid</td>
<td>Caproic acid</td>
</tr>
<tr>
<td>7.</td>
<td>C10</td>
<td>Decanoic acid</td>
<td>Capric acid</td>
</tr>
<tr>
<td>8.</td>
<td>C12</td>
<td>Dodecanoic acid</td>
<td>Lauric acid</td>
</tr>
<tr>
<td>9.</td>
<td>C14</td>
<td>Tetradecanoic acid</td>
<td>Myristic acid</td>
</tr>
<tr>
<td>10.</td>
<td>C16</td>
<td>Hexadecanoic acid</td>
<td>Palmitic acid</td>
</tr>
<tr>
<td>11.</td>
<td>C18</td>
<td>Octadecanoic acid</td>
<td>Stearic acid</td>
</tr>
<tr>
<td>12.</td>
<td>C20</td>
<td>Eicosanoic acid</td>
<td>Arachidic acid</td>
</tr>
<tr>
<td>13.</td>
<td>C22</td>
<td>Docosanoic acid</td>
<td>Behenic acid</td>
</tr>
</tbody>
</table>
Continued

2. UNSATURATED FATTY ACIDS (Double C bonds)

a. Caproleic acid, C10 =1
b. Lauroleic acid, C12 =1
c. Myristoleic acid, C14 =1
d. Palmitoleic acid, C16 =1
e. Oleic acid, C18 =1
f. Linoleic acid, C18 =2
g. Linolenic acid, C18 =3
PALM OILS REACTIVITY/SENSITIVITY - 01

A. HYDROLYSIS X ESTERIFICATION:
   * Triglyceride ester + Water $\rightarrow$ Glycerol + FFA

B. REACTION with BASE (viz. Caustic soda):
   * Produces SOAP (Saponification)
   * Neutralization of the FFA

C. HYDROGENATION OF DOUBLE BONDS
   * Hydrogen saturation.
D. OXIDATION or HYDROLYSIS OF DOUBLE BONDS.

* Primary Oxidation produces Hydro-peroxide :
  - The peroxide can be substituted by I₂ (Iodine)
  \[
  \text{C} = \text{C} + \bigOX \rightarrow \text{C} = \text{O} \quad \text{or} \quad \text{CH}=\text{O}
  \]
* Secondary Oxidation produces Ketones or Aldehydes
  = Rancid odour

E. FFA + METAL (Fe, Zn, Cu, Mn, Ni etc):

\[
\text{RCOOH} + \text{M} \rightarrow \text{M}^+ + \text{RCOO}^- + \text{H}_2\uparrow
\]

* Produces Cathion/ Salt and Hydrogen gas.
* Pro-oxidant metals can accelerate Oxidation process
CONTAMINATION & QUALITY DETERIORATION of PALM OILS

A. OXIDATIVE RANCIDITY
   - Accelerated by overheating, pro-oxidative metals (Fe, Cu, Zn, Mn, Ni), UV light, direct contact with O2.

B. HYDROLYSIS
   - Accelerated by acids, emulsifier, Phosphorous, lipolytic enzyme, soap forming agent.

C. CROSS CONTAMINATION
   - Contamination by PO with different grade

D. CONTAMINATION BY FOREIGN SUBSTANCE
   - Metals, toxic materials, coating, tank & accessories materials, previous cargoes, sea water etc.
# PALM OIL SPECIFICATION
( Typical: Indonesian Government )

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CPO</th>
<th>CPKO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Free Fatty Acid, % max</td>
<td>5</td>
<td>3.5</td>
</tr>
<tr>
<td>2. Volatile matters, % max</td>
<td>0.5</td>
<td>0.2</td>
</tr>
<tr>
<td>3. Moisture &amp; Imp., % max</td>
<td>0.5</td>
<td>0.02</td>
</tr>
<tr>
<td>4. Peroxide Value, meq max</td>
<td>6</td>
<td>2.2</td>
</tr>
<tr>
<td>5. Iodine Value, mg/gr</td>
<td>44 - 58</td>
<td>10.5 -18.5</td>
</tr>
<tr>
<td>6. Metal ( Fe, Cu ), ppm</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>7. Lovibond, R</td>
<td>3 - 4</td>
<td></td>
</tr>
</tbody>
</table>
MEANING OF THE FOLLOWING PARAMETERS

1. FFA: - indicates degree of hydrolysis

2. Moisture & Impurities: - potential of further hydrolysis

3. Iodine Value: - indicates %-age of Unsaturated FA (capacity of oxidation)

4. Peroxide Value: - indicates degree of primary oxidation (oxidized double C bonds).
5. Saponification Value: - Indicates fatty acids content (lower mol weight higher Sap. Value (in mg KOH/gr oil)).

6. Unsaponifiable matters: - Indicates non-ester that dissolves in oil, but not in water, viz.: sterols, tocopherols etc.
   - In vegetable oil ranges 0.1 – 2.5%

7. Cloud Point: - Indicates solidifying substances.
   - Palm olein with IV : 56, Cloud point max. 10 deg. C.

8. Slip Melting Point: - Indicates degree of fineness of fat by capillary flow.

9. DOBI/DF: - Indicates level of oxidation (primary & secondary)
# ADDITIONAL SPECIFICATION FOR CPO

( special for CPO )

<table>
<thead>
<tr>
<th>DOBI</th>
<th>DISC. FACTOR</th>
<th>GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 1.68</td>
<td>Below 0</td>
<td>Sludge oil</td>
</tr>
<tr>
<td>1.68 – 2.30</td>
<td>1 - 10</td>
<td>Poor</td>
</tr>
<tr>
<td>2.31 - 2.92</td>
<td>11 - 20</td>
<td>Fair</td>
</tr>
<tr>
<td>2.93 – 3.24</td>
<td>21 - 25</td>
<td>Good</td>
</tr>
<tr>
<td>3.24 and upper</td>
<td>25 and upper</td>
<td>Excellent</td>
</tr>
</tbody>
</table>
A. DETERMINATION OF OIL CONTENT & MOISTURE :
- Extraction by using Soxlet App. with solvent, Chloroform, CCl4 or CS2
- Weighing of the Extract phase before and after evaporation :

\[
\text{OIL CONTENT} = \left[ \frac{(B - A)}{\text{SAMPLE WEIGHT}} \right] \times 100\%
\]

B. DETERMINATION OF ACID VALUE :
- 10 – 20 gram of Oil/ Fat is dissolved in 50 neutral Alcohol 96% and heated.
- Titration by using KOH 0.1 N :

\[
\text{ACID VALUE} = \left[ \frac{V_i \times N_i \times 56.1}{56.1} \right] \text{( mg KOH/ gr of sample )}
\]

\[
\text{ACID VALUE, %} = \left[ \frac{M_{Wo} \times V_i \times N_i}{10 \text{ gr Sample}} \right] \times \% \text{ mole}
\]

Remarks : - MW of Coconut Oil = 205, Palm Oil = 263; Acid = 282
C. DETERMINATION OF SAPONIFICATION VALUE.

- 4 – 5 gram of Oil/ Fat + 50 ml KOH 0.5 N with Alcohol.
- Titration of Blank and Sample with HCl 0.5 N and using PP as indicator.

\[
\text{SAPONIFICATION VALUE} = \left[ \frac{(A - B)}{\text{gr of Sample}} \right] \times 28.05
\]

- A, B : ml of HCl 0.5 N of Blank test and Sample
- 28.05 : half of MW of KOH

D. DETERMINATION OF UNSAPONIFIABLE VALUE:

- 5 gram of Oil/ Fat + 30 ml of Alcohol 95% + 5 ml of KOH 50%
- Add with 50 ml of Petroleum Ether for flushing.

Extract and then evaporated and the residue is weighed accurately.

\[
\text{UNSAPONIFIABLE VALUE} = \left[ \frac{(W \text{ resd.} - W \text{ fatty acid})}{W \text{ sample}} \right] \times 100\%
\]
E. DETERMINATION OF IODINE VALUE

- 0.1 – 0.5 gram of Oil/ Fat + 20 ml CCl₄ as a solvent
- Add 25 ml of Wijs solution in excess
- Add 20 ml of KI 15% and 100 ml of water
- Titration with 0.1 N Na₂S₂O₃ for Blank test and Sample.

\[
\text{IODINE VALUE} = \left[ \frac{(B - S)}{W \times N \times 12.69} \right]
\]

- B, S : ml of Na₂S₂O₃ for Blank and Sample test
- N : Normality of Na₂S₂O₃ solution
- W : Weight of Sample, gram
- 12.69 : MW of Iodium/ 10
TYPICAL
IODINE VALUE & PEROXIDE VALUE OF VEGETABLE OILS

1. IODINE VALUE:
   a. CPO : 50 - 54
   b. CPKO : 16 - 19
   c. Palm Olein : 56 - 60
   d. Palm Stearin : 27 - 45
   e. Soybean oil : 120 - 141
   f. Corn oil : 103 - 128

2. PEROXIDE VALUE:
   a. Fresh refined oil : PV max. 1.0
   b. Refined Bleached oil : PV approx. 0
TYPICAL SPEC. OF PROCESSED PALM OIL
( PORAM STANDARD SPECIFICATION )

A. NEUTRALISED PALM OIL:
   - FFA (as Palmitic) : 0.25% max.
   - M & I : 0.10% max.
   - Iodine Value : 50 – 55
   - Melting point : 33 – 39 deg. C

B. RBD/ NBD PALM OIL:
   - FFA (as Palmitic) : 0.25% max.
   - Iodine Value : 50 – 55
   - M & I : 0.10% max.
   - Melting point : 33 – 39 deg. C
   - Colour : 20 Red max.
Continued

C. NEUTRALISED PALM OLEIN:
   - FFA (as Palmitic) : 0.25% max.
   - M&I : 0.10% max.
   - Iodine Value : 56 min.
   - Melting point : 24 deg. C max.

D. NEUTRALISED & BLEACHED PALM STEARIN:
   - FFA (as Palmitic) : 0.25% max.
   - M & I : 0.15% max.
   - Iodine Value : 48 min.
OLEOChemicals

A. Basic Oleochemicals: (5 groups)
   a. Fatty acids: plastics, soap, cosmetics, dyes, lube
   b. Fatty esters: cosmetics, detergents
   c. Fatty alcohols: fuel additives, cosmetics, detergent
   d. Fatty amines: conditioners, textile, additives
   e. Glycerol: explosives, cosmetics, tooth paste

B. Oleochemical Derivatives
   - Derivates of Basis Oleochemicals: methyl ester, medium chain triglycerides, sulphate of fatty ester etc.
HANDLING OF PALM OIL

A. PREVENTION OF CONTAMINATION
   a. Dryness & cleanliness of the surface & atmosphere
   b. Oxygen removal (injected with nitrogen)
   c. Anti-oxidant (Citric acid, BHA, BHT, TBHQ)
   d. Suitable materials (tank material, coating, interior etc)

B. RECOMMENDED TEMPERATURES & HEATING (IASC)
   (for lowering self quality deterioration)
   a. Min – max temperature of transit/ loading, storage and discharge.
   b. Rate of heating max. 5 deg C per day.
   c. Alcohol column thermometer is recommended (mercury is strictly prohibited).
Continued

C. PREVIOUS CARGOES ( revised annually )
   a. More refined products is acceptable.
   b. FOSFA List of Acceptable previous cargoes: acceptable when effective tank cleaning is applied.
   c. FOSFA List of Banned immediate previous cargoes:
      - Leaded cargoes: 3 previous cargoes
      - Proper tank cleaning is not sufficient
<table>
<thead>
<tr>
<th>PRODUCT TYPE</th>
<th>DISCH. TEMP. Deg C</th>
<th>STORAGE &amp; TRANSIT TEMP. Deg C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Palm oil (Crude &amp; Processed)</td>
<td>50 - 55</td>
<td>32 - 40</td>
</tr>
<tr>
<td>2. Palm olein</td>
<td>30 - 35</td>
<td>25 - 30</td>
</tr>
<tr>
<td>3. Palm stearin (crude – processed)</td>
<td>55 – 60  65 - 70</td>
<td>40 - 45</td>
</tr>
<tr>
<td>4. Palm mid fraction</td>
<td>40 - 45</td>
<td>35 - 40</td>
</tr>
<tr>
<td>5. Palm kernel oil</td>
<td>30 - 35</td>
<td>27 - 32</td>
</tr>
</tbody>
</table>
ANTI – OXIDANT ( ADDITIVES )

1. CITRIC ACID (= Asam sitrat )
2. BHA : Butylated Hydroxyl Anisole
3. BHT : Butylated Hydroxyl Toluene
4. TBHQ : Tertiary Butyl Hydroquinone

SUITABLE MATERIALS

1. TANK MAT’L : - Stainless steel and free of Copper or Copper alloy, other heavy metal & metal oxides, incl. rust, lose scale etc.
2. COATING : - Zinc rich coating is strictly prohibited.
   - Epoxy, Polyurethane are suitable
THANK YOU