From CPO to Cooking Oil
Introduction to Palm Oil Processing
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Department of Food Science and Technology
And
Southeast Asian Food & Agricultural Science & Technology (SEAFAST) center
BOGOR AGRICULTURAL UNIVERSITY
BOGOR-INDONESIA

Introduction

Average Oil Yield (t/ha/year)

<table>
<thead>
<tr>
<th>Oil Crop</th>
<th>Production (mil tonnes)</th>
<th>% of Total Production</th>
<th>Average Oil Yield (t/ha/year)</th>
<th>Total Area (mil ha)</th>
<th>% Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean</td>
<td>35.19</td>
<td>34.24</td>
<td>0.38</td>
<td>92.63</td>
<td>42.27</td>
</tr>
<tr>
<td>Sunflower</td>
<td>11.09</td>
<td>10.79</td>
<td>0.48</td>
<td>22.95</td>
<td>10.47</td>
</tr>
<tr>
<td>Rapeseed</td>
<td>18.34</td>
<td>17.84</td>
<td>0.67</td>
<td>27.29</td>
<td>12.45</td>
</tr>
<tr>
<td>Oil Palm</td>
<td>36.90</td>
<td>35.90</td>
<td>3.74</td>
<td>219.15</td>
<td>4.50</td>
</tr>
<tr>
<td>Total</td>
<td>102.78</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Oil World 2007
** only for the 7 major oils

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Total crude palm oil and palm kernel oil production:
41.1 million metric tone

Characteristic Unique of Palm Oil

1. Proven –long history of- safe uses for human consumption
2. Wide range of potential applications (cooking oil, shortening, margarine and other)
Characteristic Unique of Palm Oil

2. Wide range of potential applications

3. Can be utilized as a good energy source.

4. No cholesterol and no trans fats
Characteristic Unique of
Palm Oil

Trans fats

- Unsaturated fatty acids with one or more double bond in trans configuration
- Structure similar to saturated fatty acids
  - Higher melting point than cis isomers
  - Negative nutritional properties: unwanted in food fats
- Renewed interest because of stricter legislation
  - trans labelling in USA from 2006
  - Very strict Danish regulation: max. 2% in food fats
  - Canada considers to adopt some regulation
Characteristic Unique of Palm Oil

Trans fats

U.S. Food and Drug Administration

Required 01/01/06

Nutrition Facts

Serving Size 1 Tbsp (14g)
Servings Per Container 32

<table>
<thead>
<tr>
<th>Amount Per Serving</th>
<th>Calories</th>
<th>% Daily Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories 100</td>
<td>Calories from Fat 100</td>
<td></td>
</tr>
<tr>
<td>Total Fat 11g</td>
<td>17%</td>
<td></td>
</tr>
<tr>
<td>Saturated 2g</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>Trans Fat 2g</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polyunsaturated Fat 3.5g</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monounsaturated Fat 3.5g</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cholesterol 0mg</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Sodium 115mg</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>Total Carbohydrate 0g</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Protein 0g</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin A 6%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Percent Daily Values are based on a 2,000 calorie diet.

Intro to Palm Oil Processing

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Characteristic Unique of Palm Oil

6. Rich in natural carotenoids

<table>
<thead>
<tr>
<th>FOOD</th>
<th>µg RETINOL EQUIVALENT/100g E.P.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oranges</td>
<td>21</td>
</tr>
<tr>
<td>Bananas</td>
<td>50</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>130</td>
</tr>
<tr>
<td>Carrots</td>
<td>400</td>
</tr>
<tr>
<td>Red Palm Oil (refined)</td>
<td>5,000</td>
</tr>
<tr>
<td>Crude Palm Oil</td>
<td>6,700</td>
</tr>
<tr>
<td><strong>RBO Olein</strong></td>
<td>~1000</td>
</tr>
</tbody>
</table>
Characteristic Unique of Palm Oil

6. Rich in natural carotenoids

- Rich in natural antioxidant (tocopherol and tocotrienol)

<table>
<thead>
<tr>
<th>Vitamin E content in Fats &amp; Oils</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palm Oil</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>1200 ppm</td>
</tr>
</tbody>
</table>

(Purwiyatno Hariyadi; hariyadi@seafast.org)
Characteristic Unique of Palm Oil

**PHYTOCHEMICALS in PALM OIL**

1. Carotenoids: 500–800 µg/g
   - β-Carotene
   - α-Carotene
2. Tocopherols & Tocotrienols: 500–1000 µg/g
   - α-Tocopherol
   - γ-Tocopherol
   - α-Tocotrienol
   - γ-Tocotrienol

---

Characteristic Unique of Palm Oil

<table>
<thead>
<tr>
<th>Carotenes</th>
<th>Crude Palm Oil (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phytoene</td>
<td>1.27</td>
</tr>
<tr>
<td>Phytofluene</td>
<td>0.06</td>
</tr>
<tr>
<td>β-Carotene</td>
<td>56.02</td>
</tr>
<tr>
<td>α-Carotene</td>
<td>35.06</td>
</tr>
<tr>
<td>Cis-α-Carotene</td>
<td>2.49</td>
</tr>
<tr>
<td>ζ-Carotene</td>
<td>0.69</td>
</tr>
<tr>
<td>γ-Carotene</td>
<td>0.83</td>
</tr>
<tr>
<td>δ-Carotene</td>
<td>0.33</td>
</tr>
<tr>
<td>Neurosporene</td>
<td>0.29</td>
</tr>
<tr>
<td>β-Zeacarotene</td>
<td>0.74</td>
</tr>
<tr>
<td>α-Zeacarotene</td>
<td>0.23</td>
</tr>
<tr>
<td>Lycopene</td>
<td>1.30</td>
</tr>
</tbody>
</table>
6. Rich in natural antioxidant (tocopherol and tocotrienol)

- Decrease Tromboxan A-2 (TXA2)
- Increase Prostaglandin I-2 (PGI2)
- Decrease Cholesterol
- Decrease LDL-Cholesterol
Characteristic Unique of Palm Oil

1. Crude Palm Oil
2. Crude Palm Olein
3. Crude Palm Stearin
4. RBD Palm Olein
5. RBD Palm Stearin
6. RBD Palm Oil

'mild' refining & degumming

Red Palm Oil

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Characteristic Unique of Palm Oil

Canadian, European, and Australian customers: click here to learn more

Coconut Crops
Coconut Leaves
Coconut Oil
Coconut Oil Miracle
Cooking with Coconut Flour
Coconut Oil: The Health Food of the 21st Century

The Palm Oil Miracle
By Bruce Fife, N.D.

Format: Paperback
Size: 5 1/2 x 8 1/2
Illustrated: Yes
Page Count: 191
ISBN: 978-0-941599-05-8
List Price: $15.95

Orders weighing more than 10 lbs will be shipped via UPS. Do not give a physical shipping address as UPS does not deliver to PO Boxes.

Characteristic Unique of Palm Oil

Natural Palm Oil

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Virgin Palm Oil

Virgin Red Palm Oil - Organic from Tropical Traditions

What is Virgin Red Palm Oil?

Virgin Palm oil is palm oil that is traditionally made and maintains the natural

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Characteristic Unique of Palm Oil

7. Balance composition of fatty acids
8. Contain linoleic as essential fatty acid

<table>
<thead>
<tr>
<th>Fatty Acid</th>
<th>% of total Fatty acids</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:0</td>
<td>0.1-1.0</td>
</tr>
<tr>
<td>14:0</td>
<td>0.9-1.5</td>
</tr>
<tr>
<td>16:0</td>
<td>41.8-46.8</td>
</tr>
<tr>
<td>16:1</td>
<td>0.1-0.3</td>
</tr>
<tr>
<td>18:0</td>
<td>4.2-5.1</td>
</tr>
<tr>
<td>18:1</td>
<td>37.3-40.8</td>
</tr>
<tr>
<td>18:2</td>
<td>9.1-11.0</td>
</tr>
<tr>
<td>18:3</td>
<td>0.0-0.6</td>
</tr>
<tr>
<td>20:0</td>
<td>0.2-0.7</td>
</tr>
</tbody>
</table>

1. Palm Oil
2. Palm Kernel Oil
Characteristic Unique of Palm Oil


Composition of PO Mesocarp.

- Oil 39%
- Water 41%
- Fiber 20%
Characteristic Unique of Palm Oil

10. Researches show that palm oil has positive health effect.

Palm olein reduces cholesterol as effectively as olive, Canola and rapeseed oils.
Intro to Palm Oil Processing

Palm Oil Processing Flow Chart

FFB Received At Mill

Palm Oil Processing Flow Chart

FFB Loaded Into Cages Ready for Sterilization
Palm Oil Processing

Flow Chart

BUNCH RECEPTION
BUNCH STERILIZATION
BUNCH THRESHING
FRUIT DIGESTION
PULP PRESSING
OIL CLARIFICATION
OIL DRYING
OIL PACKING

Empty Bunches

NUT & FIBRE
NUT RECOVERY
NUT DRYING
NUT CRACKING
KERNEL SEPARATION
KERNEL STORAGE

STERILISATION IN LARGE PRESSURE VESSELS/CAGES
STRIPPING IN ROTATING DRUM STRIPPER
EXTRACTION IN A HOMOGENEOUS OIL MASH
PURIFICATION IN A CONTINUOUS CLARIFICATION TANK

CRUDE PALM OIL
Palm Oil Processing

Unit Operations

Sterilization

• Placing sterilizer cages in horizontal vessels at steam pressure of 3 kg/cm² (143°C); 60 minutes
  • Enzyme inactivation → prevention of FFA increase
  • Facilitation of mechanical stripping
  • Preparation of pericarp for sub-sequential processing
  • Preconditioning of the nuts to minimize kernel breakage

Stripping

• Separation of sterilized fruits from the bunch stalks
  • Drum type:
    • Vigorous shaking
    • Beating
Palm Oil Processing
Unit Operations

Digestion
- Reheating the sterilized fruits (mixing the fruits at 95-100°C, 20 minutes.
  - To loosen the pericarp from the nuts
  - To break the oil cell before passing to oil extraction unit

Oil Extraction
- Continuous screw pressing to produce:
  - Mixture of oil (~66%), water (~24%) and non-oily solid (~10%).
  - Press cake, containing fibers and nuts
Palm Oil Processing

Unit Operations

Clarification

- Dilution with water – to facilitate settling
  - Screen – to remove fibrous material
  - Pump to settling tank – to obtain oil and sludge

- "Top" oil is skimmed off → centrifuge → vacuum dryer → oil storage

- Sludge (~ 10% oil) → reclaimed and fed back to main settling tank
Palm Oil Processing

Unit Operations

Oil Storage

• Internally coated with epoxy material to prevent iron pickup
• Oil: water content 0.1 -0.12%; impurities < 0.02%.
• Temperature controlled: Storage 32-40°C, (loading/unloading: 50-55°C (heating rate 5°C per 24 hr)

Palm Oil Processing

Flow Chart

CPO
• Color: Dark Red
• Rich in Micronutrient: (Carotenoids; Tocoferol; Tocotrienol; Fitosterol)
• Need to be refined

Refining Process

OIL EXTRACTION AT MILL
STERILISATION IN LARGE PRESSURE VESSELS/CAGES
STRIPPING IN ROTATING DRUM STRIPPER
EXTRACTION IN A HOMOGENEOUS OIL MASH
PURIFICATION IN A CONTINUOUS CLARIFICATION TANK

FOB ENTERS THE PLANT FOR PROCESSING

TRANSPORTATION OF FFB

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Palm Oil Processing

Flow Chart

CPO

• Commonly consists of desirable triglycerides, unsaponifiable matter together with small amount of impurities.
• Impurities contribute undesirable effects to the oil, for instance color, flavor, odor, instability and foaming.
• Should be removed by a purification step in order to produce good quality of refined oil with minimal possible oil loss or damage to the oil and desirable materials such as tocopherols and carotenes.
Palm Oil Processing
Flow Chart

CPO → Typical composition

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Crude Palm Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triglycerides, %</td>
<td>95</td>
</tr>
<tr>
<td>Free Fatty Acids, FFA, %</td>
<td>2 - 5</td>
</tr>
<tr>
<td>Red Colour (5 ¾ &quot; Lovibond Cell)</td>
<td>Orange red</td>
</tr>
<tr>
<td>Moisture &amp; Impurities, %</td>
<td>0.15 – 3.0</td>
</tr>
<tr>
<td>Peroxide Value, PV (meq/kg)</td>
<td>1 - 5.0</td>
</tr>
<tr>
<td>Anisidine Value, AV</td>
<td>2 – 6</td>
</tr>
<tr>
<td>β-carotene content, ppm</td>
<td>500-700</td>
</tr>
<tr>
<td>Phosphorus, P, ppm</td>
<td>10-20</td>
</tr>
<tr>
<td>Iron (Fe), ppm</td>
<td>4-10</td>
</tr>
<tr>
<td>Tocopherols, ppm</td>
<td>600-1000</td>
</tr>
<tr>
<td>Diglycerides, %</td>
<td>2-6</td>
</tr>
</tbody>
</table>

Palm Oil Processing
Flow Chart
– further processing (refining process)
**Palm Oil Processing**

**Flow Chart**

**– further processing (refining process)**

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**Palm Oil Refining Processing**

**Unit Operations**

**-Degumming of CPO**

- Crude oils contain complex organo-phosphorus compounds referred to as phospholipids (phosphatides) or more usually, as gums.
- Phospholipids should be removed because of their strong emulsifying action and if they are not removed, the oil will undergo undue darkening during deodorization at high temperature.
- The phospholipids (phosphatides) are removed during processing by a variety of treatments collectively referred to as degumming.
- The treatment usually involves hydration with water, orthophosphoric acid, and polybasic organic acids either singly or in combination, followed by centrifuging the precipitated material or by its adsorption on bleaching earth or filter.
- Degumming of CPO

\[ X = \text{choline (phosphatidyl choline or PC)} \]
\[ X = \text{ethanolamine (phosphatidylethanolamine or PE)} \]
\[ X = \text{inositol (phosphatidylinositol or PI)} \]
\[ X = \text{hydrogen (phosphatidyl acid or PA)} \]
Palm Oil Refining Processing

Unit Operations

-Degumming of CPO
Palm Oil Refining Processing
Unit Operations

-Bleaching of CPO

- Treatment that is given to remove color producing substances and to further purify the fat or oil.
- The usual method of bleaching is by adsorption of the color producing substances on an adsorbent material.
- There are a lot of adsorbent materials being used in vegetable oil industry for examples; acid activated bleaching earth, natural bleaching earth, activated carbon and synthetic silicates.
- Acid activated bleaching earth (fuller’s earth) or clay, sometimes called bentonite, is the adsorbent material that has been used most extensively.
- This substance consists primarily of hydrated aluminum silicate. Usually, bleaching earth does not remove all the color producing materials, much of which are actually removed by thermal destruction during the deodorization process.
- Activated carbon is also used as a bleaching adsorbent to a limited extent.

- Deodorization of CPO

- Deodorization is a vacuum steam distillation process for the purpose of removing undesirable flavors and odors, mostly arising from oxidation, in fats and oils.
- Using steam under reduced pressure the volatile compounds are removed from fats and oils.
- Typical conditions approximate 250°C at 2.0 mm absolute pressure for 1-4 hr with strong steam sparging.
- The deodorization utilizes the differences in volatility between off-flavor and off-odor substances and the triglycerides.
Palm Oil Refining Processing

Unit Operations

- Deodorization of CPO

Typical deodorization conditions

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Chemical Refining</th>
<th>Physical Refining</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>U.S.</td>
<td>Europe</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>250-260</td>
<td>230-240</td>
</tr>
<tr>
<td>Pressure (mbar)</td>
<td>3-4</td>
<td>2-3</td>
</tr>
<tr>
<td>Sparger steam (%)</td>
<td>0.5-2.0</td>
<td>0.5-1.0</td>
</tr>
<tr>
<td>Time (min)</td>
<td>20-40</td>
<td>40-60</td>
</tr>
<tr>
<td>Final FFA (%)</td>
<td>0.03-0.05</td>
<td></td>
</tr>
</tbody>
</table>

Palm Oil Refining Processing

Unit Operations

- Deodorizations

Component: Mol. Weight, Relat. volatility

- Fatty acid: 260, 2.5
- Phospholipids: 411, 5
- Tocopherol: 415, 1
- Sterol: 410, 0.5
- Sterol ester: 675, 0.04
- Oil: 885

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Degumming and pre-bleaching of CPO

- Add concentrated (80-85%) phosphoric acid (dose at 0.05-0.2% of fed oil), 13-30 minutes
  - Precipitate nonhydratable phosphatides
- Adsorptive cleansing with bleaching clay (add as slurry 0.8 – 2%); under vacuum 20-25 mmHg; 95-110°C, 30-45 min.
  - Adsorb impurities (trace metal, moisture, insoluble, and part of the carotenoids and other pigments
  - Adsorb/reduce oxidation products
  - Adsorb phospholipids precipitated by phosphoric acids
  - Remove any excess phosphoric acids
Palm Oil Refining Processing

Unit Operations - A. Physical Refining

- Deacidification & Deodorizations
  - Oil is deaerated → heating 240-270°C (using external HE) → pumped into deodorizer (2-5 mmHg).
    - Remove FFA (incl volatile odoriferous, oxidation products (aldehyde and ketone).
    - Thermally compose carotenoids
    - Produced light-colored, bland RBDPO

![Graph showing residual carotene (%) over time at different temperatures (180°C, 200°C, 240°C) for 0 to 60 minutes.](image)
# Palm Oil Refining Processing

## Unit Operations

### A. Physical Refining

#### -Desirable Quality of pretreated and RBDPO

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pretreated PO (Degummed/Bleached)</th>
<th>RBDPO</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFA (as C16:0; %)</td>
<td>Same as Crude feed</td>
<td>0.10%, max</td>
</tr>
<tr>
<td>Peroxide value (mEq/kg)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Moisture and Impurities (wt, %), max</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Iron (mg/kg), max</td>
<td>0.12</td>
<td>0.12</td>
</tr>
<tr>
<td>Copper (mg/kg), max</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Phosphorus, (mg/kg), max</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

### A. Chemical Refining

![Image of chemical refining process](image-url)
Palm Oil Refining Processing

Unit Operations

A. Chemical Refining

-Alkali Refining
- Heating CPO to 80-90°C
- Dose concentrated (80-85%) phosphoric acid at 0.05-0.2% (of fed oil)
- Add caustic soda solution (4N = 20Be) with calculated excess of ~20%
- Soap removal by centrifugation
  - Lighter phase (oil with 500-1000 mg soap/kg oil; moisture) \( \rightarrow \) Neutralized Palm Oil (NPO)
  - Heavier phase (soap, insoluble impurities, gum, phosphatides, excess alkali, and loss oil/emulsion).
- Washing NPO with 10-20% hot water \( \rightarrow \) centrifugation
- Washed oil is dried under vacuum to a moisture level < 0.05%.

-Bleaching
- NPO is bleached (similar process as that of physical refining)
- Adsorptive cleansing with bleaching clay (add as slurry 0.8 – 2%); under vacuum 20-25 mmHg; 95-110°C; 30-45 min.
  - Adsorb impurities (trace metal, moisture, insoluble's, and part of the carotenoids and other pigments)
  - Adsorb/reduce oxidation products
  - Adsorb phospholipids precipitated by phosphoric acids
  - Remove any excess phosphoric acids
A. Chemical Refining

-Palm Oil Refining Processing

Unit Operations

-Deodorization
- NBPO is deodorized (similar process as that of physical refining)
- Oil is deaerated 240-270°C (using external HE) pumped into deodorizer (2-5 mmHg).
- Remove FFA (incl volatile odoriferous, oxidation products (aldehyde and ketone).
- Thermally compose carotenoids
- Produced light-colored, bland NBDPO
- RF (refining factor):
  - RF = % total Oil Loss/% FFA in the Oil
  - 1.5 – 2.0

Desirable Quality of pretreated and NBDPO

<table>
<thead>
<tr>
<th>Parameter</th>
<th>N-PO</th>
<th>NB-PO</th>
<th>NBD-PO</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFA (as C16:0; %)</td>
<td>0.15%, max</td>
<td>0.15%, max</td>
<td>0.10%, max</td>
</tr>
<tr>
<td>Peroxide value (mEq/kg)</td>
<td>-</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Moisture and Impurities (wt, %), max</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Iron (mg/kg), max</td>
<td>-</td>
<td>0.15</td>
<td>0.12</td>
</tr>
<tr>
<td>Copper (mg/kg), max</td>
<td>-</td>
<td>0.06</td>
<td>0.05</td>
</tr>
<tr>
<td>Phosphorus, (mg/kg), max</td>
<td>-</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Soap Content (mg/kg)</td>
<td>20</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Palm Oil Processing Flow Chart
– further processing (refining process) & fractionation

Palm Oil Processing
Flow Chart
– further processing (refining process)
Palm Oil Processing

Flow Chart

- further processing (refining process) & fractionation

CRUDE PALM OIL

CRUDE PALM KERNEL OIL

CRUDE STEARIN

CRUDE OLEIN

Physical Refined Neutralized
Refining Bleached
Acid Distillates Deodorized

Soap

Stock

Fractionation

S

L

Fractionation

S

L

To Chemical/Physical
Refining

1. CPO
2. CP Olein
3. CP Stearin
4. RBO Olein
5. RBD Stearin
6. RBD PO

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Palm Oil Processing
Fractionation

- Triacylglycerols/triglyceride (TAG) of PO consist of combination of FAs
- 3 commercial methods of fractionations
  - Dry fractionation
  - Detergent fractionation
  - Solvent fractionation

Palm Oil Processing
Fractionation

- To separate olein (low-melting liquid phase) and stearin (high-melting solid phase) fraction
- Olein usually used for cooking oil
- Stearin usually for margarine and industrial frying
Palm Oil Processing

Fractionation

- Dry fractionation
  - Oil is kept homogenized at 70°C
  - Cooled at specific cooling program; up to 20°C (depend on quality requirement)
  - Filtration (filter press; membrane filter)
  - About 65-75% olein + 25-35% stearin
Palm Oil Processing

**Fractionation**

- **Detergent fractionation**
  - Usually done on CPO
  - Hot oil is cooled up to –usually about 20°C
  - Add and mix with aqueous detergent solution (0.5% sodium lauryl sulfate/SDS)
  - Stearin crystals are wetted with SDS → go to aqueous phase
  - Centrifugation → olein is washed with hot water → vacuum dried
  - Yield ~ 80% olein

- **Solvent fractionation**
  - Most expensive, need lower temp; more safety feature
  - Hexane and acetone
  - Oil is dissolved in the solvent → cooled → filtration
  - Yield ~ 80% Olein
  - Viable in production of high value products → PMF → cocoa butter equivalent
Palm Oil Processing

Fractionation

1st Fractionation

- Olein Fraction 65-75 - 80%
- Stearine Fraction 10-35%

2nd Fractionation

- 2nd Olein Fraction (Super Olein) 55-65%
- Palm oil Midfraction 25-30%

Palm Oil Processing

Fractionation

PALM OIL

1st Fractionation

Acetone:oil=4:1
Crystallize at ~ 0°C
Reheat to 40°C
add more acetone (acetone:oil=4:1)
Crystallize at 20-24°C

2nd Fractionation

LOW MELTING FRACTION
- Yield >60%
- M.Pt. <15°C
- 16:0 ~35%
- IV > 65

PALM MIDFRACTION
- Yield 25-30%
- M.Pt. 30-35°C
- 16:0 ~60%
- IV > 32-36
- POP = 56%
- POS = 10%
- SOS = 1%

HIGH MELTING FRACTION
- Yield >10%
- M.Pt. 55-60°C
- 16:0 ~80%
- IV > 10
Palm Oil Processing

**Fractionation**

**PALM OIL**

Acetone:oil=4:1
Crystallize at ~ 0°C
Reheat to 40°C
add more acetone
(acetone:oil=4:1)
Crystallize at 20-24°C

1st Fractionation

**LOW MELTING FRACTION**
Yield >60%
M.Pt. <15°C
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**PALM MIDFRACTION**
Yield 25-30%
M.Pt. 30-35°C
16:0 ~60%
IV > 32-36
POS = 10%
SOS = 1%
POP = 56%

2nd Fractionation

**HIGH MELTING FRACTION**
Yield >10%
M.Pt. 55-60°C
16:0 ~80%
IV > 10
Palm Oil Refining Processing
Processing Aids

<table>
<thead>
<tr>
<th>Aid</th>
<th>Effect</th>
<th>Mode of Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium hydroxide</td>
<td>Refining aid</td>
<td>Acid neutralization</td>
</tr>
<tr>
<td>Carbon somebody (diatomaceous earth)</td>
<td>Bleaching aid</td>
<td>Filtration</td>
</tr>
<tr>
<td>Nickel Sodium methylxide</td>
<td>Hydrogenation catalyst</td>
<td>Filtration</td>
</tr>
<tr>
<td>Phosphoric acid</td>
<td>Refining acids, metal chelators</td>
<td>Water or acid neutralization, filtration, and deodorization</td>
</tr>
<tr>
<td>Citric acid</td>
<td></td>
<td>Neutralization with base, filtration, or water washing</td>
</tr>
<tr>
<td>Acetone</td>
<td>Crystallization media for fractionation of fats and oils</td>
<td>Solvent stripping and deodorization</td>
</tr>
<tr>
<td>Hexane, Isopropenol, Nitrogen</td>
<td>Oxygen replacement</td>
<td>Diffusion</td>
</tr>
<tr>
<td>Polyyglycerol esters</td>
<td>Crystallization modification</td>
<td>None</td>
</tr>
<tr>
<td>Silica hydrogel</td>
<td>Adsorbent</td>
<td>Filtration</td>
</tr>
<tr>
<td>Sodium laurel sulfate</td>
<td>Fractionation aid, wetting agent</td>
<td>Washing and centrifugation</td>
</tr>
</tbody>
</table>

Thank You ...

Resources/References:
- Palm Oil World ([http://www.palmoilworld.org/](http://www.palmoilworld.org/))
- PPKS ([iopri.org/](http://www.iopri.org/))
- MPOB ([www.mpob.gov.my](http://www.mpob.gov.my))