Palm oil and Palm Kernel Oil for Frying, Baking and Specialty Fats

by
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Presentation Outline

• Introduction
• Chemical, physical properties → functionalities
• Sources of oils and fats
• Cooking oil – frying
• Margarines – cake and pastries
• Specialty fats
• Conclusion
<table>
<thead>
<tr>
<th>CARBOHYDRATE</th>
<th>PROTEIN</th>
<th>OIL/ FAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>Meat</td>
<td>Meat</td>
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<tr>
<td>Vegetables</td>
<td>Ice-cream</td>
<td>Bread</td>
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<tr>
<td>Cake</td>
<td>Pizza</td>
<td>Ice-cream</td>
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<tr>
<td>Fruit</td>
<td>Soup</td>
<td>Potato</td>
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<td>pizza</td>
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Why we need oils and fats

- Medium for Heat Transfer
- Physical properties of food  
  - body and strength
- Quality - Moisture Barrier
  - Taste and odour
- Source of Essential Fatty Acid
- Carrier of Oil Soluble Vitamins
- Bulk Supply of Energy

Oils/Fats: Function in Food
Sources of Oils and Fats and Their General Properties

Plant: fruit oils
- oil palm
- olive
- coconut

Plant: seed oils
- sunflower
- soybean
- cottonseed
- canola
Animal: adipose tissue, flesh, butter oil

Chemical Properties of Oils and Fats
- fatty acid composition
- distribution of the FAC in the TAG

→ Its Physical Properties → Functionalities
CRUDE OIL ---> FOOD USES*

- Refining
- Bleaching
- Deodourising

Oil from the Endocarp

fractionation

Palm kernel oil derivatives
Oil from the Mesocarp

Some Functional Uses of Palm oil Products

Solid Fat Content of Palm oil Products

Frying

Cooking oil, Margarines, shortening and vanaspati ..
Cooking Oil

Refined oils and fats should be:
- tasteless
- odourless
- clear
- Free from free fatty acid
- Free from contaminants

Should be protected from:
- Contaminants eg foreign odours, matters
- Hydrolysis - water
- Heat deterioration – extreme heat
- Oxidative deterioration – air (oxygen)
### PORAM Standard Specifications
For NBD/RBD Palm Oil

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>FFA (as palmitic)</td>
<td>0.1% max</td>
</tr>
<tr>
<td>M&amp;I</td>
<td>0.1% max</td>
</tr>
<tr>
<td>IV (Wijs)</td>
<td>50-55</td>
</tr>
<tr>
<td>MP/°C</td>
<td>33-39</td>
</tr>
<tr>
<td>(AOCS Cc3-25)</td>
<td></td>
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<tr>
<td>Colour (5 1/4” cell)</td>
<td>3 or 6 Red max</td>
</tr>
</tbody>
</table>

### Oxidation-off flavours

- Photo oxidation
- Enzymatic
- Autooxidation- unsaturation
- Hydrolysis
Deterioration Theory of Oils and Fats by Oxidation

Unsaturated fats → easily oxidised (rancid)
- Double bonds = oxidation target
- C18:3 → C18:1
- C18:2 → C18:1

Oxidation activities
- Oxidative deterioration → hydroperoxide → carbonyl → dimerization → polymerized products

Oxidation is supported by
- Elevating in temperature,
- Increase in air pressure (oxygen),
- Catalytic metals,
- Storage time,
- UV light
Slowing the Onset of Auto Oxidation

- Low temperature during processing - realistically possible
- Reduce access to air (oxygen)
- Avoid contact with metals eg copper, iron
- Rotate stock efficiently, maintain good hygiene practices

Quality of Palm Olein During Frying

Che Man et al., 2006 (J Food Lipids)
Oils And Fats and Fried Products

- Reduce contact with $O_2$
- Head space to be filled up with nitrogen gas
- Close lid – avoid low pressure in the container

Baking Fats

Overall function

Oil - Tenderness and lubricant
Solid fats - Structure
Functionality of Oils and Fats
-The way fats solidify

• Polymorphism-ability to crystallize in different form and different slip melting point
• Polymorphs is critical in its functionality-formulation and processing is critical leading to polymorphic stabilization

Ensuring Optimum Baking Performance

• Melting properties
• Proportion of solid to liquid –NMR Spectrometry
• crystal structure

control functionality
Functionality
- depend on finished baked product (known application)

• Shortening power
• Batter aeration
• Emulsifying properties
• Provision of impervious layer
• Improvements in keeping quality - Moisture barrier
• Provision of flavours
• Provision of calories

Improvememts in Keeping Quality

• Moisture barrier – lost or gain of moisture
• Fats prevent picks up of moisture - soggy
• Fats prevents lost of moisture – dry out
Short Pastry

- Sweet pastry, pie pastry and biscuit
- Ingredients; flour, fat, salt and water
- Fats; shorten the texture
- Flour; protein combines with water forming long strands of gluten – tough and elastic

Short Pastry Without Fat

- Dough produced will be tough and elastic
- When baked – flinty, brittle
- Shrinkage and distortion
Short Pastry With Fat

- Dough easier to handle
- After baking-more crumbly texture
- Melts in mouth

How the fats function:
- Fats being distributed as globules through the paste during mixing
- Distributed fats interrupts the dev of gluten strands ie protecting the gluten from the water (in the recipe)
- Thus, gluten formation is shortened – giving weaker and less rigid structure to the baked pastry

Fats In Cake Batter

- Incorporation of air and provide emulsifying properties
- Holds liquid oil → increase cake softness
- Shortens (interrups) gluten continuity → tenderize crumb
Fats in Cake Batter

- Creaming properties are affected by liquid to solid ratio
- Sufficient liquid to envelope air bubbles
- Sufficient crystalline fat (about 20%) to stabilize the system
- The smaller beta prime crystal – effective at stabilizing air bubbles.

Industrial – Cake Margarine

100% palm based

Good product Consistency at 20 and 30°C for 25 days

Crystal distribution at 20°C
- Crystal size < 4µm
Palm Stearin (IV< 40) as hard stock
Palm oil or palm olein; palm kernel oil

Shortening for Bakery Products
100% palm-based

Palm Stearin (IV=30) as hard stock: soft oil
Puff Pastry

- Laminated products-formation of alternate and discrete layers of dough and fats
- The lift – depend on pressure of the steam trapped between the layers of dough during baking
- Microscopic holes may assist steam to escape – lest lift and flakiness
- High air velocity convection oven at early stage-dry the surface too rapidly leading to reduce pastry lift

- Low levels of fat smp 34-37C
- Laminating fat – smp > 40C (sufficient solid at dough mixing temp 20C, limit 5%)
Palm-based pastry margarine using POS as hard stock showed no significant post-hardening on storage at 20 and 25 °C.

Smooth penetration (red) and broad release (green) indicating flexibility of the product.

Performance test on palm based pastry shortening in Samples 1325, 1326 and 1327 in comparison the control sample.

Performance test: sample 1326 is the best.
Production Potential

- Pastry shortening can be produced in a pastry shortening/margarine production line.
- Specific requirements: back pressure of > 60 bar and resting tube

Specialty Fat

- Specialty fat is a category of fat used for substitution of other type of fats such as cocoa butter (CB) and milk fat (MF).
- Demand for the fat is growing as price of CB and MF is high - in chocolate production, ice-cream, non dairy creamer and infant formula.
Right choice of fat → right product texture

* If we are in the Chocolate & Confectionery Business:
  • We will be looking for a specific oil/fat suitable for a particular product we are going to produce in our factory

Such as; bars, tablets, chocolate shells, filled chocolates, panned products, hollow figures...

these are just some of the many exciting and varied applications in the world of chocolate moulding.

What suitably-performing fats can we use

Besides cocoa butter….?

Specialty fats are mainly processed from lauric-based palm kernel oil (PKO) over coconut oil (CNO).

- PKO contains higher oleic acid (C18:1) and lower short chain fatty acids (C6:0 to C10:0)
  - makes it more stand up in hot summer months/ hot climate.

- CNO contains a substantial amount of short chain fatty acids, make it much softer

Palm Kernel Oil → most common lauric type confectionery fat.

Commonly modified by fractionation, hydrogenation, interesterification and blending to produce wider range of functional specialty fat products.
PKO – first oil obtained from kernel of palm fruit. The oil has narrow melting range of 25-27°C and sharp melting solid fat profile. This unique characteristic makes PKO and the derivatives excellent raw materials for specialty fat.

- **PKOo** - liquid fraction of fractionated PKO.
  - Has low melting point due to high content of short chain fatty acids (caproic, capric and caparylcy- C6, C8, C10)

- **PKS** - solid fraction of fractionated PKO.
  - Contains high solid at < 25°C
  - Sharp melting at > 30°C.

### Some Functional Uses of Palm Kernel Oil Products

![Solid Fat Content of Palm Kernel Oil Products](image)
Importance of Hard Type Specialty Fat

IV of Bulk PKO Fat

PKO (IV=17.7-18.3),
PKOo (IV=23.0-28.5)
PKS (IV=7.5-8)

Soft type specialty fat
- leads to poor tolerance to warmer weather
- problem in moulding due to adhesion of chocolate to the mould.

Fractionation and Hydrogenation

- Hydrogenated PKO
- Hydrogenated palm kernel olein
- Hydrogenated palm kernel stearin

Refined / Crude Palm Kernel Oil (PKO), IV=17.7

Fractionation, 23C

Crude Palm Kernel Olein, IV=27

Crude Palm Kernel Stearin, IV=7.5

Hydrogenation

Refining process

Hydrogenation

Refining process
Note: To produce ultra hard lauric CBS fat to attain the almost non-blooming properties the SFC at 10-25°C must be > 90%.

Hydrogenated PKS

- Hydrogenation lowers the iodine value (IV) of the PKS
- decreasing IV → improves shrinkage of chocolate → eases demoulding = delays bloom formation

HPKS with the lowest IV = the most resistant to blooming
**Fully Hydrogenation Increases the Solid Fat Profiles of PKO, PKS, PKOo**

- Hard fat with good snap could be produced by hydrogenation.
  - HPKS > HPKO > HPKOo
- Sharp melting profiles are reflected in the SMP range:
  - HPKOo; 31.3-39.9°C (wide range), HPKO 31.9-35.3°C, HPKS 32-35°C

**Fatty acid compositions of PKO, PKOo, PKS and fully hydrogenated products**

<table>
<thead>
<tr>
<th>Fatty acid composition</th>
<th>PKO</th>
<th>HPKO</th>
<th>PKOo</th>
<th>HPKOo</th>
<th>PKS</th>
<th>HPKS</th>
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<tbody>
<tr>
<td>C 12:0</td>
<td>48.3</td>
<td>48.5</td>
<td>44.7</td>
<td>43.4</td>
<td>54</td>
<td>54</td>
</tr>
<tr>
<td>C 14:0</td>
<td>15.6</td>
<td>17</td>
<td>14.0</td>
<td>13.9</td>
<td>20</td>
<td>21</td>
</tr>
<tr>
<td>C 16:0</td>
<td>8</td>
<td>9</td>
<td>8.3</td>
<td>8.9</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>C 18:0</td>
<td>2</td>
<td>18</td>
<td>2.3</td>
<td>20.2</td>
<td>4</td>
<td>9.5</td>
</tr>
<tr>
<td>C 18:1</td>
<td>15.1</td>
<td>0</td>
<td>19.2</td>
<td>6.2</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>C 18:2</td>
<td>2.7</td>
<td>0</td>
<td>3.3</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Complete Hydrogenation of PKO, PKS and PKOo - significant increase in C 18:0, reduction in C 18:1 and C18:2
Hydrogenation = tailor making SFC profile meeting desired functionalities

Hydrogenated PKO
- Hydrogenated palm kernel olein
- Hydrogenated palm kernel stearin

Enrobing and toffee making
- Produces fat with high melting and less steep melting properties. Useful and preferred in tropical countries
- Produces the steepest-melting fat - the highest CBS quality
- Fully hydrogenated PKS (IV < 0.5) for high-melting product; Ideal for compound chocolate
- Compound chocolate for molding and coating

Various Degrees of Hydrogenation Commonly Employed for Tailor Making the Functionality of PKO

- Fat 1: for soft filling, toffee and wafer
- Fat 2: filling fat
- Fat 3: biscuit coating, wafer, nuts and non-dairy whipping cream
The Functionality of PKO and PKOo for Specific Application can be improved by:

- Complete hydrogenation of PKO or PKOo yielding firm and high melting fat (smp = 44-45°C)

- Random interesterification on hydrogenated fat improves its melting properties.
  - Producing fat that is firm and brittle at 25-30°C and complete melt < 37°C

- Blending of hydrogenated PKO fats with various PKO fractions extends the usage range of lauric fats.
  eg. HPKOo + HPKS or + PKS → yields less steep-melting SFC profile

Suitability of Specialty Fat in Selected Food Products

Compound and Coating Chocolate

- Replaces cocoa butter completely
- Tempering is not required - easy and economical to work with
- Crystallizes rapid - provides good moulding properties
- Produces chocolate with excellent gloss retention and resistant to bloom
- Good melting properties and excellent flavour release.
- Produces hard and good snap chocolate but melt easily in the mouth
- Produces heat stable chocolate that can withstand warm climate
• Palm oil and palm kernel oil products are versatile ingredients in food preparations and food manufacture.

• Fractionation (physical process), produces palm stearin of various hardness as healthier alternative to hydrogenated oils/fats

• Continuous R&D in MPOB and universities creates opportunities and improvements for palm-based food industry
The Palm Oil event of the year is back!

The Malaysian Palm Oil Board is organising

PIPOC 2013

19 - 21 November 2013
Kuala Lumpur Convention Centre,
Kuala Lumpur, Malaysia

The grand MPOB International Palm Oil Congress (PIPOC) with five concurrent Conferences will examine and discuss the many facets of the oil palm industry. PIPOC 2011 was attended by more than 2000 participants from 46 countries.

Thank you