Controlling Oxidation During Vegetable Oil Processing

Presented By: Lucky Inturrisi, Technical Director, Mewah Oils
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Lipid Analysis and Oxidation Short Course
Barossa Valley, South Australia, 11th September 2017
Controlling Oxidation During Vegetable Oil Processing

- Vegetable Oil Processing
- Antioxidant Addition
- Oil Handling and Storage
Vegetable Oil Processing
Nutritional Information of Some Fats / Oils

% of Fatty Acid Present

- MONOUNSATURATES
- POLYUNSATURATES
- SATURATES
- TRANS

- BUTTER FAT
- CANOLA
- COCONUT
- CORN
- COTTONSEED
- HI-OLEIC SUN
- LARD
- OLIVE
- PALM
- PEANUT
- SOYBEAN
- SUNFLOWER
- TALLOW
Vegetable Oils: General Composition

**Acylglycerols (92-95%)**
- Mainly Triacylglycerols
- Some Di- and Monoacylglycerols

**FFA (0.3-5%)**

**Phospholipids (<3%)**
- Hydratable PL
- Non-hydratable PL

**Minor components (0.3-2%)**
- Tocopherols, Sterols, Pigments,…
- Contaminants, Impurities,…
Refining Techniques

**Chemical Refining**
- Degumming
- Neutralising
- Bleaching
- Deodorising

**Physical Refining**
- Degumming
- Bleaching
- Physical Refining

**MODIFYING PROCESSES:**
- HYDROGENATION, FRACTIONATION, INTERESTERIFICATION, WINTERISATION
Refining Process

CRUDE OIL → DEGUMMING & NEUTRALISING
- Removes: Gums, Phosphitides, FFA, Trace Metals

CRUDE OIL → BLEACHING
- Removes: Pigments, Oxidation Compounds, Trace metals, Other impurities

CRUDE OIL → FILTRATION
- Removes: Spent Clay

CRUDE OIL → DEODORISATION

PACKAGING

BLENDING

DEODORISATION

Fatty Acid Distillate (Co-product)
FFA, Volatiles, Oxidation Compounds

Caustic Soda / Phosphoric Acid

Bleaching Earth

Fatigue Distillate (Co-product)
Deodorisation Process

- **Feed**: RB Oil
- **High Pressure Steam**: (280°C, 80bar)
- **Sparge Steam**: (3bar)
- **Heat exchanger**
- **Vacuum system**: 2 - 6mbar
- **Cooling water**: 35°C
- **Nitrogen**

**Process Flow**:
1. RB Oil enters the process as feed.
2. Heat exchanger
3. High Pressure Steam (280°C, 80bar)
4. Sparg Steam (3bar)
5. Citric Acid (20 – 30ppm)
6. 120-140°C
7. 200-260°C
8. FAD Tank
9. RBD Oil to Tank
10. 35°C
11. Cooling water
12. Nitrogen
## Canola Oil Quality

<table>
<thead>
<tr>
<th></th>
<th>Crude Oil (%)</th>
<th>Refined, Bleached and Deodorised (RBD) Oil (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triglycerides (%)</td>
<td>95-97</td>
<td>&gt;99</td>
</tr>
<tr>
<td>Free Fatty Acids (%)</td>
<td>0.4 – 1.0</td>
<td>0.03 - 0.05</td>
</tr>
<tr>
<td>Phosphatides (%)</td>
<td>1.0 - 1.5</td>
<td>0.003-0.0045</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>0.2 – 0.4</td>
<td>&lt; 0.1</td>
</tr>
<tr>
<td>Unsaponifiables (%)</td>
<td>0.5 – 1.2</td>
<td>0.3</td>
</tr>
<tr>
<td>(e.g. Sterols, Tocopherols)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlorophyll (ppm)</td>
<td>10 – 35</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Iron (ppm)</td>
<td>&lt; 2 ppm</td>
<td>0.1-0.3</td>
</tr>
<tr>
<td>Copper (ppm)</td>
<td>0.03-0.05</td>
<td>0.02-0.06</td>
</tr>
<tr>
<td>Sulphur (ppm)</td>
<td>3 – 15</td>
<td>&lt; 0.1</td>
</tr>
</tbody>
</table>
Cooling

Water

Oil
In-Line Nitrogen Sparging

Nitrogen

Non-return valve

Vegetable Oil Flow

Sparged product out

Inert gas bubbles
## In-Line Nitrogen Sparging

### PV & FFA Changes From Origin To Destination (Palm Oil)

<table>
<thead>
<tr>
<th></th>
<th>PV (Meq/kg)</th>
<th>FFA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nitrogen sparged</td>
<td>Not sparged</td>
</tr>
<tr>
<td>Voyage (T1 = 48 days)</td>
<td>0.05</td>
<td>1.66</td>
</tr>
<tr>
<td>Voyage (T1 = 63 days)</td>
<td>0.18</td>
<td>2.62</td>
</tr>
<tr>
<td>Storage T1</td>
<td>0.35</td>
<td>1.60</td>
</tr>
<tr>
<td>Storage T2</td>
<td>0.42</td>
<td>2.20</td>
</tr>
<tr>
<td>Trucks (Stainless, 1 day)</td>
<td>0.24</td>
<td>1.22</td>
</tr>
<tr>
<td>Rail (Mild Steel, 14 days)</td>
<td>0.71</td>
<td>3.40</td>
</tr>
</tbody>
</table>

Source: “Quality Preservation During Transportation”, B A Elias, Table 1 page 2, *Palm Oil Development No. 12*
Antioxidant Addition
Antioxidants

- **Synthetic**
  - TBHQ, BHA, BHT, Propyl Gallate
    - Effective
    - Not accepted world-wide

- **Natural**
  - Tocopherols, Rosemary, Ascorbic Acid, Green Tea
    - Not as effective (require higher dosage)
    - More accepted world-wide
    - Usually more expensive

- **Protect Oil / Fat from Oxidation**
  - Most degradation during frying
## Antioxidants: Comparison Of Oxidative Stability with AO Systems

<table>
<thead>
<tr>
<th>Product</th>
<th>Loss (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canola</td>
<td>2.1</td>
</tr>
<tr>
<td>Canola Mixed Tocopherols 600ppm</td>
<td>2.8</td>
</tr>
<tr>
<td>Canola TBHQ 200ppm</td>
<td>3.1</td>
</tr>
<tr>
<td>HOSUN</td>
<td>5.9</td>
</tr>
<tr>
<td>HOUN Mixed Tocopherols 1000ppm</td>
<td>8.3</td>
</tr>
<tr>
<td>HOSUN Mixed Tocopherols 100ppm, AP 50ppm</td>
<td>8.6</td>
</tr>
<tr>
<td>Palm Olein</td>
<td>6.4</td>
</tr>
<tr>
<td>Palm Olein Mixed Tocopherols 100ppm, AP 50ppm</td>
<td>9.2</td>
</tr>
<tr>
<td>Palm Olein Mixed Tocopherols 200ppm</td>
<td>7.7</td>
</tr>
<tr>
<td>Soybean Oil</td>
<td>1.8</td>
</tr>
<tr>
<td>Soybean Oil TBHQ 200ppm</td>
<td>3.8</td>
</tr>
<tr>
<td>Sunflower</td>
<td>1.3</td>
</tr>
<tr>
<td>Sunflower, 200ppm Mixed Tocopherols</td>
<td>1.9</td>
</tr>
<tr>
<td>Sunflower, 1000ppm Rosemary Extract + 100ppm Mixed Tocopherols</td>
<td>2.1</td>
</tr>
<tr>
<td>Sunflower TBHQ 200ppm</td>
<td>2.8</td>
</tr>
</tbody>
</table>

2.5gm samples using an airflow of 20l/min at 130ºC
Oil Handling And Storage
Oil Handling and Storage

Aim: Minimise oxidation, hydrolysis and contamination

- Inlet lines for bulk deliveries of oils
- Pump System
- Materials of Construction
Oil Handling and Storage

Design of Storage Tanks
Oil Handling and Storage

Cleaning of Systems

- Tanks and equipment should be inspected at frequent, regular intervals and cleaned accordingly
- Do not wash to bare metal (non-stainless)
- Season with oil before start-up
Loading System for Oil

Vegetable Oil from Storage Tank → Loading Pump → Filter → Sparger → N2 → Road Tanker of Oil

Vents Valve