Challenges in the refining and processing of boutique oils

Dr Laurence Eyres
Mr. Geoff Webster
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Agenda

• Extraction
• Degumming
• Classic caustic refining
• Bleaching
• Deodorising
• Chilling and working for end uses
Extraction of oils and fats

- Fruit oils such as olive and avocado
- Fish oil
- Flaxseed
# New Zealand Boutique Oil Production

<table>
<thead>
<tr>
<th>Company</th>
<th>Oils</th>
<th>Essential Equipment</th>
<th>Approx Tonnes p.a.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Olivado</strong></td>
<td>Avocado</td>
<td>Centrifugal decanter &amp; separator</td>
<td>350</td>
</tr>
<tr>
<td><strong>Avocado Oil NZ</strong></td>
<td>Avocado</td>
<td>Centrifugal decanter &amp; separator</td>
<td>300</td>
</tr>
<tr>
<td><strong>Waihi Bush Organic Farms</strong></td>
<td>Flax seed</td>
<td>Screw press</td>
<td>120</td>
</tr>
<tr>
<td><strong>Extracts NZ</strong></td>
<td>Various</td>
<td>Screw press</td>
<td>Small</td>
</tr>
<tr>
<td><strong>Oil Seed Extractions</strong></td>
<td>Flax seed, hemp seed, walnut, borage, evening primrose</td>
<td>Screw press</td>
<td>150</td>
</tr>
</tbody>
</table>
Boutique or nutraceutical oils in NZ

• Recently reviewed by Dr. Glenn Vile,
• Whilst normal expellers operate at 100 degrees, for specialty oils they operate at much lower temperatures although yields are much lower

• Glenn Vile, Handbook of Australasian Edible Oils, NZIC, 2007
Different Processing Steps for Flaxseed Oil Production

- Pre-pressing
- Intermediate pressing
- Preconditioning
- Final pressing
- Argon sparging
Different Processing Steps for Flaxseed Oil Production

Cold pressing – intermediate pressing – final pressing

- Pre-pressing
- Intermediate pressing
- Preconditioning
- Final pressing
- Argon sparging
Screw presses

In oil industry, screw presses (expellers) are mostly utilized for expression. The main parts of continuous-screw press are:

- **Seed feeder**
- **Cone-shaped cage**
- **Adjustable cone for press-cake outlet**
- **Worm** (pressure and feed)
Rendering

• Breaking down the waste tissues of meat fats and fish waste.

• Low temperature rendering is done at 90 °C, followed by acid breakdown of the emulsion then centrifuging the mixture of fat, water and protein to remove the fat.

• Carried out successfully utilising stainless, nitrogen sparging and fresh tissues-low FFA, PV material produced
Olive Oil and Avocado Oil

Introduction

- World Olive Oil production is 3.0 million tonne
- Total Imported Olive Oil into NZ is 3240 tonne (30% EV)
- New Zealand current produces about 400 tonne (Northland, Waiheke, Wairarapa, Marlborough, Nelson)
- Avocado oil production about 700 tonne
- N.Z. Extra Virgin Olive Oil is very good quality ($40 - $100 1L)
- Olive Oil is growing @ 4% per annum about $26M at retail
Composition of the Olive Fruit

- Pulp
  - Water
  - Triglycerides
  - Sugars
  - Glucosides
  - Phenolics

- Stone
  - TG’s
  - sterols

- Kernel

- Cuticle
  - Alkanes
  - Alcohols
  - Aldehydes
  - Wax Esters
  - Triterpenes
Avocado Oil in NZ

- An efficient modern plant
- Capable of processing 15 tonne fruit/day.
- Utilises modern centrifugal extraction equipment.
- Can process Avocado, Olive, Pumpkinseed, Macadamia etc.
Avocado Oil - Properties

• Extra virgin oil retains many properties of the fruit:
  – Creamy texture
  – Delicate nutty flavour
  – Bright green colour
  – Low FFA and Low PV – stabilization process

Avocado Oil – Further processing

• Produced from Extra Virgin Avo oil.
• Phosphatides and Chlorophyll removed, FFA reduced, peroxides removed, residual flavour and odour taken out.
• Objective is a water white oil with high stability.
• Can be used as a food or cosmetic oil.
• Eyres *et al.* (Year?), Lipid Technology
Using enzymes

• Standard practice in the olive industry
• Experimental use in avocado oil production
• Variable results using pectinases

• Massey University 4th year project, 2004
Review

- Extracting oil in the lab by Soxhlet or Bligh Dyer (chloroform/methanol)
- In Industry - cold pressing natural
- Rendering - wet or dry
- Expelling - high temperature
- Solvent extraction with hexane (pet ether)
Degumming

- Crude oils contain mainly triglycerides (triacylglycerols)
- Free fatty acids
- Phosphatides
- Mono and diglycerides
- Sterols
- Tocopherols
Acid Degumming Process Steps

• Heat oil to 60 - 70 °C
• Acid addition and mixing
• Hydration mixing 30 minutes
• Centrifugal separation of hydrated gums
• Vacuum drying of degummed oil
• Gums - recombined in meal
Refining Methods

Chemical Refining

• Degumming
• Neutralizing
• Bleaching
• Deodorization

Physical Refining

• Degumming
• Bleaching
• Steam distillation
Neutralization

- Refining of vegetable oils is essential to:
  - Ensure removal of gums, waxes, phosphatides and free fatty acid (F.F.A.) from the oil
  - Impart uniform colour by removal of colouring pigments
  - Get rid of unpleasant smell from the oil by removal of odiferous matter
- Refining is carried out either on batch operation or as continuous operation.
- With certain oils even physical refining can be carried out instead of chemical.
Conventional edible oil processing

- **Degumming**: Process to remove mainly phosphatides at temperatures between 60-80°C.
- **Neutralisation**: Process to neutralise free fatty acids at temperatures of 75°C.
- **Bleaching or “Adsorptive cleansing”**: Process to improve colour and remove mainly primary oxidation products (as well as other impurities) at temperatures of 110°C.
- **Winterisation**: Process to remove undesired odours, flavours, residual free fatty acids and peroxides; usually carried out with steam at temperatures of up to 270°C and vacuum with pressures up to 3mmHg.
- **Deodorisation**:
Adsorptive cleansing

- Conventional utilised bleaching earths consist of montmorillonites, activated with sulphuric acid.
- They accelerate oxidation in oil, generating secondary & tertiary oxidation products.
- Novel adsorbents have been identified to be able to modify the conventional refining.
Alteration of clay’s structure during activation

Attack of acid protons on structural OH groups leads to:

- disconnection of octahedral layer from silica sheets (development of free silica) => increased surface area.
- depletion of central (octahedral) ion => change in cation exchange capacities (CEC).
Objectives

• Identification of novel adsorbents by:
  • Activation of un-activated adsorbents with citric acid
  • Determination of their ability to remove oxidation products in fish oil

• Characterisation of the best working adsorbents
Materials & Methods

- 3 types of clay were submitted to a citric acid activation process

- Crude fish oil was then mixed with each of the un/-activated clay and subsequently extracted

- PV, pAV and TOTOX in the oil were determined using AOAC methods

- FTIR spectra (best working + conventional adsorbent) were obtained from 4000 to 400/cm using KBr press disk technique
PV of extracted oil

p-AV of extracted oil
TOTOX of extracted oil

- Montmorillonite (unactivated)
- Montmorillonite (activated)
- Bentonite (unactivated)
- Bentonite (activated)
- Halloysite (unactivated)
- Halloysite (activated)
- Tonsil 231S

Adsorbents

TOTOX (2xPV + p-AV)
Deodorising

- Steam distilling the volatiles out of the oil under reduced pressure (1-5mmHg)
- High temperatures 200-250 °C
- Air must be kept out
- Stainless steel equipment
- Condensed material includes fatty acids, tocopherols, sterols and squalene
7 to 15 Kg Glass Deodorizer
Nutritional Margarine Blends

High polyunsaturated content and low-to-zero trans-acid containing margarines are produced by interesterifying a blend of liquid oil and a fully hydrogenated oil.
Chilling, working and plasticizing of oil/fat blends

• Oil must be blended to meet correct properties
  – solids and crystallisation rates
  – hydrogenated or not

• The oil must be chilled and simultaneously worked in scraped surface heat exchange units

• Packed in tubs or cartons (bulk)
Alternative scraped surface heat exchanger designs
Final Summary

• World oils and fats needed for Food Industry
• Boutique and healthy oils require different approach
• Small scale and low capital requires different methods
• Extraction mechanisms important