Challenges in the refining and processing of boutique oils

Dr Laurence Eyres
Mr. Geoff Webster
ISF 2009

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

Company	Oils	Essential Equipment	Approx Tonnes p.a.
Olivado	Avocado	Centrifugal decanter & separator	350
Avocado Oil NZ	Avocado	Centrifugal decanter & separator	300
Waihi Bush Organic Farms	Flax seed	Screw press	120
Extracts NZ	Various	Screw press	Small
Oil Seed Extractions	Flax seed, hemp seed, walnut, borage, evening primrose	Screw press	150

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

Cold Pressing	Intermediate Pressing	Final Pressing

- 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 continous-screw press are:

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

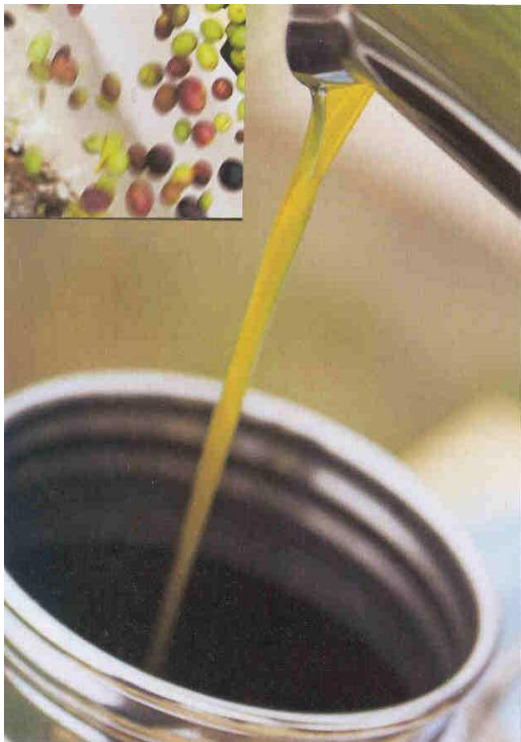
Rendering

- 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

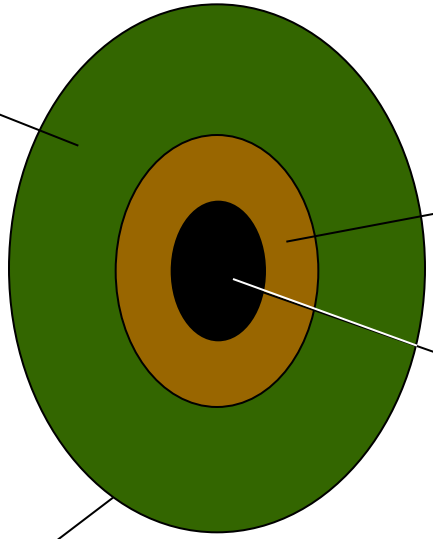
Introduction

- 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

Kernel
TG's
sterols

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

- Woolf *et al.* (2009) “Gourmet and Health Promoting Specialty Oils”, AOCS Press

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 degummedoil
- 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

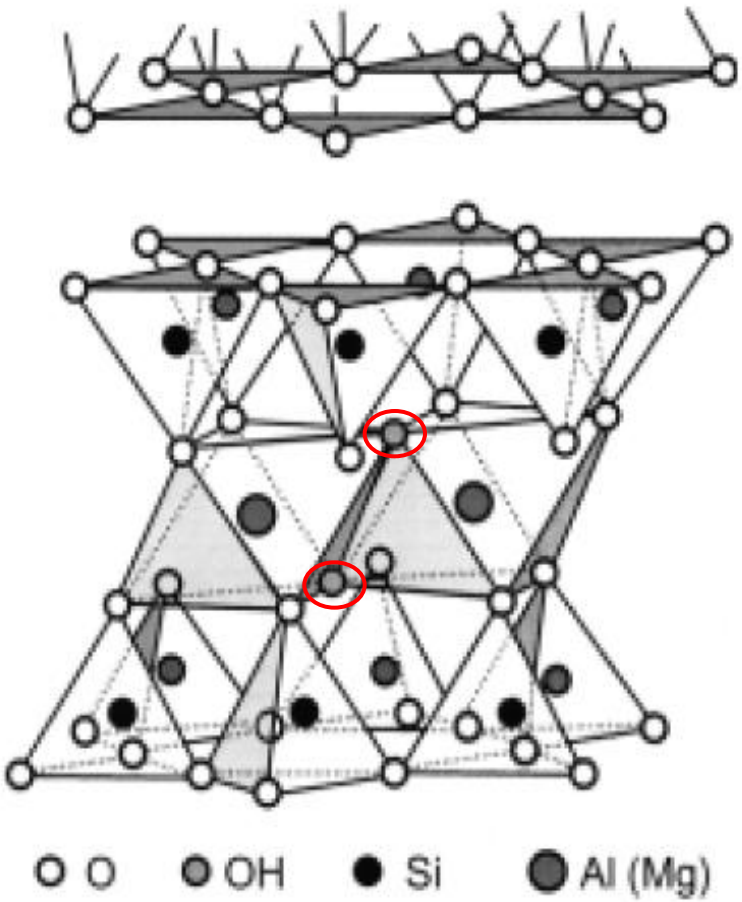
Deodorisation

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.

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).

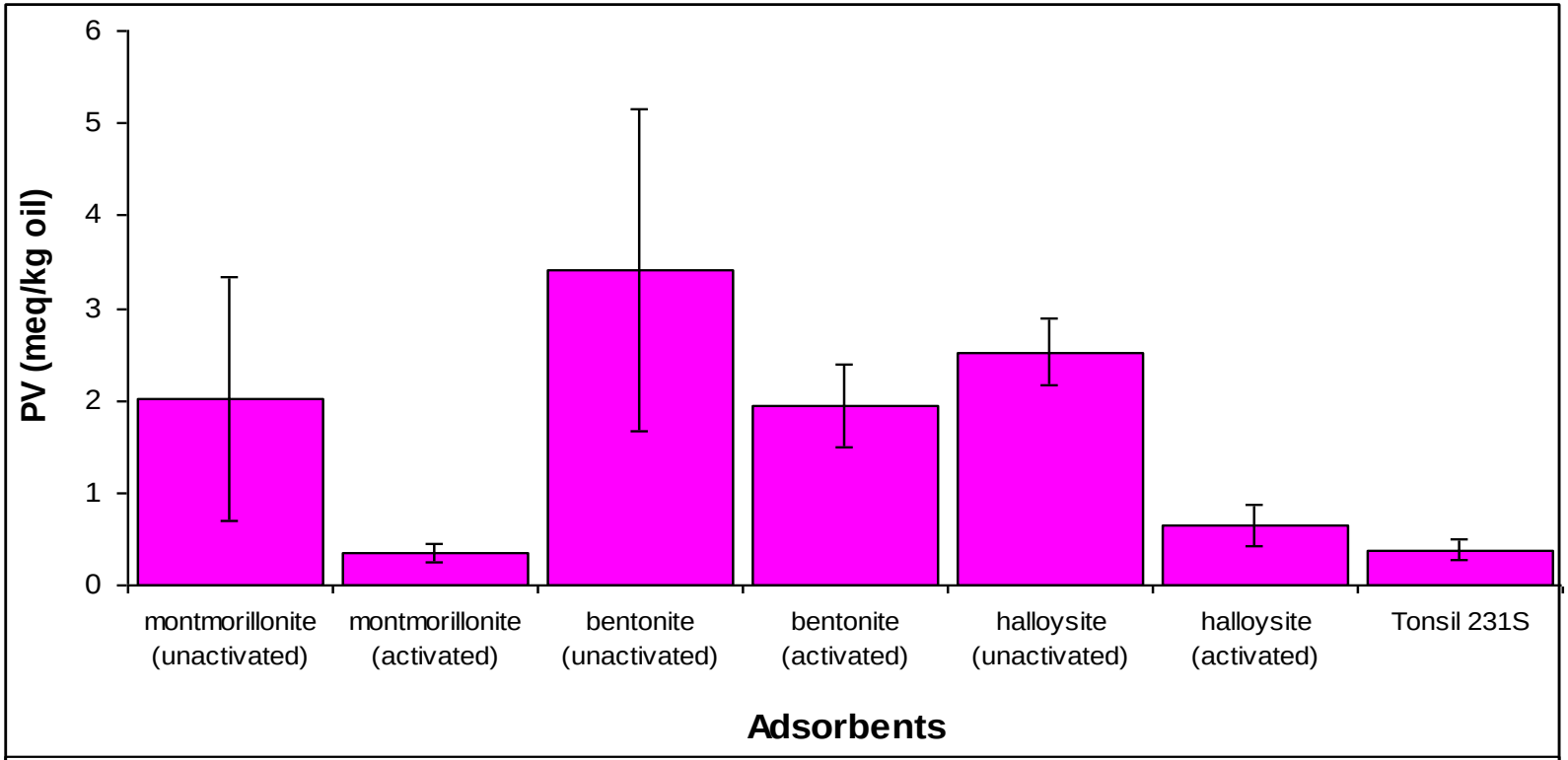
Objectives

- 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

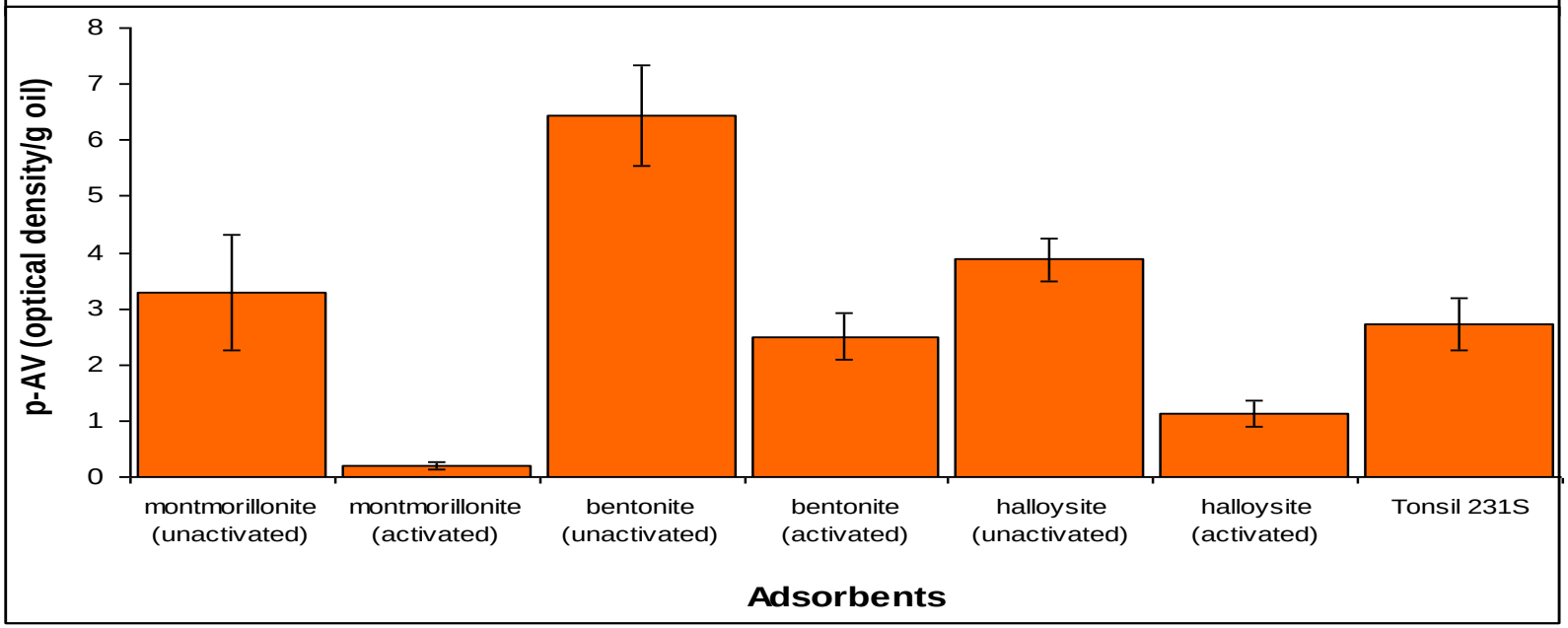
Materials & Methods

- 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

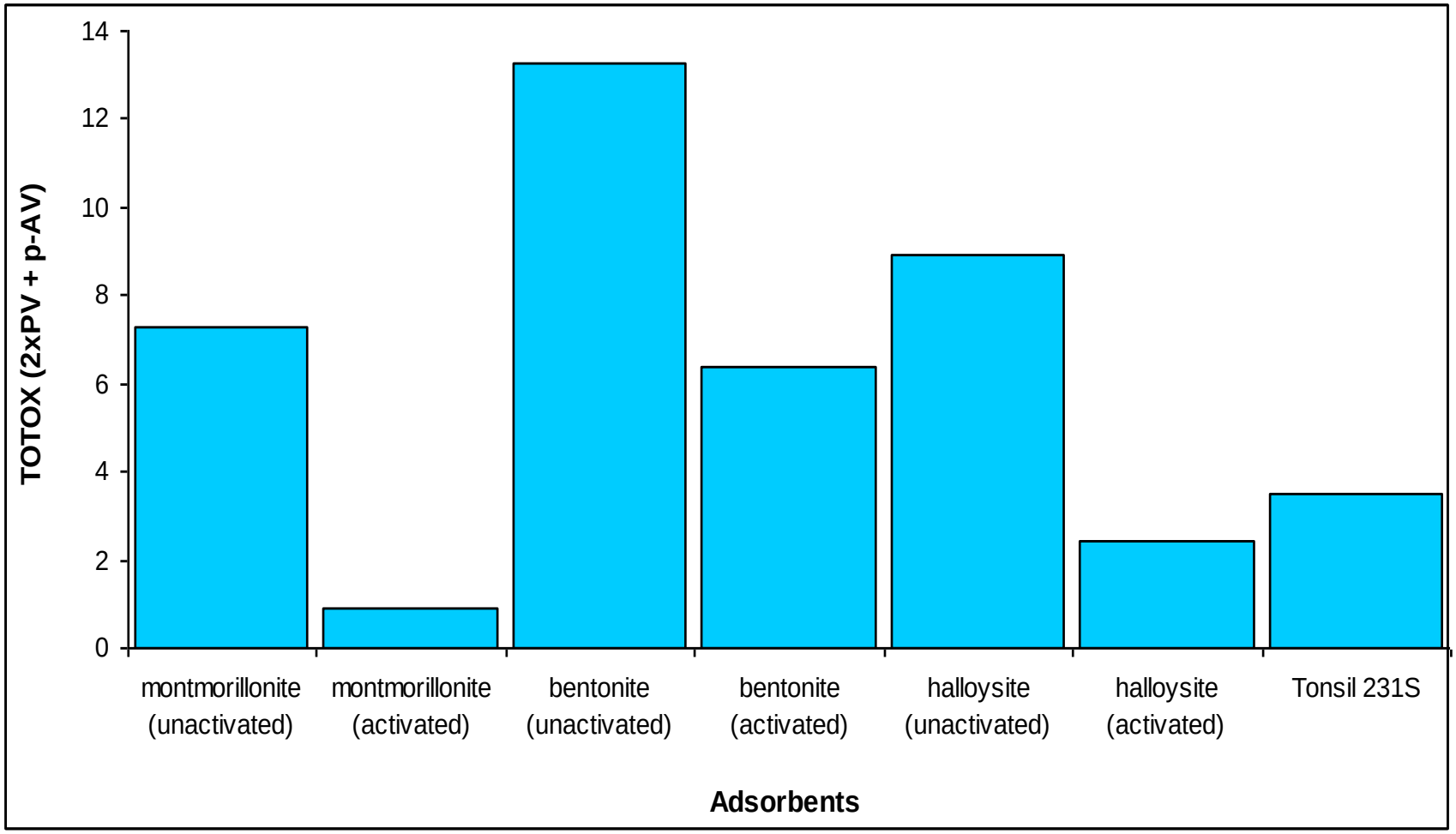
PV of extracted oil



p-AV of extracted oil



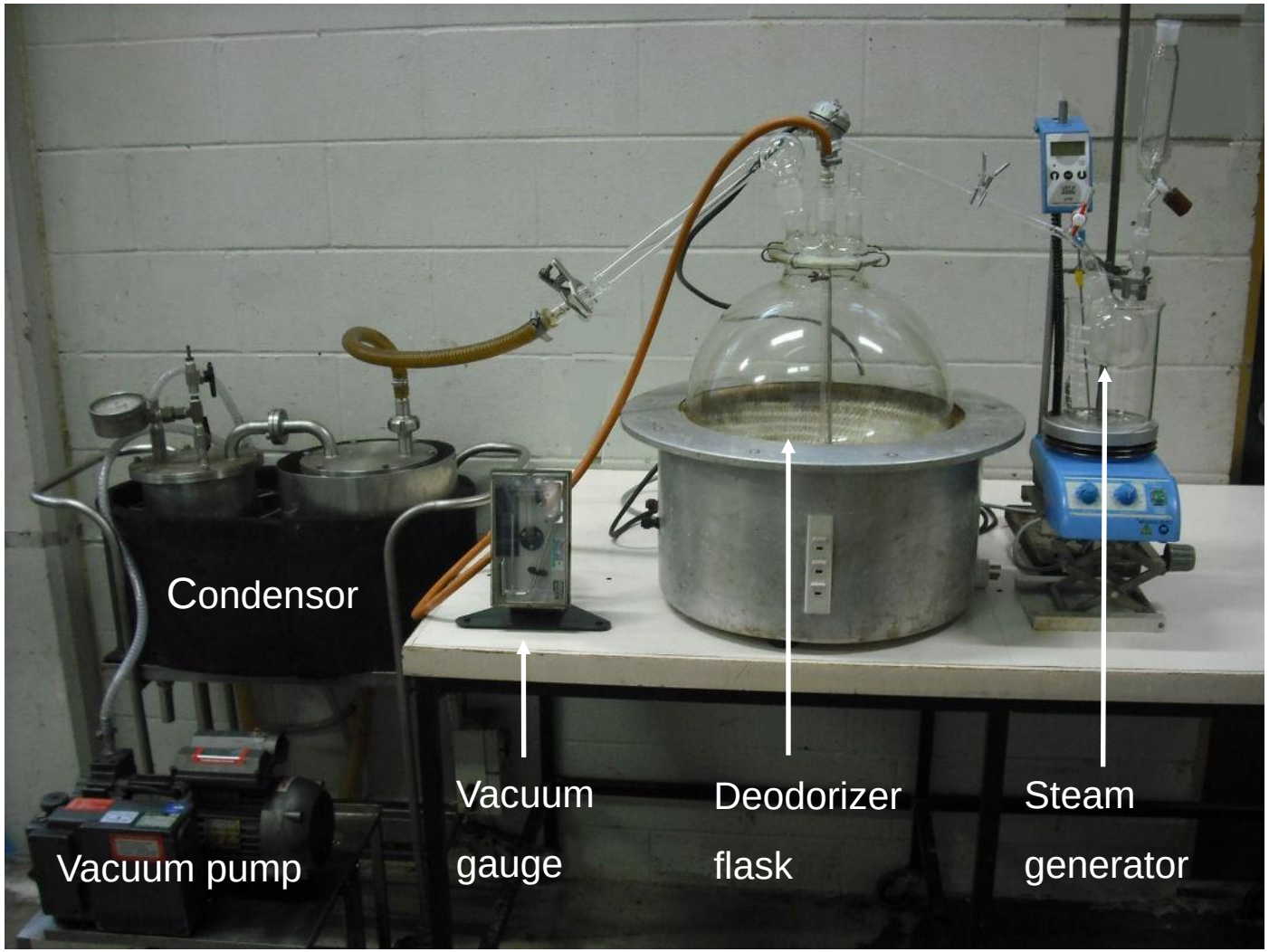
TOTOX of extracted oil



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



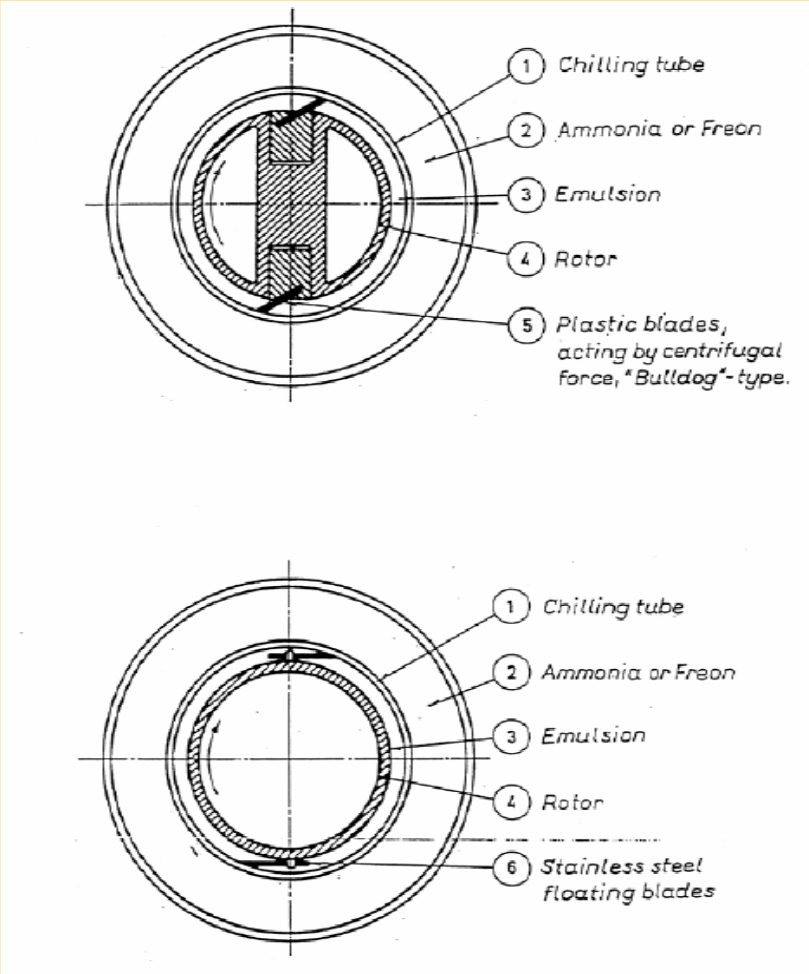
Nutritional Margarine Blends

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