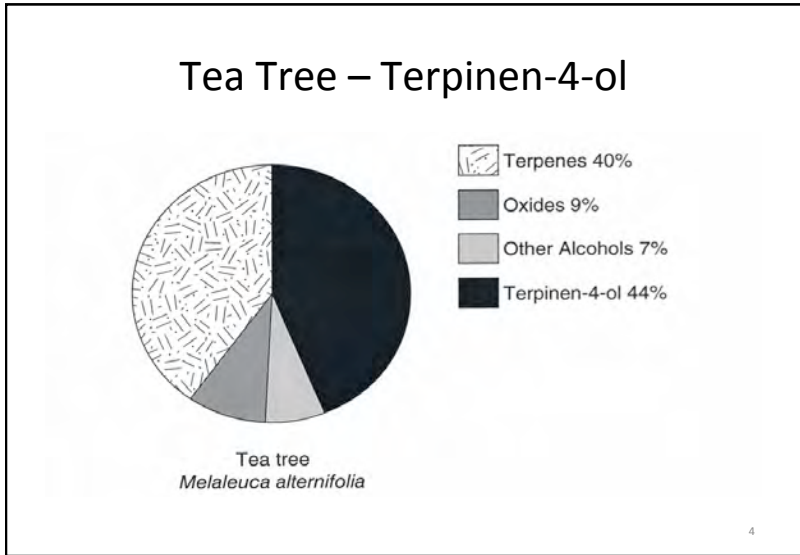
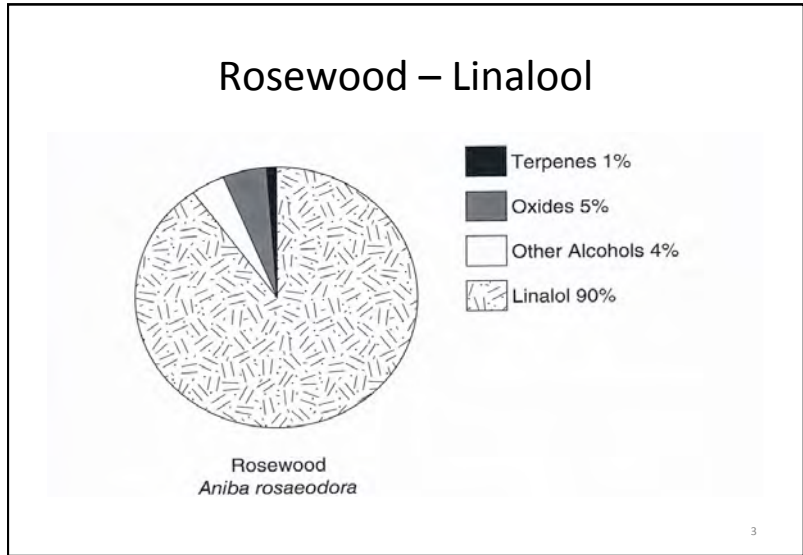
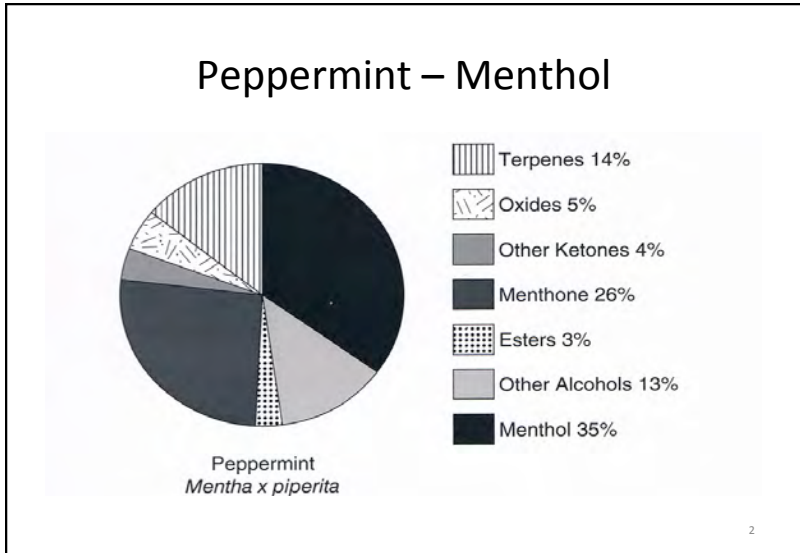
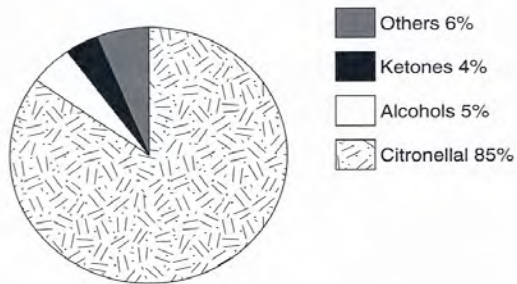


# Essential Oil Therapeutics

1



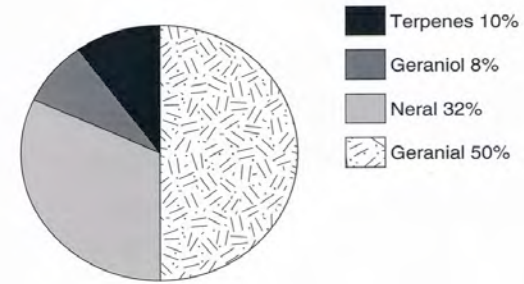
### Eucalyptus citriodora – Citronellal



Eucalyptus  
*Eucalyptus citriodora*

5

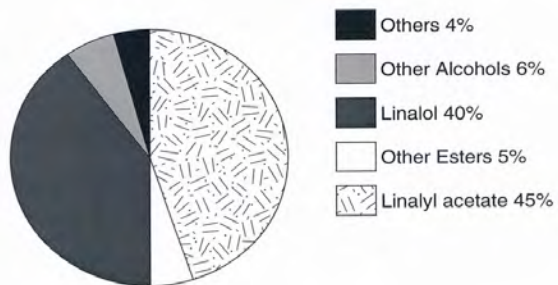
### Lemongrass – Geranial/Neral



Lemongrass  
*Cymbopogon citratus*

6

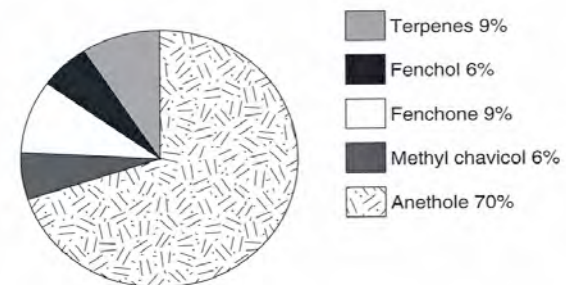
### Lavender – Linalool



Lavender  
*Lavandula angustifolia*

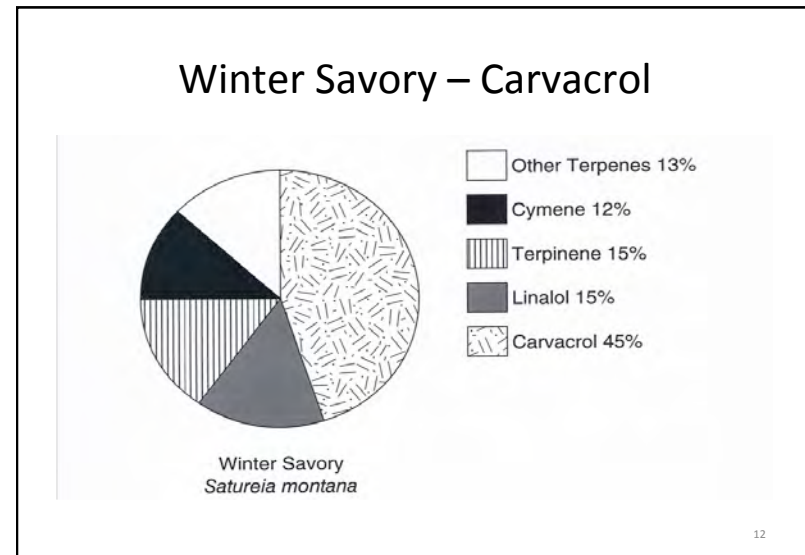
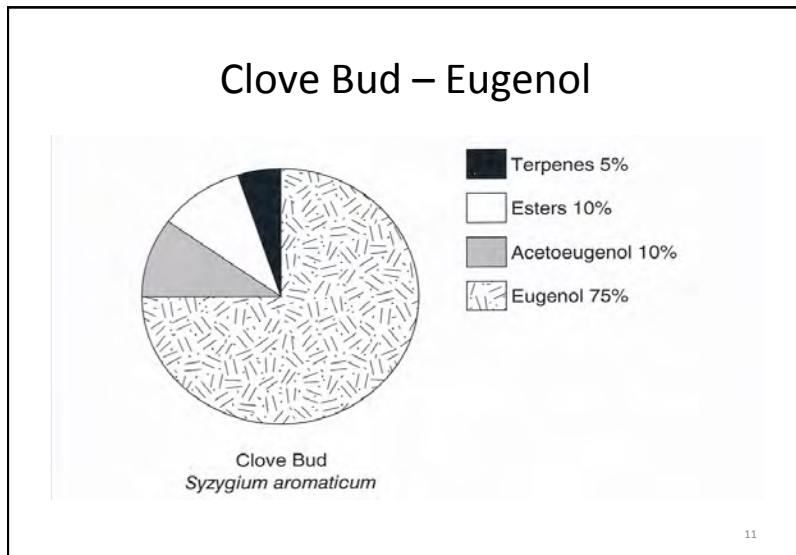
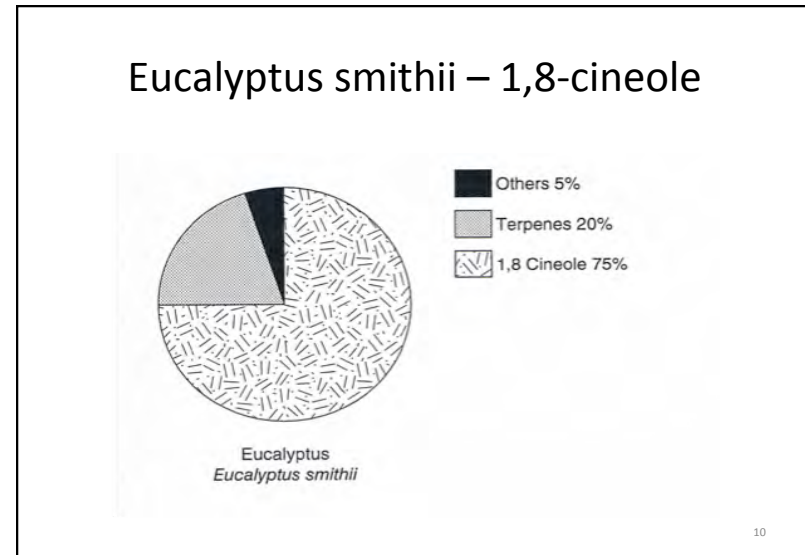
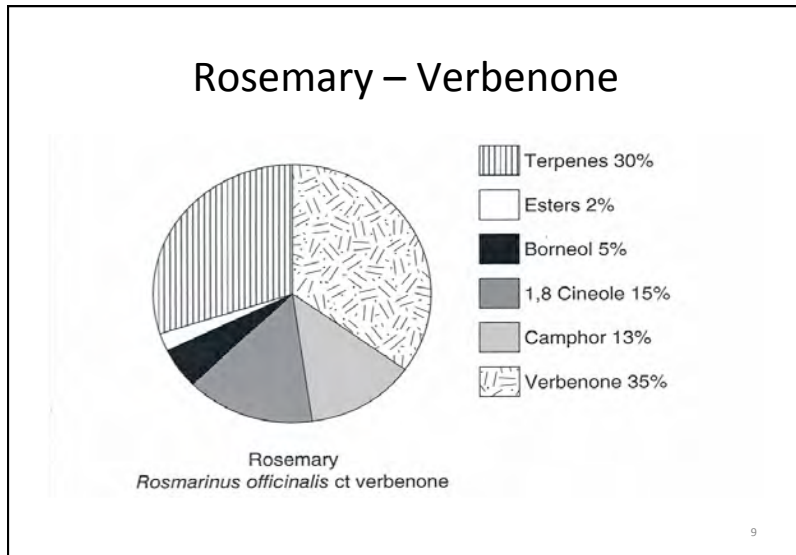
7

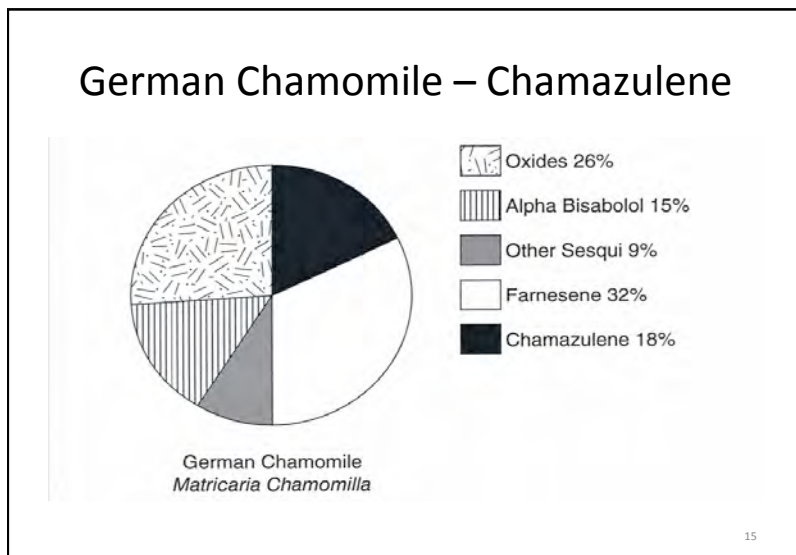
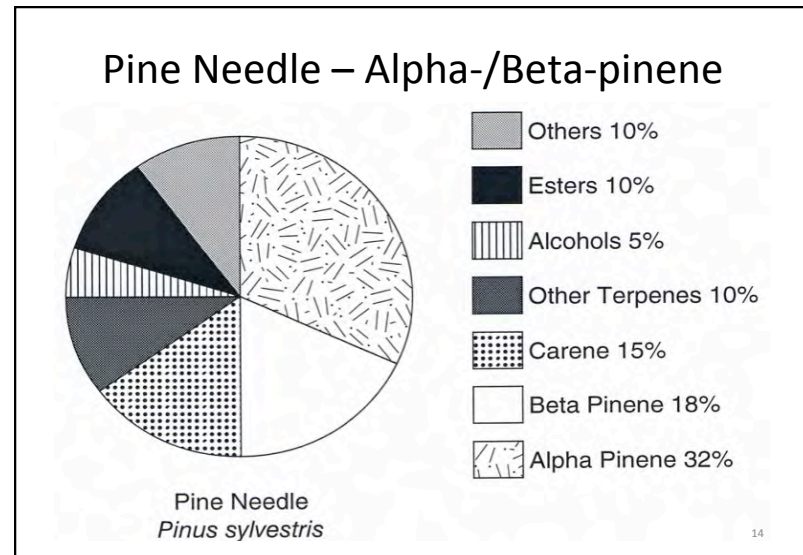
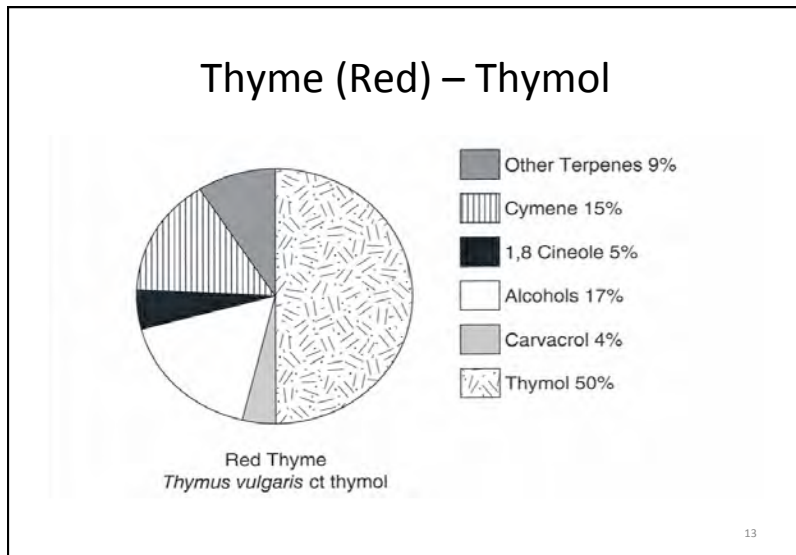
### Fennel – Anethole



Fennel  
*Foeniculum vulgare var. dulce*

8





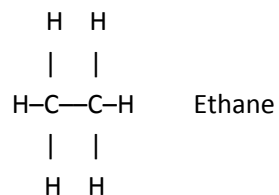
## The Nature of Carrier Oils

16



## Saturation

Carbon atom can form chemical bonds to a maximum of four other atoms –

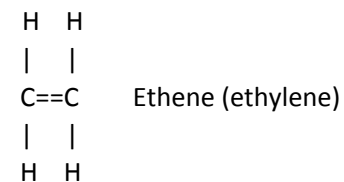


Compound is said to be *saturated*

21

## Unsaturation

Carbon atom can also form multiple bonds with itself, in which case it will not be bonded to a maximum of four other atoms –



Compound is said to be *unsaturated*

22

## Long chain fatty acids

Fatty acids found in oils and fats can be:

- ◇ Saturated – no carbon-carbon double bonds
- ◇ Unsaturated – one or more carbon-carbon double bonds
  - Monounsaturated – one double bond
  - Polyunsaturated – two or more double bonds

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## Long chain fatty acids

Saturated fatty acids:

Lauric acid	12 carbons
Myristic acid	14 carbons
<b>Palmitic acid</b>	<b>16 carbons</b>
<b>Stearic acid</b>	<b>18 carbons</b>
Arachidic acid	20 carbons
Behenic acid	22 carbons

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## Long chain fatty acids

### Unsaturated fatty acids:

Myristoleic acid	14 carbons
Palmitoleic acid	16 carbons
Oleic acid	18 carbons
Linoleic acid	18 carbons
Linolenic acid	18 carbons
Arachidonic acid	20 carbons

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## Long chain fatty acids – carbon atoms and double bonds

Saturated		Unsaturated	
Myristic acid	C14:0	Myristoleic acid	C14:1
Palmitic acid	C16:0	Palmitoleic acid	C16:1
Stearic acid	C18:0	Oleic acid	C18:1
Arachidic acid	C20:0	Linoleic acid	C18:2
		Linolenic acid	C18:3
		Arachidonic acid	C20:4

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## Oils vs Fats

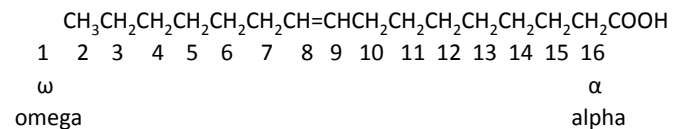
Difference is due to the number of double bonds present in the triglyceride chains:

- ✧ Fats <60% unsaturation
- ✧ Oils >80% unsaturation
- ✧ But coconut oil is highly saturated - 87–95% as is palm oil - 47–50%

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## Omega Classification

- ✧ In common use for dietary applications
- ✧ Identifies position of one double bond in an unsaturated fatty acid



Palmitoleic acid – a C16 omega-7 fatty acid

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## Omega Classification

Unsaturated fatty acids:

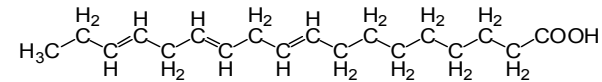
Palmitoleic acid	C16:1	Omega-7
Oleic acid	C18:1	Omega-9
Linoleic acid	C18:2	Omega-6
Alpha-linolenic acid	C18:3	Omega-3
Gamma-linolenic acid	C18:3	Omega-6
Arachidonic acid	C20:4	Omega-6

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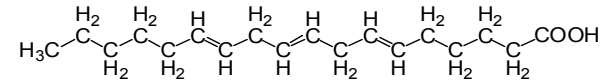
## Linolenic Acid

Two isomers ie structural forms:

Alpha linolenic acid



Gamma linolenic acid



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## Unsaturated Fatty Acids

Palmitoleic acid	C16:1	Omega-7
Oleic acid	C18:1	Omega-9
Linoleic acid	C18:2	Omega-6
Alpha-linolenic acid	C18:3	Omega-3
Gamma-linolenic acid	C18:3	Omega-6
Arachidonic acid	C20:4	Omega-6

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## Essential Fatty Acids

- ✧ Essential for continuing good health
- ✧ Body cannot synthesise directly
- ✧ Have to ingest as part of diet
- ✧ Both omega-3 and omega-6 required
  - 4 omega-6 to 1 omega-3

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## Essential Fatty Acids

Body converts EFAs into longer, more highly unsaturated derivatives:

➤ Prostaglandins

Important functions in all cells eg brain cells, nerve endings, sense organs, adrenal glands, sex glands

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## Signs of EFA Deficiency

- ✧ Increased trans-dermal water loss
  - Dry skin
  - Thirst
- ✧ Eczema, psoriasis
- ✧ Liver/kidney degeneration
- ✧ Wounds not healing/susceptibility to infection
- ✧ Growth retardation
- ✧ Weakness/motor incoordination

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## Essential Fatty Acids

Good sources:

<u>Oil</u>	<u>% Omega-3</u>	<u>% Omega-6</u>
Hemp	20	60
Flax	58	14
Pumpkin	0–15	42–57
Soybean	7	50
Walnut	5	51

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## Oil Use

Topical application:

- ✧ Generally considered oil molecules too big to penetrate through the skin – molecular weight >500
- ✧ Essential oil molecules much smaller – molecular weight ca 250
- ✧ But let's consider the skin

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## Topical Application

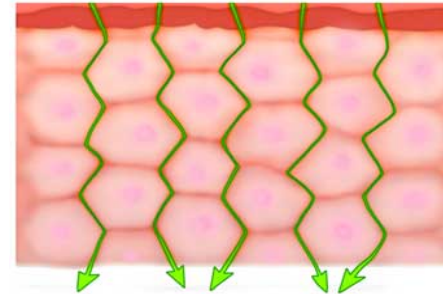
### Skin:

- ✧ Outer layer – epidermis
  - Acts as an initial barrier
  - Top surface – stratum corneum – made up of dead and dying cells
- ✧ Covered with sebum – protective oil made up of fatty acids and triglycerides
  - Dead cells held in place by this fatty film

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## Topical Application

Fatty film provides a route around the dead cells for oils and lipophilic materials:



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## Topical Application

- ✧ Oils may not be absorbed into circulatory system but passage through epidermis possible
- ✧ Breakdown in epidermis possible
- ✧ Penetration means oils able to support skin activity
  - Moisturising and skin softening basic uses

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## Topical Application

### Other benefits:

- ✧ Difficult skin conditions – eczema, psoriasis
  - Oil blends rich in gamma-linolenic acid of value
- ✧ Ease symptoms of EFA deficiency
  - Oils containing omega-3 and omega-6 fatty acids
- ✧ Restore EFA levels
  - Some evidence but perhaps research not 'rigorous'

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## Topical Application

- ✧ Counteract age-related reduction in NMFs
  - Macadamia oil – high in palmitoleic acid components
- ✧ Dry skin – apply as oils or emulsion (creams/lotions)
- ✧ Oily skin – use light oils or emulsion with hydrolat
- ✧ Cleansing – gently lift out grime
  - Lecithin-rich oils excellent – avocado, soybean

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## Oil Production – Commercial

### Pressing:

- ✧ Mechanical work required
- ✧ Heat is produced
- ✧ ‘Cold’ pressed as no *extra* heat used
  - Does not mean cooled or at room temperature

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## Oil Production – Commercial

### Terminology:

- ✧ Crude – unrefined, does not mean process-free
- ✧ Virgin – obtained solely by mechanical means
- ✧ Refined – subject to further processing
  - Lightly refined – improve stability, handling
  - Highly refined – tailored for particular requirements

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## Oil Production – Process

### Initial procedure:

1. Plant material is cleaned – remove dirt, leaves etc
2. Broken up between rollers – provides flakes, meal
3. Pre-heating at 45°C to 85°C – frees oil from within cells

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## Oil Production – Process

### Pressing – screw expeller:

- ✧ Powerful screw squeezes the prepared material, liberating the oil
- ✧ Heat is generated – depends on speed and pressure
  - 45°C to 50°C is best but process slow and so premium price for oil
  - 70°C to 85°C more typical, quicker throughput and cheaper oil

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## Oil Production – Process

### Filtration:

- ✧ Succession of filters to remove all plant material
- ✧ Natural waxes removed by winterisation
- ✧ Oil may be referred to as ‘virgin cold pressed’ as no extra heat used in the expeller

Most oils follow these stages – softer plant material (sunflower, sesame, olive), may go through a simple press

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## Oil Production – Process

### Residual plant material holds 9–18% oil:

- ✧ Used for animal feed
- ✧ Also subject to solvent extraction
  - Broken up and flaked
  - Mixed with solvent
  - Filtered and solvent evaporated away
  - Oil obtained may be added to original material from expeller
  - Can still be called ‘cold pressed’

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## Refining

- ✧ Aim to produce product for a specific purpose
- ✧ Covers a number of operations – all or some may take place
- ✧ Procedures can be simple or ‘aggressive’
  - Minimise possible changes to the oil or obtain standardised product?

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## Refining

### Colour:

- ✧ Carotenes and chlorophyll will oxidise
- ✧ Colour removed if storage expected
  - Fullers Earth or charcoal absorption preferred – coloured material is removed
  - Chemical bleaching is quicker and cheaper – coloured material is destroyed

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## Refining

### Deodorising:

- ✧ Best achieved by filtering through activated charcoal
- ✧ Use of superheated steam (230°C to 260°C) is quicker and more efficient
  - Above 200°C, damaging changes to the oil take place
  - Can still be labelled as 'cold pressed'

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## Refining

### Highly refined oils also undergo:

- ✧ Degumming – also removes phospholipids, involves heating to 60°C with water and phosphoric acid
- ✧ Neutralisation – removes unreacted fatty acids using caustic soda at around 75°C
- ✧ Addition of antioxidants, pigments etc – replacing natural materials destroyed during processing

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## Oil Production – Processing

- ✧ Some plant material, by its very nature, requires special industrial processing
  - eg grape seeds, cherry stones, rosehip seeds
- ✧ Some oils need need to undergo some refinement to make them usable
  - eg grapeseed

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## Unsaturation

Double bonds:

- ✧ Introduce 'weakness' into triglycerides – possible centre for attack by oxygen ie rancidity
- ✧ Provide structure or shape
- ✧ Provide a common structural element for all natural oils and fats – known as the *cis*- form

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## Unsaturation

- ✧ Weakness of double bonds presents a problem –
  - Reduced shelf life
  - Poor stability of cooking oils
- ✧ Can be overcome by modifying triglycerides –
  - Process known as hydrogenation
  - Reduces number of double bonds present by adding hydrogen atoms

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## Hydrogenation

Complete hydrogenation ie all double bonds converted to single bonds – hard fat:

- ✧ Very stable
- ✧ Does not spoil, so long shelf life
- ✧ Typically carried out on coconut or palm oil for chocolate

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## Hydrogenation

Also carry out partial hydrogenation ie only some double bonds converted to single bonds:

- ✧ Products find use in commercial foodstuffs
- ✧ Soft margarines

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## Hydrogenation

Process involves:

Hydrogen gas  
 Temperature of 120–210°C  
 Metal catalyst – nickel  
 Under pressure  
 6–8 hours

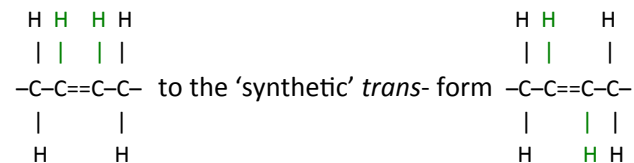
Control conditions to achieve required level of unsaturation

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## Partial Hydrogenation

But:

Configuration around remaining double bonds is changed from natural *cis*- form



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## Partial Hydrogenation

- ✧ Breakdown of fats in the body facilitated by enzymes
- ✧ Enzymes have developed to recognise the *cis*-structure found in nature
- ✧ Enzymes do not recognise *trans*- form so unable to breakdown the double bonds
- ✧ Body treats *trans*-fats as if they were saturated

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## *Trans*- Fats

Affects on the body:

- Increase cholesterol levels
- Decrease levels of beneficial high-density lipoprotein
- Interfere with liver's detoxification process
- Clog arteries

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### Trans-Fats

- ✧ Concerns expressed in late 1990s – typically >50% present in hydrogenated oil
- ✧ Soft margarine manufacturers first to act
- ✧ Fast food outlets had 30% *trans*-fats in cooking oil (7–8g per portion of fries)
- ✧ In 2002 McDonald’s announced would reduce *trans*-content of oil but did not have ‘suitable’ *trans*-fat-free oil until 2007
- ✧ Most major stores now insist on zero *trans*-fat products

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### Oil Stability

- ✧ Presence of double bonds means oils will breakdown
- ✧ Light, oxygen, heat, moisture will promote rancidity
- ✧ Light-induced breakdown spoils oils 1000 times faster than breakdown in the dark
- ✧ Important that oils are stored properly by producers, suppliers and therapists

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### Oil Stability

#### High quality oils:

- ✧ Require proper consideration
  - More liable to attack by oxygen, light, moisture
  - Need to be stored with awareness
- ✧ More expensive
  - Buy little and often

#### Therapist must consider ‘fitness for purpose’:

- ✧ Premium oils for treatments
- ✧ Refined oils where extra stability needed eg products

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### Oil Quality

#### Example – Rosehip seed oil

Test	Range	Result
Saponification value - mg KOH/g	165 – 195	Conforms
Unsaponifiable matter - %	≤1.5	Conforms
Iodine value	161 – 185	177
Peroxide value - Meq O <sub>2</sub> /kg	≤15.0	1.1
Acid value - mg KOH/g	≤4.0	0.54

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## Oil Use

### Ingestion:

- ✧ For benefits to be available oils must first be broken down to constituent parts – fatty acids and glycerol
- ✧ Break down catalysed by a lipase enzyme
- ✧ Enzyme produced in stomach but inactive due to high pH
- ✧ Break down takes place in duodenum and jejunum

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## Ingestion

### Digestion:

- ✧ Mouth and stomach – mixing: oils/fats unchanged
- ✧ Duodenum/jejunum – break down: fatty acids and glycerol obtained
  - Bile produced in liver, stored in gallbladder, mixes with triglycerides
  - Oils and fats form tiny droplets (emulsion) stabilised by lecithin
  - Increased surface area increases rate of digestion
- ✧ Rest of small intestine – absorption

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## Ingestion

### Once absorbed:

- ✧ Essential fatty acids able to perform their vital tasks
- ✧ Materials transported by bloodstream
  - Found in cell walls and membranes
  - Act as energy stores
  - Vitamin E, carotenoids, antioxidants mop up free radicals

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## Peanut Allergy

- ✧ Associated with allergy to tree nuts
  - Brazils, almonds, hazelnuts, walnuts
- ✧ Research indicates associated with eczema and rashes in early childhood
  - Chances increased if rash severe
- ✧ Use of preparations containing peanut oil on rashes associated with increased risk
- ✧ Exposure to soy formula feeds in infancy significant
- ✧ No evidence of peanut allergy at birth
- ✧ No link between maternal use of peanuts – pregnancy/feeding

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## Peanut Allergy

Preparation of peanuts may contribute:

- ✧ Dry roasted – Western countries, high levels of peanut allergy: allergen becomes more resistant to digestion
- ✧ Boiled or fried – typical in China, peanut allergy rare

Peanut proteins may be the trigger

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## Nut Allergy

Suitable oils:

- ✧ Sunflower
- ✧ Safflower
- ✧ Grapeseed
- ✧ Coconut
  - International Association of Infant Massage recommend fractionated for infant massage, as 'free from fungal spores, pesticides, yeast moulds that *may* be present in some unrefined oils'; other oils should be refined

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## Nut Allergy

Other concerns:

- ✧ Oleic acid increases skin permeability, has been evaluated as a medium for transdermal drug delivery
  - Suggested 'high' oleic acid oils should not be used where there is nut allergy
  - Presupposes oil triglycerides are broken down on the skin, liberating oleic acid in sufficient quantity to be effective
- ✧ No evidence oils have this effect

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## Nut Allergy

- ✧ Still many unanswered questions
- ✧ Cautious approach would seem prudent
- ✧ Particular care with very young children
- ✧ Useful resource
  - [www.anaphylaxis.org.uk](http://www.anaphylaxis.org.uk)

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## Oils and Cooking

high temperature + light + oxygen → rapid oxidation

Antioxidants used up → Free radicals produced → Chain reactions start up → Oil begins to smoke

Resulting in production of harmful:

- Trans-fatty acids
- Polycyclic aromatic hydrocarbons
- Other unknown dimer and polymer products

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## Oils and Cooking

- ✧ Refined cooking oils
- ✧ Saturated/monounsaturated oils and fats preferred:
  - Butter
  - Coconut oil
  - Palm oil
  - Sesame seed oil
  - Olive oil
- ✧ In general:
  - Do not let oil smoke
  - If using a wok put a little water in and add vegetables before oil

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## Fatty Acid Profile

Figures give indication, natural products vary

Oil	Saturated %	Unsaturated – mono %	Unsaturated – poly %
Sweet almond	8	67	25
Grapeseed	11	20	69
Olive	10	74	16
Macadamia	15	83	2
Evening primrose	19	1	80
Coconut	85	12	3
Jojoba	93	6	1

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## Fatty Acid Profile

Oil	Saturated %	Unsaturated – mono %	Unsaturated – poly %
Argan	16	49	35
Avellana	7	88	5
Avocado	19	68	13
Borage	15	25	60
Hazelnut	9	74	17
Kukui	7	22	71
Rose hip	6	16	78
Sunflower	12	24	64
Tamanu	22	35	43
Walnut	10	18	72
Wheatgerm	21	19	60

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## Caution

### Swindon Advertiser

Oils blamed for fire at college

<http://www.cultureofsafety.com/safety-tips>

Spontaneous Combustion of Oily Rags

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## Caution

- ✧ Batch of towels washed, tumble-dried, folded and stacked – heat generated by breakdown reaction built up and reached auto-ignition point
- ✧ Spa employee left towels in drier over night – towels smouldered causing extensive smoke damage  
Towels, linen left in bins to wash next day – serious fire resulted, \$600,000 of damage

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## Caution

- ✧ Unsaturated oils more prone to degradation
- ✧ This oxidation reaction is exothermic
- ✧ Excessive heat responsible for fires – auto-ignition temperature is 120°C

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## Quality Issues

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## Essential Oil Quality

- ✧ Want 'good' quality essential oils
- ✧ What do you want to use the essential oils for?
  - Healing/medical use
  - Psychotherapeutic/body work
  - Ambient fragrancing
  - Perfumery
  - Cosmetics
  - Fragrancing commodities
- ✧ Does each application require the same 'quality'?

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## Essential Oil Quality

- ✧ Quality is a 'notion'
- ✧ Clearly define what the essential oil is for
- ✧ Selection based on –

**Fitness for Purpose**

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## Essential Oil 'Categories'

- ✧ Synthetic/semi-synthetic
  - Mimic plant fragrance using aroma chemicals either manufactured or processed from original plant material
  - Nature identical
  - Main use in flavourings and perfumery

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## Essential Oil 'Categories'

- ✧ Industrial
  - About blending and standardisation
  - May simply be gathering together plant material from different growers and then distilling
    - Could be a blend from a single cooperative
  - Composition may be 'adjusted' to give a reproducible product
    - Oil could be added to, using natural components or chemicals from a different species or synthetics to boost content of a particular chemical

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## Essential Oil 'Categories'

- ✧ Pure and natural – 'near to nature'
  - Obtained from a single source and a single named botanical species, using appropriate plant material and extraction process
  - Includes
    - Wild crafted
    - Organic

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## Quality

- ✧ 'Near to nature' ideal for aromatherapy
- ✧ But some form of processing necessary
  - Harvesting
  - Drying
  - Distillation/extraction
- ✧ All can have an affect on the essential oil
  - Perhaps 'as near to nature as is possible' is better definition

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## Harvesting

Machine chopping – rapid, easy handling



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## Harvesting

Machine cutting – blade height important



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## Harvesting

Hand cutting – very expensive, best for flowering tops



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## Drying

- ✧ Once cut, drying slows down decomposition
- ✧ Dried material has lower bulk, get more in still
- ✧ Fresh best but bulky, also possible problems with compaction

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## Drying

- ✧ Cut material is normally left to dry in the field
- ✧ Otherwise, dried on racks in sheds
  - Hot air may be used
- ✧ Chopped material used without drying
- ✧ Dried material for shipment may be irradiated if contamination is a possibility

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## Distillation

Typical still



Mobile still:



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## Distillation

'Tanking' lavender:



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## Distillation

The nature of the steam can vary:

- ✧ Traditional – low (ie atmospheric) pressure
  - Slow process, long distillation time, 'whole' oil ie still runs until there is no more essential oil
- ✧ High pressure – produces super-heated steam with a temperature of 175°C or more
  - Short distillation time, increased output, 'standard' oil
- ✧ At altitude boiling point of water falls, oil produced at lower temperature, best lavender at 3000 ft
  - Wild, hand cut, mobile still, 'whole' oil

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## Distillation

High costs

Low yield



95

## Standards

- ✧ Nature is not standard – it is diverse
- ✧ To produce to a standard must 'interfere'
- ✧ Essential oils 'near to nature' can never be standard
- ✧ Standards indicate consistency, not quality

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## Adulteration

Driving force – money

Consider 'standard' rosemary essential oil – 90% added chemicals:

1,8-cineole	34%	Myrcene	2%
Camphor	20%	Borneol	5%
Alpha pinene	10%	Caryophyllene	5%
Beta pinene	8%	Bornyl acetate	1%
Camphene	5%		

Cost of above about half price of the pure essential oil

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## Adulteration

- ✧ Standardised oils are a fact of life and are appropriate if made clear
- ✧ Same techniques used for adulteration but not disclosed
- ✧ Not only aromatherapists targeted

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## Adulteration

Chemical soup



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## Adulteration

Usually involves blending essential oil with:

- ✧ Its own main constituent(s) – natural and/or synthetic
- ✧ Other oils or their constituents
- ✧ A reconstituted oil
- ✧ A fragrance chemical

100

## Adulteration

Expensive oils prime targets:

- ✧ Rose phenylethanol – component  
citronellol – major component
- ✧ Neroli petitgrain – same tree  
linalyl acetate, nerol – components
- ✧ Jasmine ylang ylang fractions  
indole – component
- ✧ Melissa lemon, lemon verbena and lemongrass

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## Adulteration

Other oils:

- ✧ Lavender linalyl acetate, linalol – major components
- ✧ Bergamot linalyl acetate, linalol – major components
- ✧ Geranium Bourbon has cheaper geranium added
- ✧ Rosemary 1,8-cineole, camphor
- ✧ Tea tree terpinen-4-ol

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## Adulteration

Terms with little or no meaning:

- ✧ Nature identical – synthetic but allows a Latin name to be used
- ✧ Medical quality – implies 'high' quality but compared to what?
- ✧ True – the oil either is or is not what is on the label

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## Adulteration

What about:

- ✧ Natural? Still applies even if extended with other essential oil(s) or chemicals obtained from oils
- ✧ Pure and natural? Applies to citrus oils obtained by steam distilling fruit pulp left over from juice extraction
- ✧ Pure and natural? Also applies to juniper oil obtained from fermented fruit used in making gin

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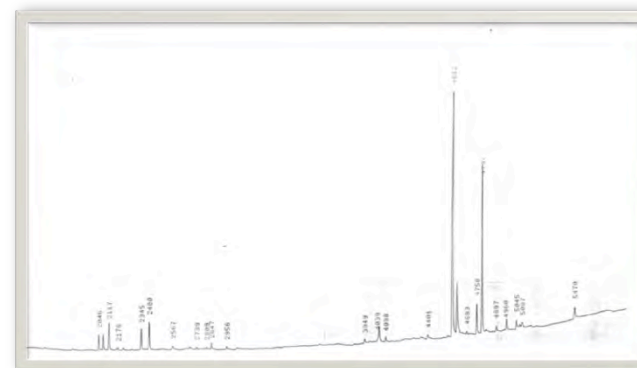
## Testing

- ✧ Analysis of an essential oil does not assure its quality
- ✧ Tests carried out are not exhaustive
  - Specific gravity
  - Refractive index
  - Optical rotation
- ✧ GLC – limited, may be top ten marker chemicals
  - Seeking obvious adulteration

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## GLC

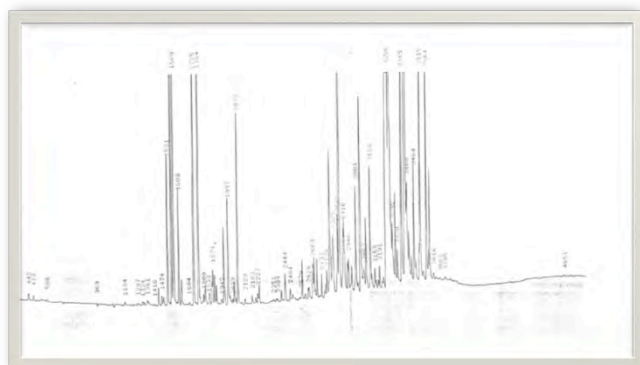
Retail brand sandalwood



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## GLC

Quality sandalwood



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## Testing

Analysis:

- ✧ Not the arbiter of quality
- ✧ It is a verification process
- ✧ Suppliers will produce what is required by the market they service

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## What to do?

Varying qualities to meet different needs

Establish your needs, what your practice requires

May decide to use more than one quality

Soon establish which suppliers are best for you

Become a connoisseur – enjoy your oils

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