

Fatty Acids for Food and Fuel

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**World Congress on Oils and Fats
& 28th ISF Congress**

27 - 30 September 2009 • Sydney Australia



THE UNIVERSITY OF
WESTERN AUSTRALIA

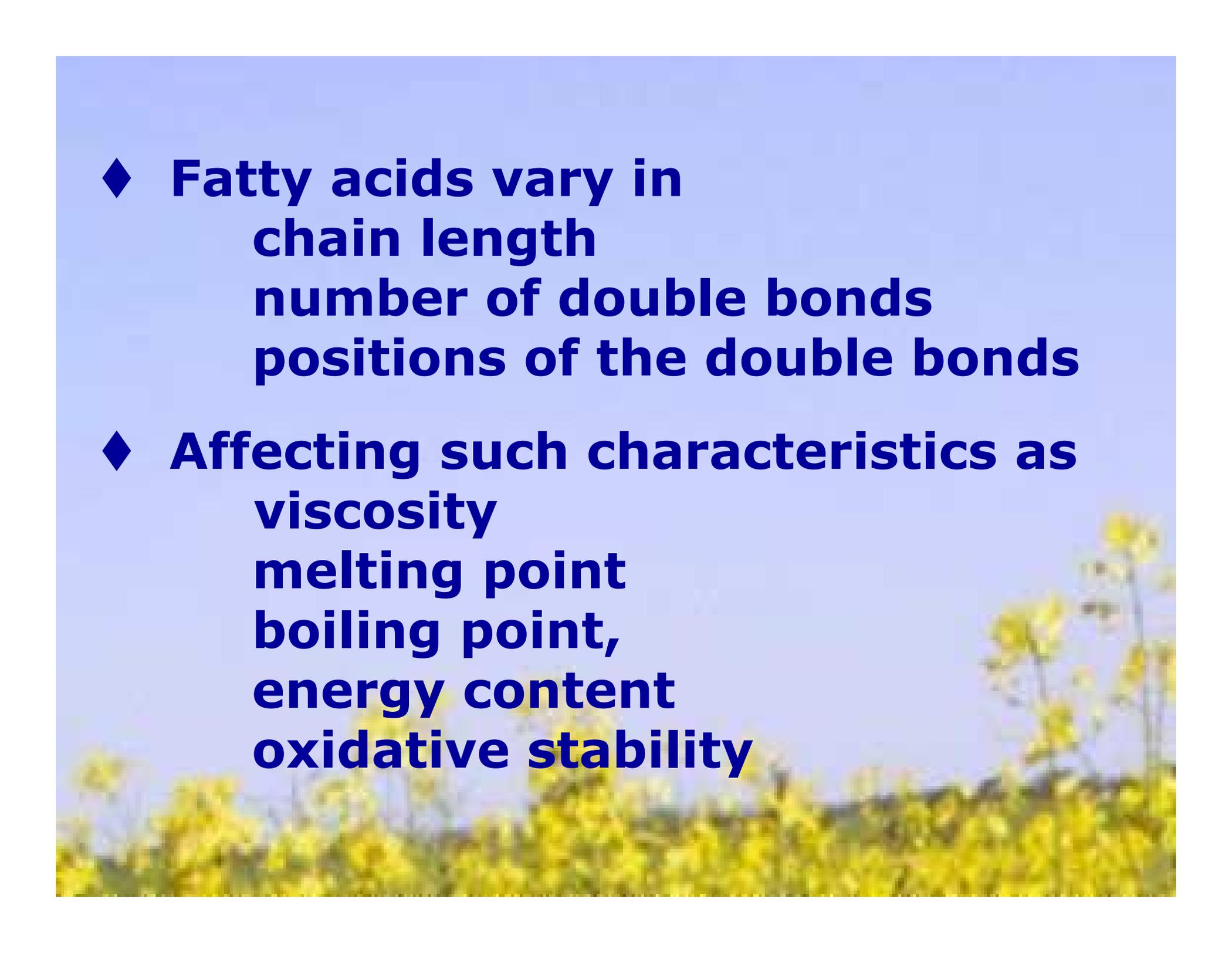


Relationships

- **Biofuel and food oils = fatty acids**
- **Fatty acids = building blocks of animal and vegetable fats and oils**

Fatty Acids

- ◆ **70 different fatty acids isolated from cells**
- ◆ **Most fatty acids have an even number of carbon atoms**
- ◆ **C16 and C18 = most common**

- 
- ◆ **Fatty acids vary in**
 - chain length**
 - number of double bonds**
 - positions of the double bonds**
 - ◆ **Affecting such characteristics as**
 - viscosity**
 - melting point**
 - boiling point,**
 - energy content**
 - oxidative stability**

Divided into 3 main groups, fatty acids can be :

1. Saturated

2. Mono-unsaturated

3. Poly-unsaturated

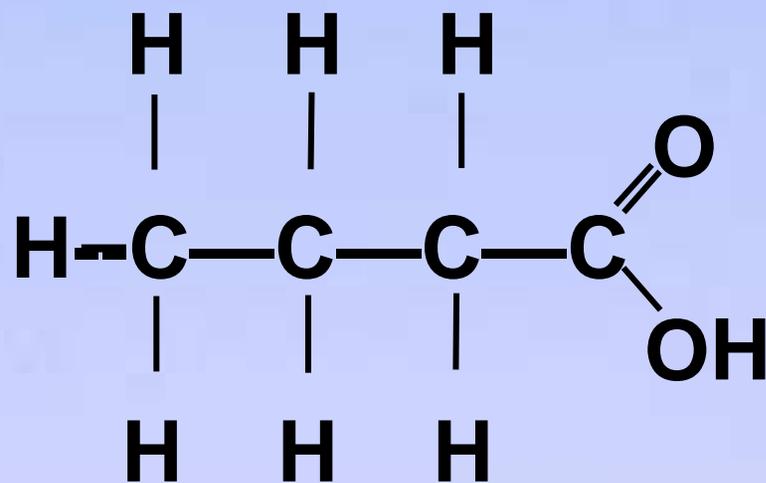
Saturated fatty acids

- ◆ **Most common** - **Found in**
 - Palmitic (C:16)** **Palm oil**
 - Stearic (C:18)** **Animal fats**
- ◆ **Less common**
 - Lauric (C:12)** **Coconut oil**
 - Myristic (C:14)** **Palm kernel oil**

Characteristics of saturated fatty acids

- ◆ **Stable**
- ◆ **High calorific value or energy content.**
- ◆ **High melting point, increasing with chain length (solid at room temperature)**

Structure of Butyric Acid (C4)



Mono-unsaturated fatty acids

Common ones - Found in

Oleic (C18:1) - Olive oil, canola

Ecosenoic (C20:1)- Brassicas, camelina

Erucic (C22:1) - Crambe, mustards

Less common

Palmitoleic (C16:1)- Animal fats

Ricinoleic (C18:1) - Castor oil

Characteristics of mono-unsaturated fatty acids:

- ◆ **Less stable than saturated fatty acids.**
- ◆ **Slightly less energy content.**
- ◆ **Liquid at room temperature.**

Poly-unsaturated fatty acids

- ◆ **2 double bonds**

 - Linoleic acid (C18:2) - soybean, sunflower and safflower oils.**

- ◆ **3 double bonds**

 - Alpha Linolenic (C18:3) – Linseed**

 - Gamma Linolenic (C18:3) – Ev. Primrose**

- ◆ **5 and 6 double bonds**

 - EPA and DHA found in fish oils**

Characteristics of poly-unsaturated fatty acids:

- ◆ **More double bonds = less stable**
- ◆ **Melting point is below 0 deg. C.**
- ◆ **Essential fatty acids = poly-unsaturated. (PUFA's)**

Images of several fatty acid molecules

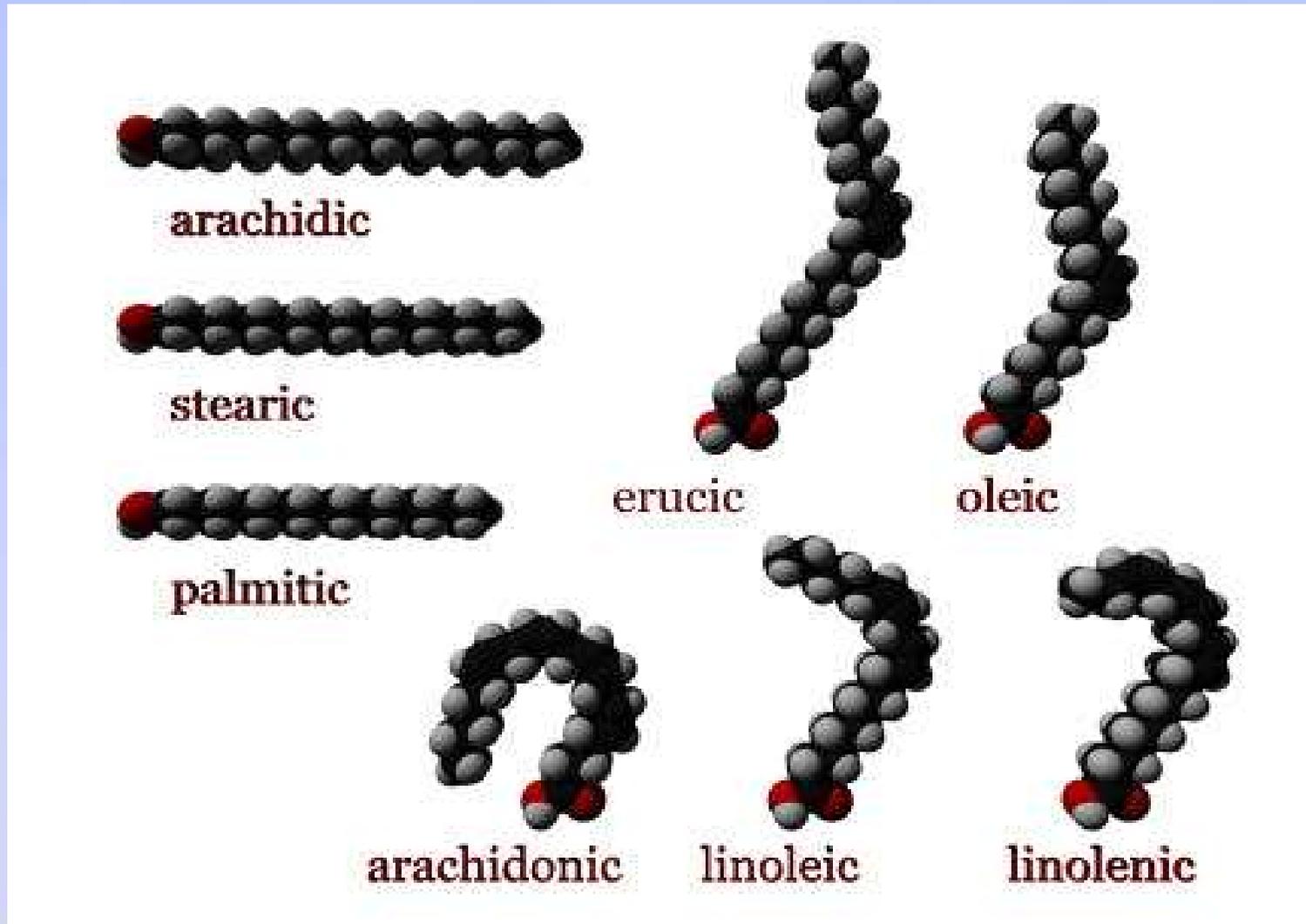


Image: Rasyslami.jpg from Wikipedia, the free encyclopedia

Melting Points of Some Fatty acids

Fatty Acid	Carbon No	Melting Pt
Lauric	C12	43.5
Myristic	C14	54.4
Palmitic	C16	62.9
Stearic	C18	69.6
Arachidic (Eicosanoic)	C20	75
Behenic	C22	80
Lignoceric	C24	84.2
Oleic	C18:1	13.5
Eicosenoic	C20:1	22
Erucic	C22:1	33
Linoleic	C18:2	-5
Linolenic	C18:3	-11

Fats and Oils

Different oils have different uses:

- ◆ **Oils for Food and cooking**
- ◆ **Oils for Health**
- ◆ **Oils for cosmetics**
- ◆ **Oils for Industry**
- ◆ **Oils for fuel or energy**

Food oils

Marketable characteristics:

- ◆ **Stability**
- ◆ **Reduced calorific content**
- ◆ **Acceptable level of flavour**
- ◆ **Acceptable colour**
- ◆ **Erucic acid content less than 2%
(for Canola)**

Food oils and Fatty acids

- ◆ **Desirable fatty acids =
oleic and linoleic acids**
- ◆ **Less desirable =
saturated fatty acids**
- ◆ **Undesirable =
erucic acid and PUFAs**

Some Oilseed Crops

- **Past, present and potentially future**





Linum usitatissimum
Linseed or Flax



Linum usitatissimum
Linseed, Flax or Linola



**Canola
Miling WA
August 2001**



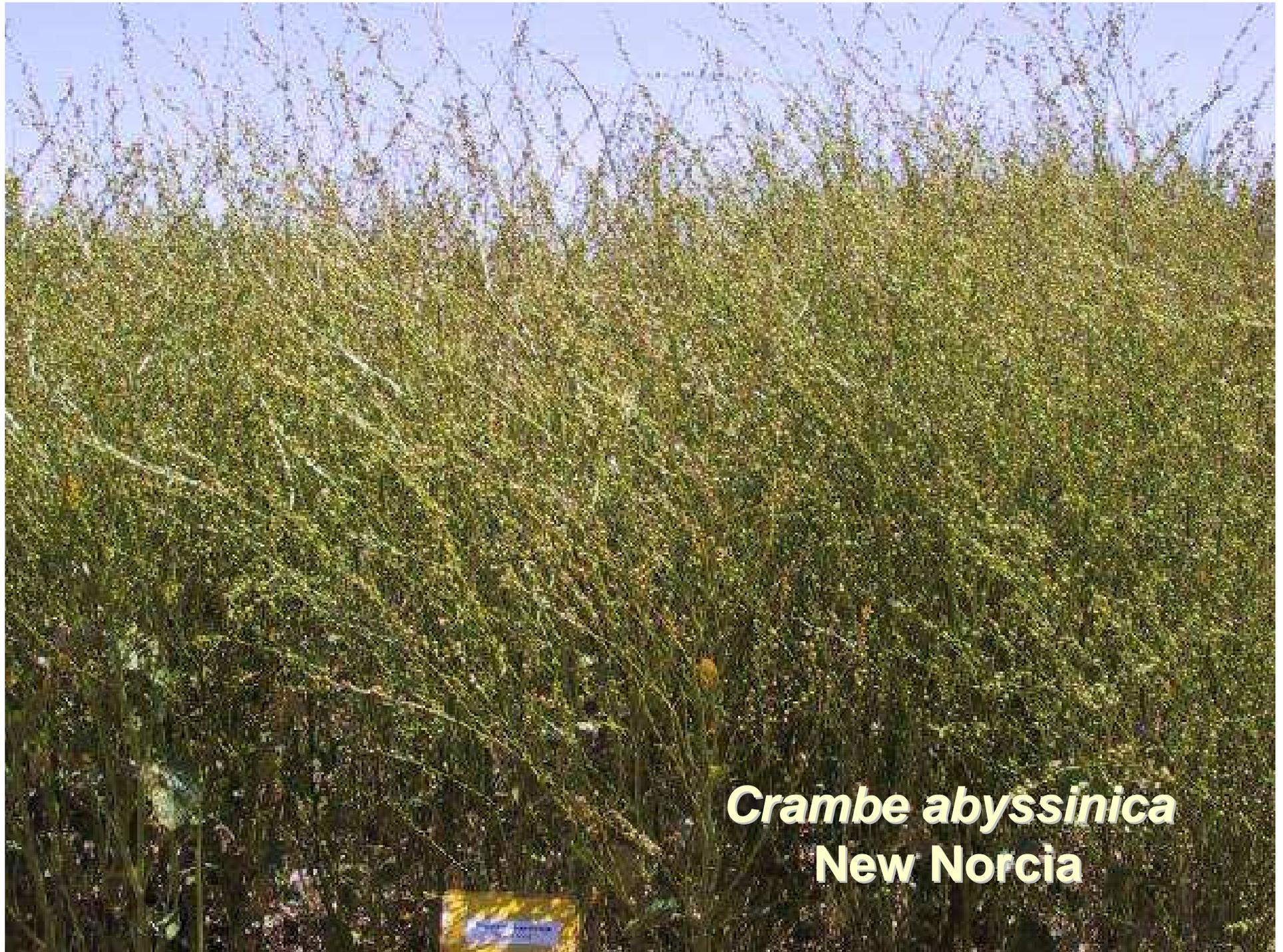
Brassica juncea
Northam
August 11th 2004



Brassica carinata
near Albany
November 12th 2004



Camelina sativa
Camelina, false flax



Crambe abyssinica
New Norcia

Fatty acid composition of some edible fats and oils

Oil or Fat	SFA	Oleic	Linoleic	ALA
Beef Tallow	46	43	3	1
Butter	56	29	2	1
Canola	6	62	22	10
Coconut	83	6	2	
Cottonseed	26	19	54	1
Flaxseed	10	21	16	53
Olive	16	71	10	1
Palm	50	40	10	
Soybean	15	24	54	7
Sunflower	12	19	68	1

Adapted from www.scientificpsychic.com/fitness/fattyacids1.html

Oils for Health

Essential Fatty Acids

- ◆ **Cannot be manufactured in the body**
- ◆ **Required for health**
- ◆ **Long chain poly unsaturated (PUFA)**
- ◆ **Omega-3 = C18:3, C20:5, C22:6**
- ◆ **Omega-6 = C18:2**
- ◆ **Taken as a supplement in a capsule or added to foods eg dairy products**

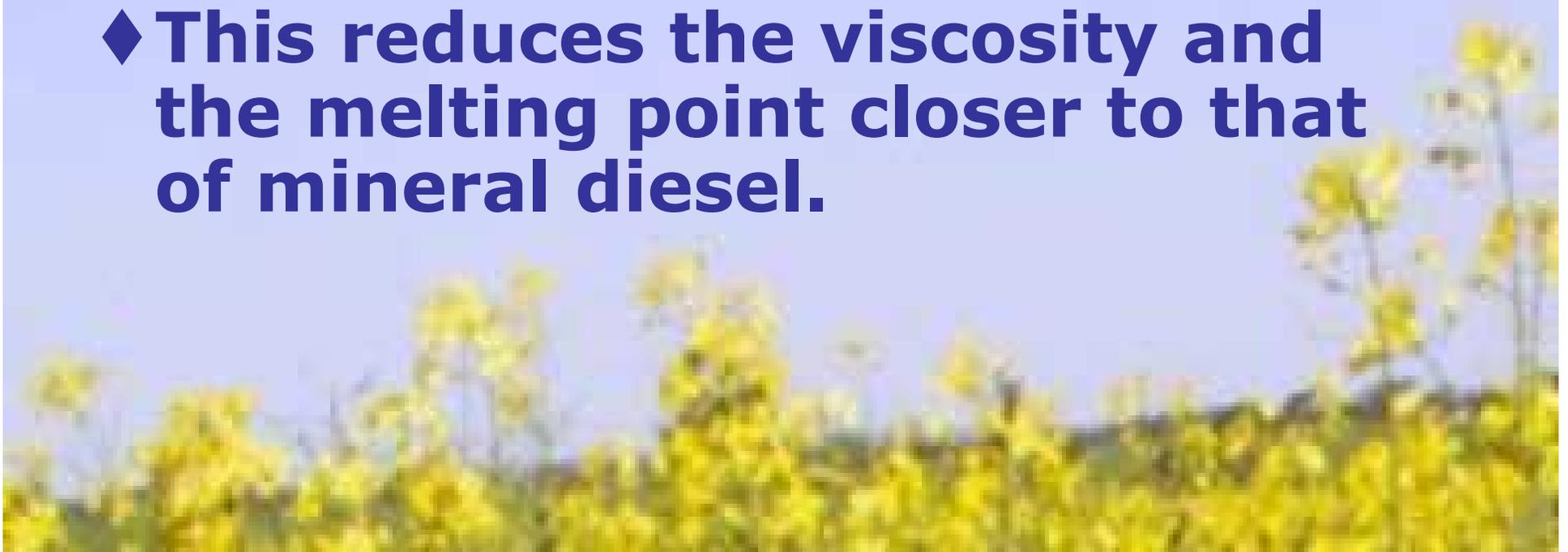
Oils for fuel

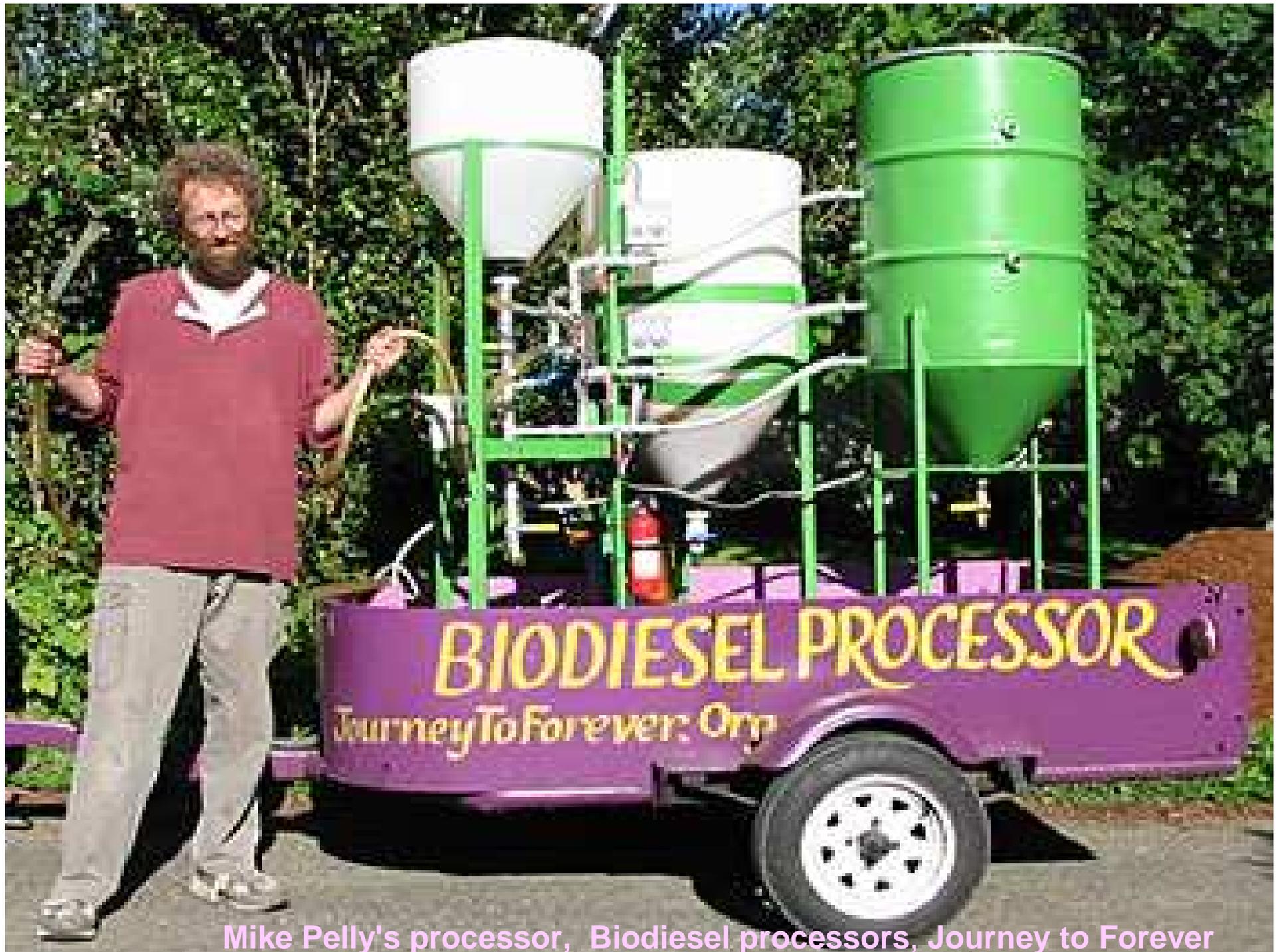
- ◆ **Animal and vegetable fats and oils**
- used for heating and light for thousands of years
- ◆ **Converted to biodiesel (or not), fats and oils can be used to power engines**



Biodiesel: What is it?

- ◆ **Animal or vegetable fat or oil that has been chemically altered to form a mono-alkyl ester.**
- ◆ **This reduces the viscosity and the melting point closer to that of mineral diesel.**





Mike Pelly's processor, Biodiesel processors, Journey to Forever

The melting points of some fatty acids and their methyl esters

Fatty Acid	Carbon No	MP of Fatty Acid	MP of Methyl Ester
Lauric	C:12	43.5	5
Myristic	C:14	54.4	19
Palmitic	C:16	62.9	30
Stearic	C18	69.6	39
Arachidic	C20	75	47

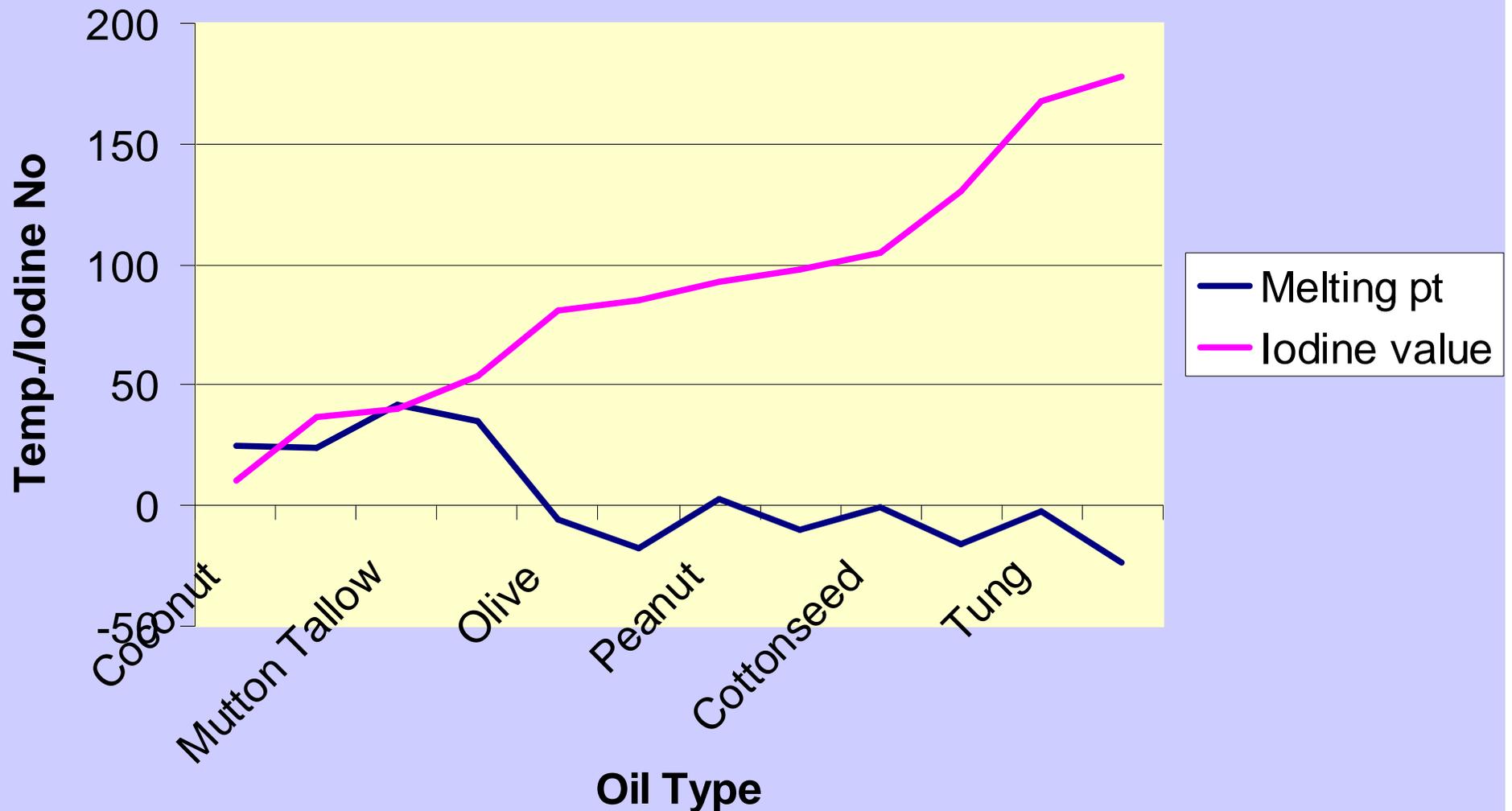
How is Biodiesel made?

- ◆ **Fats and oils are mostly triglycerides.**
- ◆ **The fat or oil is reacted with alcohol (methanol or ethanol) in the presence of a catalyst (KOH or NaOH).**
- ◆ **Forming a mono-alkyl ester (biodiesel) and glycerol (bye-product).**

Some oils, their melting points (°C), Iodine values and Cetane No.

Oil	Melting pt	Iodine No	Cetane No
Coconut	25	10	70
Palm kernel	24	37	70
Mutton Tallow	42	40	75
Palm	35	54	65
Olive	-6	81	60
Rapeseed	-10	98	55
Cottonseed	-1	105	55
Soybean	-16	130	53

Relationship between Melting Point (°C) and Iodine number



Desirable biodiesel characteristics

- ◆ **High energy content.**
- ◆ **Minimum cetane number of 51 (Australian Standard)**
- ◆ **Good stability**
- ◆ **Low cloud point and cold filter plugging point**
- ◆ **Low undesirable emissions**
- ◆ **Low iodine number**

For Fuel (Energy)

Almost any oil or fat of biological origins may be used to make biodiesel. However, the feed stock must be:

- ◆ comparatively cheap (low inputs)**
- ◆ the supply sustainable**
- ◆ there should be a use for any byproducts.**

Oils not for Biodiesel

- ◆ **High erucic acid oils valued as engine lubricants and are a source of erucamides**
- ◆ **Oils high in PUFAs are used in paints, varnishes, polishes etc and as health food supplements**
 - **PUFAs are unstable and can polymerize under heat and pressure**

Oils for Food or Fuel

- ◆ **Almost any animal or vegetable fat or oil could be used for fuel.**
- ◆ **Oils undesirable as food, which are cheap to produce and could be grown on sites unacceptable for food production, could be used for fuel.**
- ◆ **The required characteristics of fuel can be obtained by blending different oils.**

Sources of the information

- **Various chemistry text books:
eg F. D. Gunstone**
- **Various websites and papers on
the web eg journeytoforever
files**
- **My research**