



Ethnobotany. Lecture 17



Alexey Shipunov

Minot State University

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Outline

- 1 Oil plants
 - Introduction to oils
 - Sunflower, *Helianthus annuus*
 - Peanut, *Arachis hypogaea*
 - “Canola”, rapeseed, *Brassica napus*
 - Olive, *Olea europaea*
 - Sesame, *Sesamum indicum*
 - Safflower, *Carthamnus tinctorius*



Martenitsa tree (Balkan tradition)



Oil plants

Introduction to oils

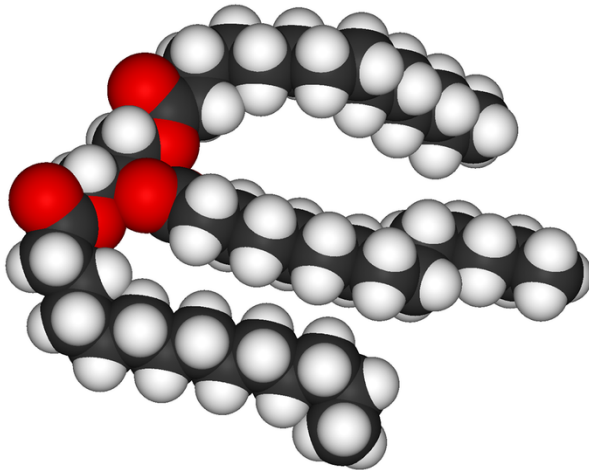


What are oils

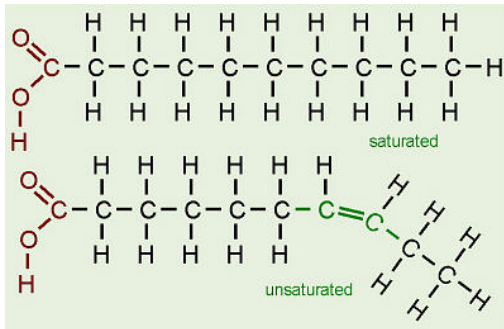
- Triglycerides: triesters of glycerol and saturated or non-saturated fatty acids
- Liquid triglycerides are **oils** whereas hard are **fats**
- *Hydrogenated* oils are hard derivatives of liquid plant oils



Triglycerides



Fatty acids



Oils features

- High energy: 9 calories per gram, two times more than carbohydrates or proteins
- Slow metabolism, several times slower than of carbohydrates

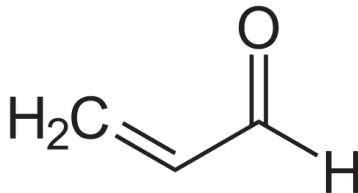


Smoke temperatures

- Under high temperatures, oils start to smoke: this is due to acrolein
- Acrolein is highly toxic (even used as chemical weapon in World War I)
- Cream butter has $\approx 175^{\circ}\text{C}$ smoke point whereas many plant oils like peanut have $\approx 250^{\circ}\text{C}$ smoke point; flax oil is an exception ($\approx 107^{\circ}\text{C}$)



Acrolein

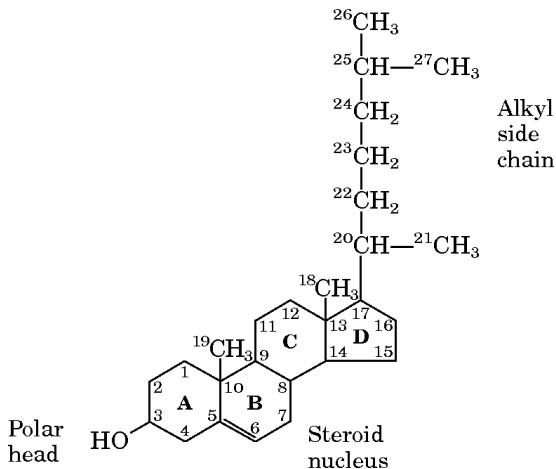


Cholesterol

- Cholesterol is a main component of membranes and predecessor of steroid hormones
- However, suspicions raised that high level of cholesterol corresponds with atherosclerosis (Ancel Keys' conception of "Mediterranean diet")
- The most risky group are men of age 35–55
- Recent experiments suggest that cholesterol level has **only weak or no relation** with vessel diseases:
 - <http://www.ncbi.nlm.nih.gov/pubmed/16340654>: 70% of human population are hyporesponders to dietary cholesterol
 - <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3900007>: population and individual differences are more important than diet
- Plant oils do not contain cholesterol



Cholesterol

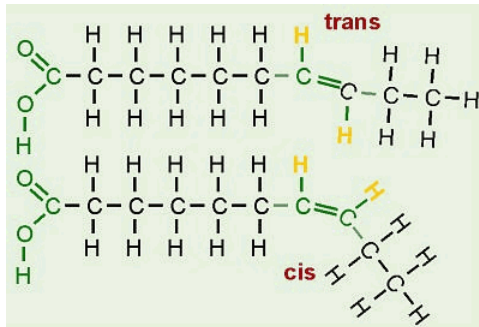


Trans fats

- Trans fats are byproducts of hydrogenation of plant oils, they also may appear in deep fat frying
- Again, *suspicion* is that trans fats are related with heart diseases
- Now most of hydrogenated oils (margarines) are almost free of trans fats



Trans fatty acids

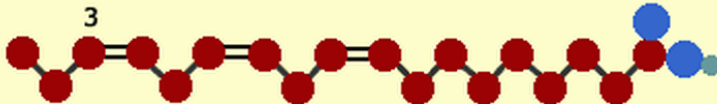


Omega-n-unsaturated fatty acids

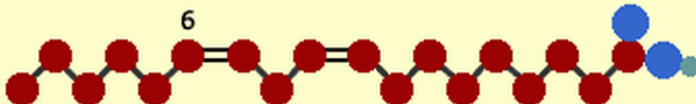
- Essential fatty acids that may only be synthesized in plants
- They *probably* related with lowering of cholesterol level, with curing Type 2 diabetes, and with general lowering of cardiovascular mortality
- Canola, flax and soybean oils contain significant amounts of omega-3-unsaturated fatty acids (and also sea fishes)



Omega-n-unsaturated fatty acids



Alpha-Linolenic acid (omega 3)



Linoleic acid (omega 6)



Oil plants

Sunflower, *Helianthus annuus*



Sunflower, *Helianthus annuus*

- Belongs to aster family, Compositae
- Big genus distributed in North and South (but not Central) Americas
- Only one species, *Helianthus annuus* is cultivated as an oil plant



Sunflower biology

- Annual plant (exception among sunflowers!)
- Young plants are highly heliotropic
- Up to 65% of oils in seeds
- Used also as forage plant, especially in northern regions
- Coordinates of flowers in the head are explained with Vogel's model:

$$r = \sqrt{n}; \quad \theta = n \times 137.5^\circ,$$

where θ is angle, r is the distance from the center, n is the index number of the floret, and c is a constant.



Sunflower head



Sunflower agriculture

- Requires light and aerated, rich soils; root system allows to use water from deep layers of soil; requires phosphorus
- Vegetation period 70–140 days
- Wind- and insect-pollinated plant
- Oil is pressed similarly to most oil plants
- There are also nut cultivars



Sunflower history

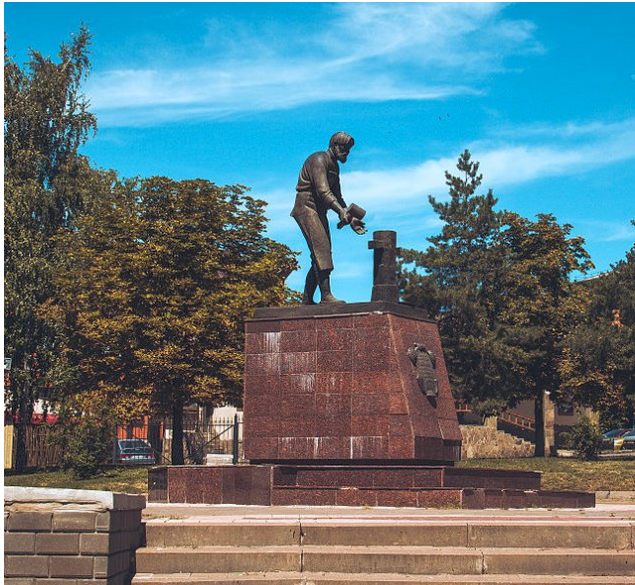
- Domesticated most probably in North America, widely used by native tribes in New Mexico and other southern states
- Went to Europe in 1510, cultivated as ornamental and forage plant and then abandoned
- In Russia, folk selection resulted in fasciated cultivars which have several times more seeds per head
- In 1829, Russian peasant Daniil Bokarjov discovered the high oil content and made first sunflower oil
- Ukraine, Germany and United States are now main producers
- Symbol of Ukraine, state flower of Kansas



Fasciation: elongation of apical meristem



Bokarjov memorial in Alekseevka, Belgorod region



Oil plants

Peanut, *Arachis hypogaea*



Peanut, *Arachis hypogaea*

- Belongs to legume family, Leguminosae
- Geocarpic plants: fruits are burying into the ground
- One of the most protein-rich oil plants (53% oils, 25% proteins)

[We skip here soybeans which were described on previous lectures]



Peanut biology

- Small, self-pollinated plant with flowers positioned nearby soil surface
- Burying structure is a gynophore, part of flower receptacle
- Legumes are indehiscent, contain 2–3 seeds
- 1–2% of human population have peanut allergy to peanuts (consequence of high protein content)



Peanut



Peanut agriculture

- Vegetation is 3–5 months
- Requires warm temperatures, average humidity (500–1,000 mm) and light, sandy soils
- As a legume, does not need many fertilizers
- Susceptible to fungus contamination in storage: some fungi produce toxic *aflatoxin*



Peanut history

- Cultivated species is a tetraploid originated from hybridization of two South American wild species
- In valleys of Peru, cultivated from 5,600 BC
- In XVII century, went independently to Africa and Asia
- Biggest producers now are China, India and U.S. Main crop in several West African countries, e.g., Ghana.
- Hundreds of cultivars, in U.S. there are mostly “Runner” and “Virginia” groups



Oil plants

“Canola”, rapeseed, *Brassica napus*



“Canola”, rapeseed, *Brassica napus*

- “Canola” stands for “**can**adian oil”, name of the group of cultivars of rapeseed, *Brassica napus* from cabbage family, *Cruiferae*
- One of the most hardy oil plants
- New culture, only in 1970s started to be used widely



Canola

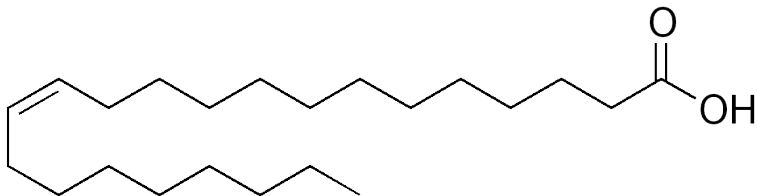


Canola biology

- Medium-sized (up to 1.5 m tall) herbaceous annual, cultivated as winter or as spring crop
- Seeds contain high amounts of unsaturated oils including omega-3 oils
- Cross-pollinated, produces significant amounts of nectar
- Non-canola cultivars contain potentially toxic erucic acid and glucosinolates
- Erucic acid, however, is used as four-to-one mixture with oleic acid and constitutes "Lorenzo's oil" (there is a movie with same name); an experimental treatment for the rare neurobiology disorder adrenoleukodystrophy



Erucic acid



Canola agriculture

- Relatively easy culture, requires water and cool temperatures, long-day plant
- Needs high amounts of fertilizers
- Harvesting should be fast because siliques are dehiscing fast



Canola siliques



Canola history

- Domesticated in Europe
- Cultivated for a long time but mostly as technical oil plant
- In 1974, zero-rapeseed was selected which contained less than 2% of erucic acid; in 1982, 00-rapeseed which contains almost 0% of erucic acid: canola
- Canola cultivars are susceptible for fungal diseases (erucic acid was a defense agent)
- Canola also susceptible to cross-pollination with technical rapeseed
- Biggest producers now are China, Canada and India



Oil plants

Olive, *Olea europaea*



Olive, *Olea europaea*

- One of the oldest oil plants, also used as vegetable
- Belongs to olive family, Oleaceae
- Relatively hardy plant despite of evergreen life form



Olive biology

- Evergreen, long-lived (up to 2,000 years), small tree
- Starts to produce fruits from 3–4 year (when grafted)
- Cross-pollinated with wind
- Oil does not contain omega-n-unsaturated fatty acids



Olives in Greece



Olive agriculture

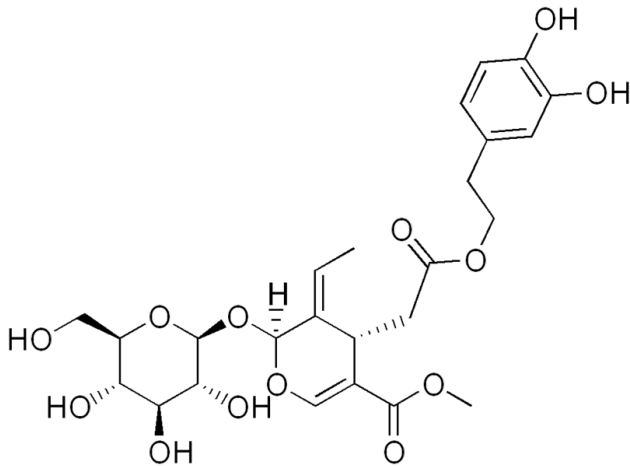
- Requires dry air and lots of sun, does not particular to soils (but grows better on limestone soils)
- One tree may produce ≈ 20 kg of fruits per year for 200 years
- Harvested in winter, half-manually, by shaking trees
- Oil is pressed, outer parts are fermented to remove bitter *oleuropein*



Olive harvesting



Oleuropein



Olive history

- Large historical and mythological background: from Old Testament and Greek mythology to Quran
- Cultivation started > 6,000 BC in Mediterranean
- More than 500 cultivars; top producers are Spain, Italy and Greece
- Olive became invasive in Australia



Oil plants

Sesame, *Sesamum indicum*



Sesame, *Sesamum indicum*

- Belongs to the tropical genus *Sesamum* (≈ 20 species) from sesame family, Pedaliaceae
- The oldest cultivated oil plant



Sesame



Sesame features

- Tropical herbaceous annual plant, vegetation 3–4 month, yield is 1–2 tons/hectare
- Seeds contain 50-65% of oil; oil contains phytosterols, vitamin E and significant amounts of microelements, especially iron and magnesium
- Can grow in dry climatic zones
- Used entirely (green mass as a forage, pressed cakes in bakery etc.)



Fruits and seeds of sesame



Sesame history

- Cultivation started in India prehistorically, went to ancient Egypt and then to Europe
- Now cultivated mostly in tropics around the world
- Biggest producers are still India and China
- Famous also after Ali-Baba story from “One thousand and one nights”



Ali-Baba (40 thieves are not at home yet)



Oil plants

Safflower, *Carthamnus tinctorius*



Safflower, *Carthamnus tinctorius*

- Belongs to Mediterranean *Carhtamnus* (distaff thistles) genus and atser family, Compositae
- Highly ornamental cultivated plant
- Multiple uses: as oil plant, as medicinal plant and as saffron substitute (red dye)



Safflower field

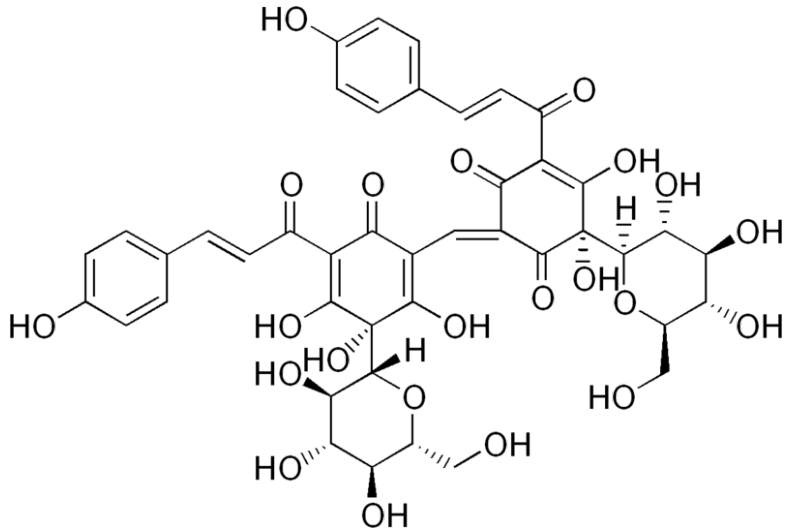


Safflower features

- Achenes contain 15–35% of oil
- Oil contains mono- and polyunsaturated fatty acids, and therefore may be used for painting (fast-dried oil)
- Flowers contain carthamin which produces a red-brown color, often used in food production
- Rich of tokoferols (vitamin E)



Carthamin



Safflower history

- One of the most ancient cultivated plants, used in Old Egypt
- Went to Japan and used there as a plant which dye had ceremonial meanings



Harvesting safflower



[From Takahata's "Only yesterday" movie]



Making Japanese clothes



Painted with safflower



Shuntei (1898): *Shadow of the Castle*



Summary

- All oil plants contain oil (non-saturated triglycerides) in seeds
- The most important oil characteristics are smoke temperature, amount of cholesterol, amount of trans fats and amount of omega-n-unsaturated fatty acids



For Further Reading



A. Shipunov.

Ethnobotany [Electronic resource].

2011—onwards.

Mode of access:

http://ashipunov.info/shipunov/school/biol_310



P. M. Zhukovskij.

Cultivated plants and their wild relatives [Electronic resource].

Commonwealth Agricultural Bureaux, 1962. Abridged translation from Russian.

Mode of access:

http://ashipunov.info/shipunov/school/biol_310/zhukovskij1962_cultivated_plants.djvu.

