

Ethnobotany. Lecture 11

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Outline

- 1 Sugar plants
 - Lesser sugar plants

- 2 Oil plants
 - Introduction to oils
 - Sunflower, *Helianthus annuus*
 - Peanut, *Arachis hypogaea*



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Sweet potato distribution revealed with the help of chloroplast DNA

Historical collections reveal patterns of diffusion of sweet potato in Oceania obscured by modern plant movements and recombination

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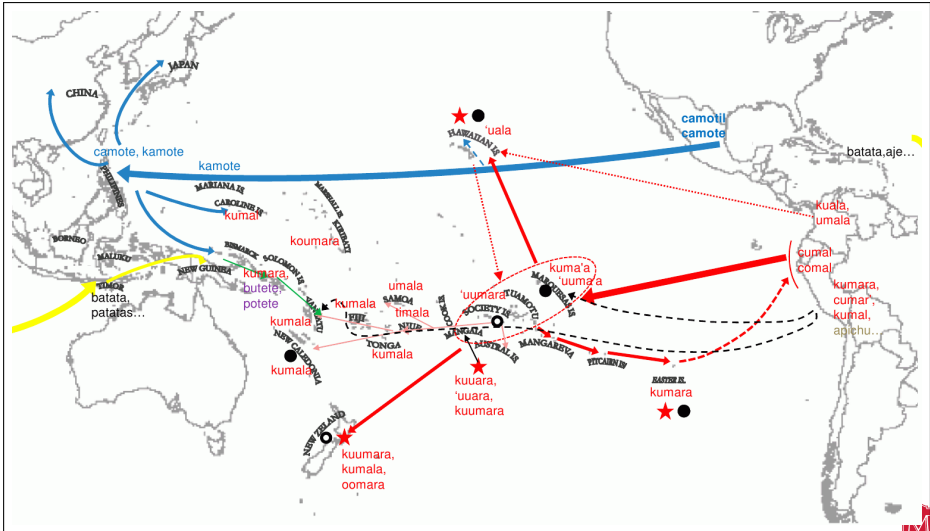
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The history of sweet potato in the Pacific has long been an enigma. Archaeological, linguistic, and ethnobotanical data suggest that prehistoric human-mediated dispersal events contributed to the distribution in Oceania of this American domesticate. According to the “tripartite hypothesis,” sweet potato was introduced into Oceania from South America in pre-Columbian times and was then later newly introduced, and diffused widely across the Pacific, by Euro-

and America (17–21). Also, the lexical similarity between terms for sweet potato in Polynesian languages (“kuumala” and its derivatives) and the terms for this plant (“kumara,” “cumar,” or “cupal”) found among Quechua speakers of northwestern South America supports the hypothesis that humans introduced sweet potato from South America to Polynesia (22), against the alternative hypothesis of natural long-distance dispersal of seeds (23).

Sweet potato distribution map



Sugar plants

Lesser sugar plants



Mezcal, tequila agave, *Agave tequilana*

- Monocarpic Mexican plant from asparagus family (Asparagaceae)
- The sap is rich of sugars, mostly fructose
- Used mostly for alcohols like mezcal, pulque and tequila



Mezcal



Yacon, *Smallanthus sonchifolius*

- Belongs to aster family, Compositae
- Roots are rich of inulin, fructose and fructo-oligosaccharides (FOS) such as kestose (F2)—“alternative sweeteners”
- Traditional Andean culture; had ceremonial importance in times of Mochica culture (Peru, 100–800 AD)



Yacon roots



Yacon plant



Japanese raisin tree, *Hovenia dulcis*

- Large East Asian tree from buckthorn family, Rhamnaceae
- Large fruit stalks (“subsidiary fruits”) may be used as replacement for honey
- Has several medicinal properties (e.g., helps recovery from alcoholism)



Japanese raisin tree



Oil plants

Introduction to oils

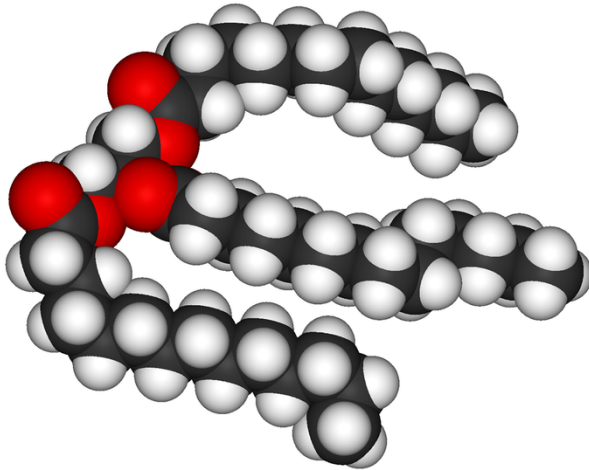


What are oils

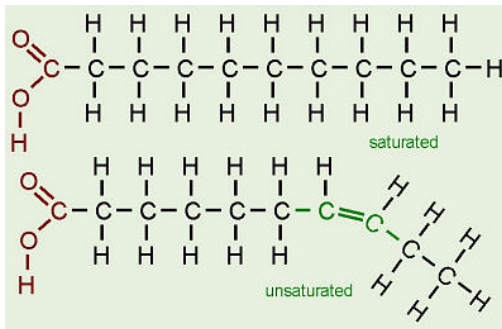
- Triglycerides: triesters of glycerol and saturated or non-saturated fatty acids
- Liquid triglycerides are **oils** whereas hard are **fats**
- *Hydrogenated* oils are hard derivatives of liquid plant oils



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

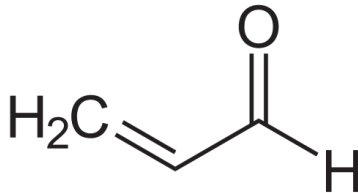


Smoke temperatures

- 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

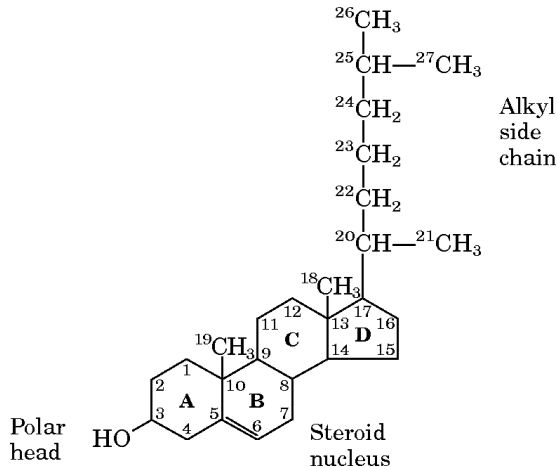


Cholesterol

- 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 relation with vessel diseases
- Plant oils do not contain cholesterol



Cholesterol

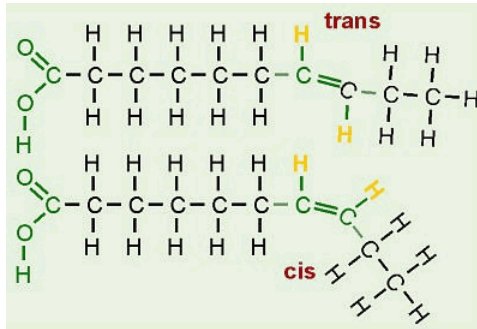


Trans fats

- 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

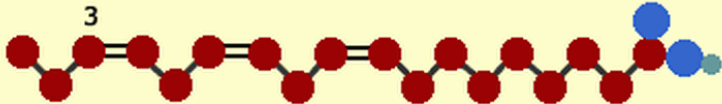


Omega-n-unsaturated fatty acids

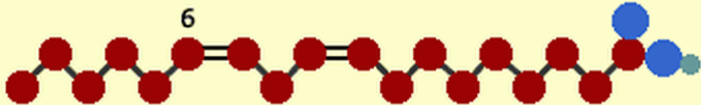
- Essential fatty acids that may only be synthesized in plants
- They *probably* related with lowering of cholesterol level, with curing Type 2 diabetes, and with general lowering of cardiovascular mortality
- Canola, flax and soybean oils contain significant amounts of omega-3-unsaturated fatty acids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



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 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 1859, cultivation started again, now as an oil plant (Bokarev discovered the high oil content)
- Ukraine, Germany and United States are now main producers
- Symbol of Ukraine, state flower of Kansas



Fasciation: elongation of apical meristem



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



Summary

- Many tropical sugar plants are used mostly for alcohol production
- 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 omega-n-unsaturated fatty acids



For Further Reading



A. Shipunov.

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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.

Mode of access:

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

Pages 16–27.

