

Ethnobotany. Lecture 16

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Outline

- 1 Sugar plants
 - Sugar cane
 - Sugar beet
 - Sugar maple
 - Sugar palms
 - Lesser sugar plants

- 2 Oil plants
 - Introduction to oils



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Sugar plants

Sugar cane



Sugar cane, *Saccharum officinarum*

- Belongs to grass family, Gramineae; it is a C₄ grass
- The oldest cultivated sugar plant
- Contains sugars in stem



Sugar cane



Sugar cane biology

- Extremely tall grass, up to 6 m tall (!)
- Stem phloem* juice contains 12–20% of sucrose in lower parts of stem
- Juice is pressed, filtrated, evaporated, centrifuged (to separate syrup from sugar crystals) and dried



Sugar cane agriculture

- Grafted culture, it is not recommended to wait until flowering
- Short-day, sun-loving plant, optimal temperatures should be $> 20^{\circ}\text{C}$
- Requires irrigation even in humid tropics (!) and significant amounts of phosphorous
- Vegetation period is up to 250 days



Sugar cane history

- The culture started in Indian center, then moved to China and with Arabs—to Europe (Spain, 1150 AD)
- Arabs first invented white, filtrated sugar
- Went to Central and South America in XVI century (Europe needs sugar but it was not growing well there!).
- Now cultivated in tropical America, Africa and Asia (top producers are Brazil and India) but culture is declining under the pressure of competition with sugar beet
- Etymological dictionary says that:

sugar: late 13c., from O.Fr. sucre “sugar” (12c.), from M.L. succarum, from Arabic sukkar, from Pers. shakar, from Sanskrit sharkara “ground or candied sugar,” originally “grit, gravel”



Sugar plants

Sugar beet



Sugar beet, *Beta vulgaris* var. *saccharifera*

- Amaranth family, Amaranthaceae (or Chenopodiaceae in older classifications)
- Same species with vegetable beet
- Has been selected from leaf and root beets for only 300 years: one of the youngest cultures
- Root contains up to 20% of sucrose



Sugar beet from North Dakota! (that's a joke photo)



Sugar beet biology

- Biennial plant: first year with rosellate leaves, second year forms stem with non-showy flowers
- The “root” is actually intermediate structure between stem and root in strict sense—hypocotyl
- Has anomalous secondary growth (layers of tissues)
- Roots are “white”: do not contain betalain (red pigment which probably helps red beet to protect tissues from fungi and animals)



Sugar beet agriculture

- Hardy plant: North Dakota is one of the leading states in sugar beet cultivation
- Yield is typically ≈ 70 ton/hectare (wet mass), and 12 ton/hectare (pure sugar): compare with ≈ 100 and ≈ 10 for sugar cane
- Some plants should be left for seeds (second year)
- Susceptible for weeds (needs herbicides)



Sugar beet history

- In 1747, the sucrose content was discovered
- In 1810s, due to continental blockade of France, sugar mills were established across all Europe
- In XX century, sugar production was almost doubled
- Leading countries now are France, Germany and U.S.; one of biggest research centers is NDSU



Sugar plants

Sugar maple



Sugar maple, *Acer saccharum*

- Tree from Sapindaceae (Aceraceae in older classifications) family
- Old semi-cultivated plant of eastern tribes of Native Americans
- Spring sap is the main source of sugar



Sugar maple



Native sugar-making



Sugar maple features and history

- Sap contains 2–5 % of sucrose, the season starts in early spring and continues 4–8 weeks
- In total one tree could produce up to 50 liters of sap per season for 60–70 years (from 30–40 to 100 years old)
- Production increased during Civil War
- Leading producer is Canada (Quebec)
- Analogous birch syrup from *Betula* is more poor, only 1–2% of sugars



Sugar collection



Sugar evaporation



Sugar plants

Sugar palms



Arenga sugar palm, *Arenga pinnata*

- Belongs to palm family, Palmae
- The source of “gur” sugar and also wine
- Inflorescences are used for taking sap (17–20% of sucrose)



Arenga sugar palm



Arenga sugar palm features and history

- Syrup are very easily inverted (hydrolyzed into glucose and fructose) and should be evaporated as soon as possible
- Every day, palm tree gives 5–7 liters of sap; the season is up to 8 weeks
- Old Indian culture spread into south-east Asia



Collection of palm sap



Toddy, *Caryota urens*

- African sugar palm, one of the largest palms
- Monocarpic tree, dies after flowering
- Since the sap is fermented fast, it mostly used as a source of palm wine ($\approx 1\%$ of alcohol)
- Starred in groundbreaking novel “The Palm Wine Drinkard” by Nigerian author Amos Tutuola



Toddy palm



Toddy palm on flowering stage



Palm-wine drinkard



Sugar plants

Lesser sugar plants



Sweet sorghum, *Sorghum saccharatum*

- Grass, selection started in 1940s
- Similar in agriculture, but much less demanding plant than sugar cane
- 10–20% of sucrose in stems
- Now cultivated mostly in U.S. and Argentine



Sweet sorghum



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



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)
- Many other fruits were and are used as sugar sources: most notable are Mediterranean **grapes**, **apricots**, **melons** and **figs**.



Japanese raisin tree



Oil plants

Introduction to oils

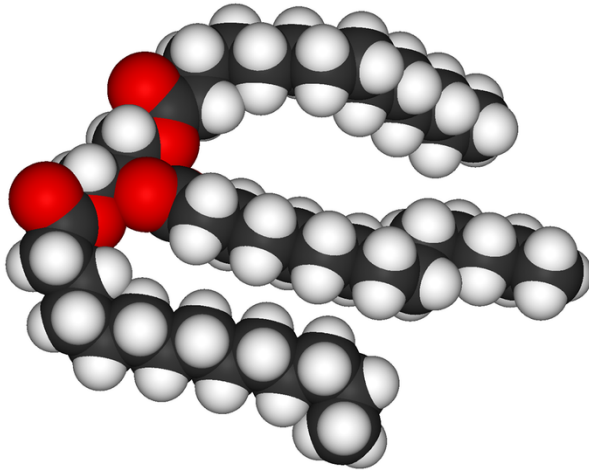


What are oils

- 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



Summary

- Two plants produce more than $\frac{2}{3}$ of sugars: sugar beet (production is increasing) and sugar cane (decreasing)
- Many tropical sugar plants are used mostly for alcohol production



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.

