

Ethnobotany. Lecture 15

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Outline

1 Centers of cultivated plants origin

2 Sugar plants

- Sugars
- Sweeteners

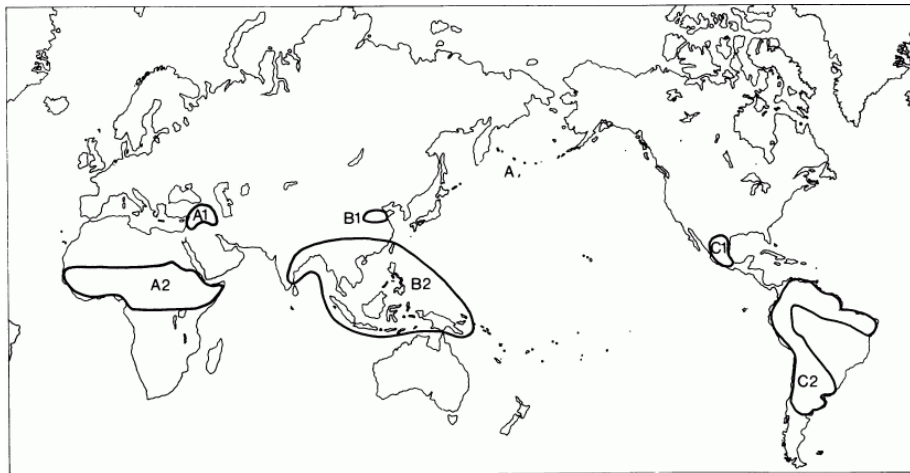


Outline

- 1 Centers of cultivated plants origin
- 2 Sugar plants
 - Sugars
 - Sweeteners



Harlan's centers of agricultural beginnings



Sugar plants

Sugars



Ethanol

- Immediate product of yeast fermentation of glucose
- Pre-adaptation to alcohol from frugivores
- Bind to GABA (gamma-aminobutyric acid) receptors
- Converted into acetaldehyde (toxic!) by alcohol dehydrogenase and then into acetic acid by acetaldehyde dehydrogenase
- “Asian flush” (result of acetaldehyde dehydrogenase deficiency) and alcoholism are related to the genetic diversity of alcohol dehydrogenases



Downsides of sugars

- Obesity, because sugars are easily convert into fats
- Diabetes, because insulin cannot deal with large quantities of sugars
- Dental diseases, especially dental caries (caused by lactobacteria taking sugars for their growth)
- Multiple sweeteners have been developed to avoid side-effects of sugars: heterocyclic saccharine (in “Sweet’N Low”), amino acid derivative aspartame (in “Equal”), chlorine hexose sucralose (in “Splenda”, “Altern”). All are controversial.



Sugar plants

Sweeteners



Stevia rebaudiana, the natural sweetener

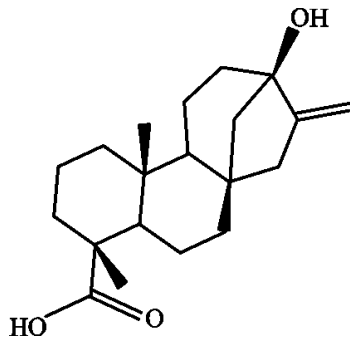
- Belongs to aster family, Compositae
- Originated in South America
- Leaves contain the group of sweet glycosides, derivatives of steviol
- They are 100–150 times sweeter than sucrose (on the weight concentration basis)
- Despite of multiple controversies (not approved in EU, banned in Norway and Singapore) used by Coca-Cola and PepsiCo in their “zero calories” drinks



Stevia flowers



Steviol



Our native natural sweeteners

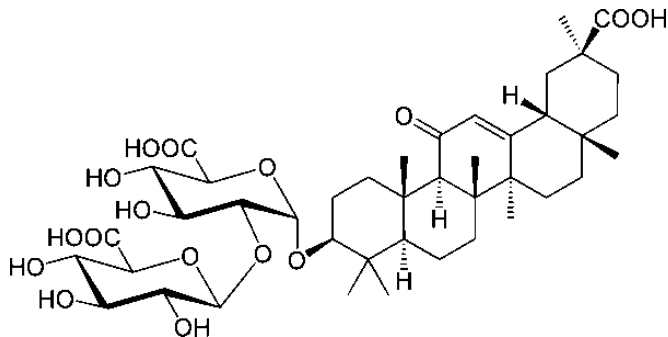
- North Dakotan wild licorice (*Glycyrrhiza lepidota*) belongs to legume family, Leguminosae
- Contains natural sweetener glycyrrhizin, about 50 time sweeter than sucrose
- Side-effects are hypertension and lowering of testosterone level in males



American licorice, *Glycyrrhiza lepidota*



Glycyrrhizin

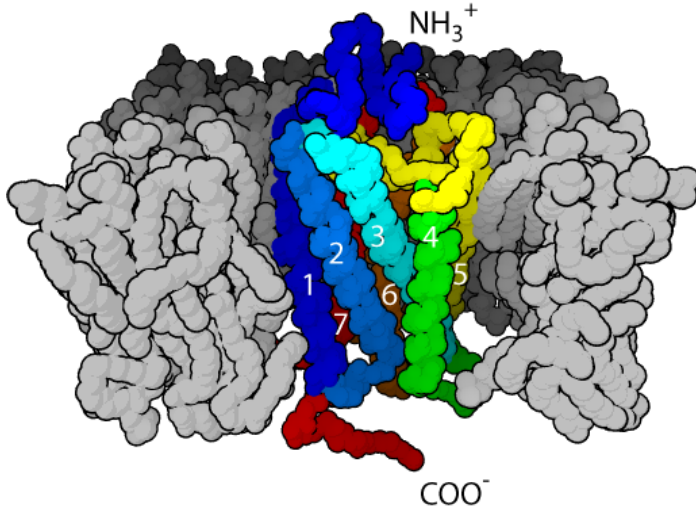


What is sweetness?

- Nature of sweetness is not yet fully discovered
- Probably due to specific Van der Waals forces occurring in variety of molecules
- These molecules have an effect on sweet receptors—large proteins from G protein-coupled receptors (GPCRs) group



GPCR, sweetness receptor



Miracle fruit, *Synsepalum dulcificum*, the super-sweetener

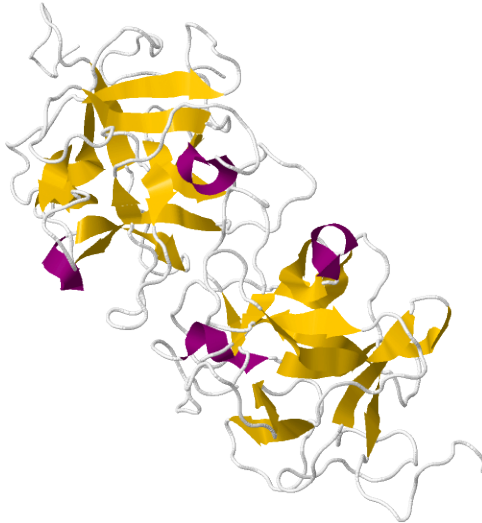
- West African tree, belongs to tropical Sapotaceae family
- Berries convert sour tastes into sweet tastes (!), effect lasts for ≈ 1 hour
- The effect is due to glycoprotein miraculin which is binding to sweet receptors
- Cultivation is now starting in Florida, approval as food additive is pending—it is heat-resistant and may be used as a “sweetener”; there are genetically modified lettuce plants which produce miraculin



Miracle fruit



Miraculin glycoprotein



Other plants super-sweeteners

- Curculin from *Curculigo latifolia* (“lumbah-lumbah”), Malaysian herb from Hypoxidaceae family, has the same effect + it is also super-sweet by itself (500–2000 times sweeter on weight basis than sucrose).
- Thaumatin from *Thaumatococcus daniellii* (“miracle berry”), West African herb from Marantaceae, is 3000 times sweeter than sucrose.
- Monellin from *Dioscoreophyllum volkensii* (“serendipity berry”), West African Menispermaceae vine, is 800–2000 times sweeter than sucrose but only to Old World monkeys including humans.



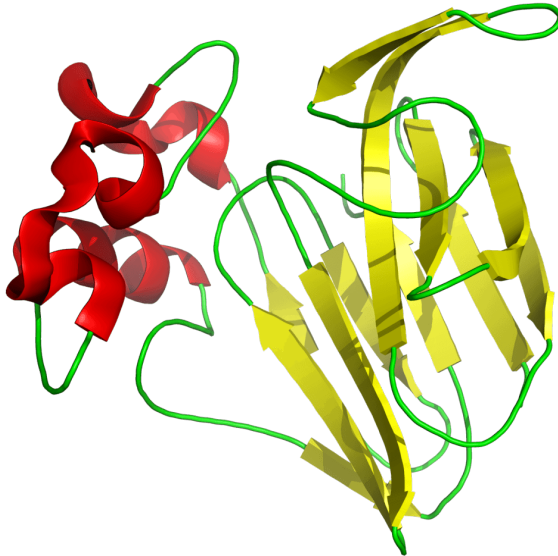
Lumbah-lumbah



Miracle berry (not “miracle fruit”!)



Thaumatin, the most sweet protein



Anti-sweeteners

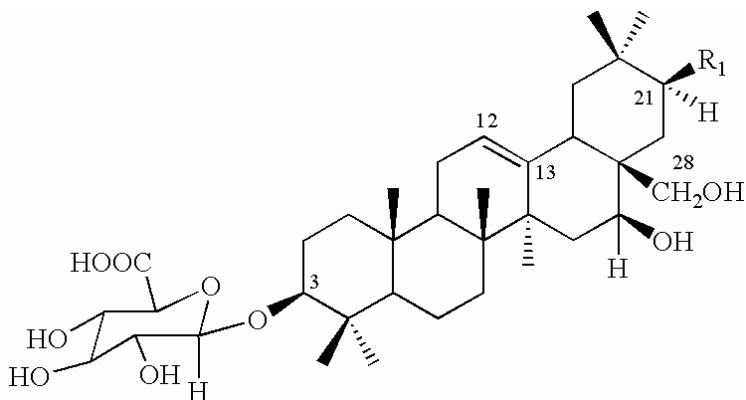
- Several plants contain chemicals which are able to suppress sweet receptors
- Indian herbaceous vine *Gymnema sylvestris* from a dogbane family (Apocynaceae) contain gymnemic acids which suppress sweet taste for ≈ 10 min
- In addition, plant has an unrelated (?) effect in lowering blood sugars
- Used as a drug for curing Type 2 diabetes and different forms of metabolic disorders



Gymnema sylvestre



Gymnemic acid



Summary

- Sugar is highly used but controversial source of energy
- Sweet taste still has undiscovered nature



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.

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

