SCIENCE ON STAGE 2017 DEBRECEN
THE EUROPEAN NETWORK FOR SCIENCE TEACHERS

All BANANA!

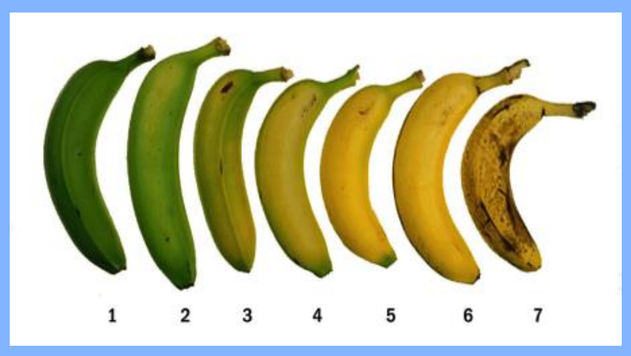
Short experiments around bananas

Science on Stage - SWITZERLAND

Dr. Sacha A. Glardon (Gymnasium Bäumlihof, Basel) & Thomas Scheuber (Gymnasium Kirschgarten, Basel)

Ripening

- *Why is a ripe banana sweet, juicy, soft and tasty, whereas a unripe fruit is sour, farinaceous and hard?*
- *Why does the colour change?*



Ethene (= Ethylene) 

Starch	*Amylase*	Glucose „sweet&juicy“
Chlorophyll	*Hydrolase*	Anthocyanin
Pectin	*Pektinase*	less Pectin „soft“
large org. substances	*Hydrolase*	flavouring substances
Acids	*Kinases*	neutral

Ripeness & Sugar

- *Which banana is the sweetest?*

The sugar content is measured with a refractometer and a graph drawn showing sugar content versus ripeness.

- *Why does the sugar content increase and decrease?*
- *Where is the sugar coming from?*

Ripeness & Starch

Iodine - potassium iodide (Lugol) staining of longitudinal and transverse sections of differently ripe bananas.

•Why does a banana not store sugar directly, but takes the ”starch loop way”?
•What are anabolic and catabolic processes?

Microscopy & iPhone Photo

•What are amyloplasts?

Lugol staining and microscopic examination of thin sections of differently ripe bananas. Documentation with a smart Phone camera.

Bananas

80’000 tonnes of bananas are imported every year into Switzerland. The per capita consume is 10 kg per year. This is after apple the second most eaten fruit.
•What is the situation in your country?
Globally bananas are with respect to cultivation and consumption the most important fruit: 100 Mio t/y. The majority of it are plantain and are consumed in the producing countries. The export market is 16.5 Mio t/y.

Banana (Musa) is a monocot plant. There are about 70 species originating from tropical and subtropical Asia und the western Pacific region. Best known at our latitude is the dessert banana (*Musa* x *paradisiaca*).

Plant breeding

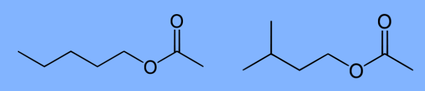
Farmers in Southeast Asia first domesticated bananas. This cultivation goes back to 8000 BCE. The modern banana *Cavendish* is a hybrid of at least two species: between *Musa acuminata* and *Musa balbisiana*. The fruit of the wild species contains big and hard seeds. Cavendish became triploid through polyploidization. It is sterile and shows parthenocarpy (production of fruit without fertilization of ovules). Reproduction occurs through artificial vegetative propagation (sucker removal). Big plantations are vulnerable to parasite, most recently the banane was at risk due to the fungus TR4. The genome oft he double haploid DH-Pahang (picture in the middle) is completely sequenced

Substances of content

- *What is the difference between natural and artificial flavours?*

INGREDIENTS: WATER (75%), **SUGARS (12%)** (GLUCOSE (48%), FRUCTOSE (40%), SUCROSE (2%), MALTOSE (<1%)), STARCH (5%), **FIBRE (3%)** (E460, E461, E462, E464, E466, E467) **AMINO ACIDS** (GLUTAMIC ACID (19%), ASPARTIC ACID (16%), HISTIDINE (11%), LEUCINE (7%), LYSINE (5%), PHENYLALANINE (4%), ARGININE (4%), VALINE (4%), ALANINE (4%), SERINE (4%), GLYCINE (3%), THREONINE (3%), ISOLEUCINE (3%), PROLINE (3%), TRYPTOPHAN (1%), CYSTINE (1%), TYROSINE (1%), METHIONINE (1%)), **FATTY ACIDS (1%)** (PALMITIC ACID (30%), OMEGA-6 FATTY ACID: LINOLEIC ACID (14%), OMEGA-3 FATTY ACID: LINOLENIC ACID (8%), OLEIC ACID (7%), PALMITOLEIC ACID (3%), STEARIC ACID (2%), LAURIC ACID (1%), MYRISTIC ACID (1%), CAPRIC ACID (<1%)), ASH (<1%), PHYTOSTEROLS, E515, OXALIC ACID, E300, E306 (TOCOPHEROL), PHYLLOQUINONE, THIAMIN, **COLOURS** (YELLOW-ORANGE E101 (RIBOFLAVIN), YELLOW-BROWN E160a), **FLAVOURS** (ETHYL HEXANOATE, ETHYL BUTANOATE, 3-METHYLBUT-1-YL ETHANOATE, PENTYL ACETATE), E1510, NATURAL RIPENING AGENT (ETHENE GAS).

Synthesis of the banana flavour:
Esterification of 2ml conc. Acetic acid with 2ml 2-methyl-1-butanol or 1-Pentanol: Synthesis of Amyl acetate (pentyl acetate) or Methylbutyl acetate.
Experiment: Mix the educts and add 2 drops of conc. acid sulphur, add boiling stones, heat the mixture in a test tube to 80° C.



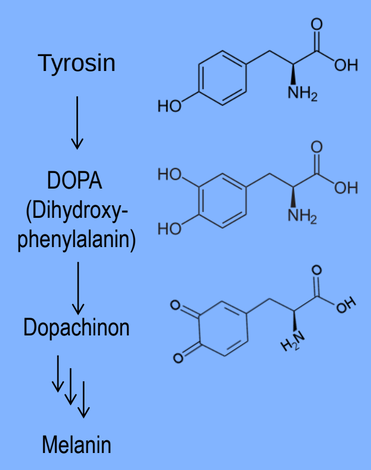
Melanin & Tyrosinase

If you dip one half of a banana into boiling water, it turns black

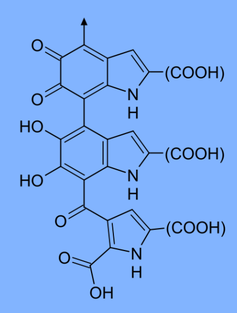
- *How and why does the black area appear?*
- *How can it be prevented?*
- *Can similar processes be found in humans?*

The heat from the boiling water destroys the cells on the edge of the banana peel. The enzyme Tyrosinase is released and starts the production of Melanin. The peel isolates the inner tissues and prevents the denaturation of the enzyme.

Tyrosine activity: Oxidation of Tyrosine



Melanin



–(COOH) stands for either –H or –COOH or other chemical groups. The arrow indicates another spot for the bonding of a functional group

Future prospects & Ideas

The banana as point of origin for interdisciplinary collaborations
•Catalase Activity
•Measurement of the sugar content (qualitatively and quantitatively)
•DNA – Isolation
•Extraction of colour components
•Nutrients and Calculations of Energy
•Biogeography
•Business and Fair Trade
•Colonialism
•Banana as a icon/symbol and banana in Arts

References

- https://de.wikipedia.org/wiki/Bananen
- http://omlc.org/spectra/melanin/
- https://de.wikipedia.org/wiki/Eumelanin
- http://www.food-scientist.com/en/banana01
- http://horttech.ashspublications.org/content/3/3/338.full.pdf+html
- http://postharvest.ucdavis.edu/Commodity_Resources/Fact_Sheets/Datastores/Fruit_English/?uid=9&ds=798
- http://www.education.com/science-fair/article/measure-sugar-ripe-fruit/
- https://alienplantation.wordpress.com/2012/07/12/this-sht-is-bananas/
- http://www.storyfilter.com/viel-chemie-ist-der-banane/2190/
- http://www.tagesanzeiger.ch/wissen/medizin-und-psychologie/Wissenschaftler-testen-Hautkrebs-mit-Bananen/story/17713388