

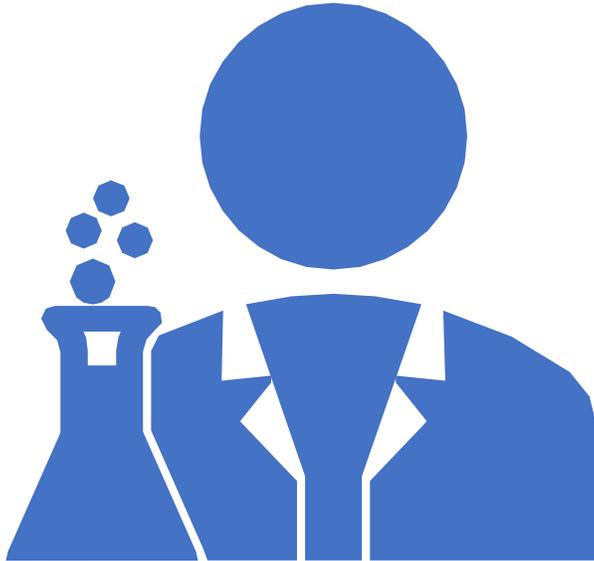


FOOD CHEMISTRY

Course No.-DTC-321, Credit Hours – 3 (2+1)



Sugar substitutes



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Sugar substitutes

Why Do We Eat Sugar ?

Well, it **tastes good**.

Most of us prefer sweet foods over bitter ones.

Why ?

And research actually shows how sugar can be highly addicting.

Each type of sugar has its own set of problems:

- **Glucose** is most rapidly metabolized by the body and can send your blood sugar levels **skyrocketing**. It has a glycemic index score of 100 (the highest possible).
- **Fructose** has no impact on insulin production or blood glucose levels. It also has a relatively low glycemic index score. But it must be metabolized by the **liver** and is associated with elevated levels of **triglycerides, metabolic syndrome, and weight gain**.
- **Sucrose** is crystalized white (table) sugar, from the cane sugar plant, and it consists of 50% glucose and 50% fructose.

Sugar substitutes

?



- **Sugar substitute** is a food additive
- provides a sweet taste like that of sugar
- contain significantly less food energy
- metabolized without influence of insulin.
- **zero-calorie or low-calorie sweetener.**

- **Artificial sweeteners** may be **derived** :
 - plant extracts or
 - chemical synthesis.



Ideal requirements

Sd provide **sweetness** with **no unpleasant after taste**

Sd have **little** or **no calories**

Sd **not** be **carcinogenic** or **mutagenic**

Sd be **economical** to produce

Sd not be **degraded by heat** when cooked

When **sweeteners** are provided to add to beverages => they are provided in small colored paper packets .

In North America, colors are :

- *blue* for aspartame,
- *pink* for saccharin / cyclamate ,
- *yellow* for sucralose,
- *orange* for monk fruit extract and
- *green* for stevia.
- These are also a fundamental ingredient in **diet drinks** => sweeten them **without adding calories**.



CLASSIFICATION OF SWEETENERS

- **two main** groups :
- **bulk** sweeteners and
- **intense** sweeteners



1. Bulk sweeteners (NUTRITIVE) :

- confer **body and texture** to foods,
 - **completely metabolized** by the body,
 - provide an important part to our **energy**,
 - referred as **nutritive or calorie** sweeteners.
-
- **Sugars** (dextrose, fructose, glucose, maltose, refined sugars, sucrose, etc.)
 - **Sugar replacements**/polyols/sugar alcohols (mannitol, sorbitol, xylitol, etc.)

2. Intense sweeteners (NON-NUTRITIVE) :

- generally **not metabolized** by body,
- excreted **unchanged**
- used at **very low levels** in foods,
- referred as **non- nutritive** or **non-calorie** sweeteners.



- **Natural** - plant origin (glycyrrhizin, steviosides)
- **Synthetic** (aspartame, acesulfame-K, saccharin, sucralose, cyclamate)

1. NUTRITIVE SWEETENERS

- products that have **> 2% of the calorific value** of sucrose per equivalent unit of sweetening capacity.
- example => **high fructose corn syrup**.
- also **adds body or thickness** to liquid preparations.
- acts as **humectants** in semi moist food systems.



Polyols

- sugar alcohols or polyhydric alcohols => produced by hydrogenating corresponding reducing sugars.
- provide bulk and texture of sucrose but => fewer kcal /g.
- do not provide browning when baked.
- erythritol (0.2 kcal /g), iso malt (2kcal /g), lactitol (2kcal /g), maltitol (3 kcal/g), mannitol (1.6 kcal /g) and sorbitol (2.6 kcal /g).
- can combine with other alternative sweeteners => use in chewing gums, candies, frozen desserts and baked goods as well as in the development of new products => that offer **neutraceutical** benefits.

Sorbitol



- Occurs naturally => cherries, plums, pears, apples.
- approximately one half sweet as compared to sucrose.
- hygroscopic in nature and also known as alcohol sugars.
- used as a sweetener => diabetics and in food canning.
- prepared by high pressure hydrogenation or by electrolytic reduction of glucose.
- Acid-catalyzed elimination of water yields => a mixture of 1,4-sorbitan (85%, I) and 3, 6-sorbitan (15%, II).
- Under more drastic conditions (action of concentrated acids), 1,4 : 3,6-dianhydro sorbitol (isosorbid III) is formed.

Advantage

- used by only 5-10% of bacteria => plaque
=> less acid production

Disadvantage

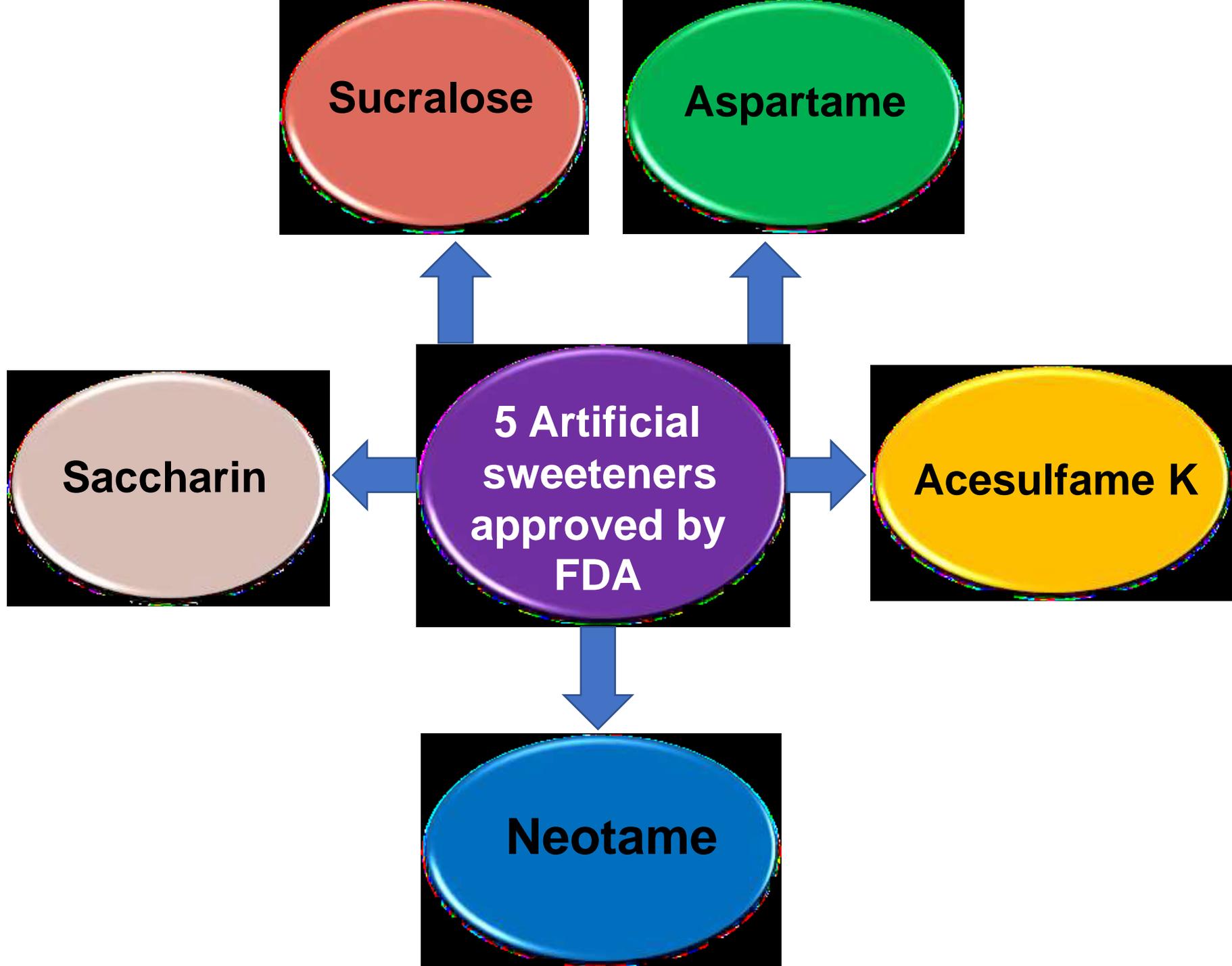
- sorbitol consumption (> 20-30 gm)
=> diarrhoea.

(act as a **laxative** because of osmotic transfer of water into the bowel).



2 . NON-NUTRITIVE SWEETENERS

- include both **naturally** occurring and **synthetic** compounds => have **elevated sweetness** or **sweetening power** as compared to sucrose.
- incorporated at low levels => various foods.
- manufacture of wide range of => low calorie foods => people => reduce calorie intake.
- Although, use of non-nutritive sweeteners is growing, only a few are currently available for food application.



Sucralose

Aspartame

Saccharin

**5 Artificial
sweeteners
approved by
FDA**

Acesulfame K

Neotame

1. Saccharin :

- **Oldest** artificial sweetener
- **primary** non nutritive sweetener.
- **300 times sweeter** > sucrose in concentrations up to the equivalent of a **10 % sucrose** solution.
- Both **sodium and calcium salts** of **orthobenzo sulfimide** => used.
- **Sodium saccharin** => high solubility & stability => commonly used.
- **higher concentration** => **light bitter** after taste.
- level of use depends => intensity of **sweetness desired**.
- present stipulated **ADI** value is **15 mg / kg** of **body weight**.

Brand name – **Sweet 'N Low** and **Sugar Twin**



ADVERSE EFFECTS :

- 5-25 gm daily => anorexia , nausea and vomiting
- Bladder cancer

2. Cyclamates :

- marketed as sodium or calcium salt of cyclo hexane sulfamic acid.
- sweetening strength < saccharin .
- 30-40 times sweeter than sucrose.
- no bitter after taste.
- sweet taste is not as pleasant as that of saccharin.
- approved for use in US in 1950 , later prohibited => evidence => carcinogenic.
- approved in > 50 countries => as a tabletop sweetener, sugar free beverages, baked goods and other low calorie foods.

its use is banned by PFA

3. Sucralose :

- high intensity, non caloric sweetener.
- chlorinated sucrose derivative.
- formed by a process wherein three hydrogen-oxygen groups on the sugar molecule are replaced with three chlorine molecules.
- free flowing, highly soluble in water and ethanol, white crystalline pd.
- 600 times sweeter > sucrose.
- small amount that is absorbed => not metabolized for energy.
- have excellent stability under a broad range of processing, pH and temperature conditions.
- carries no health warnings.
- ADI is 5 mg / kg body weight / day.

Sold under the trade name **SPLENDA**

Advantages

- Nutritive value => zero calories
- Non-cariogenic

Disadvantages

- Diarrhoea
- Dizziness
- Stomach pain



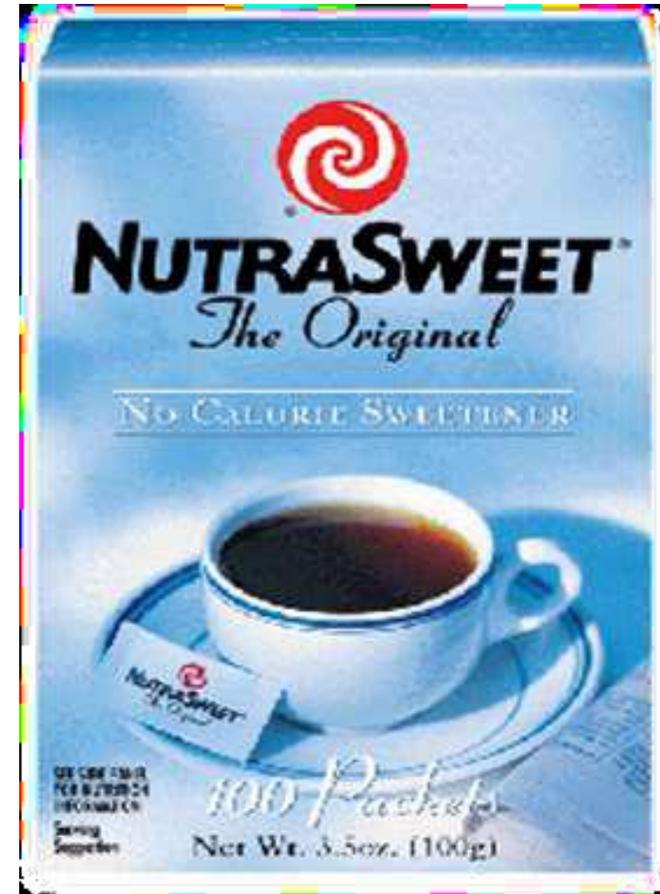
4. Aspartame

- Combination of Aspartic acid & Phenylalanine
- It is about **180-200** times **>** sucrose
- Caloric value of **4 cal / gm**

ADI- 50 mg/kg/d

- Effective in enhancing **acid fruit flavors** and extending sweet taste as in **chewing gums**

Brand names –
Nutrasweet , Equal



Toxic effects

Acute

- nausea
- Vomiting
- Headache
- dry mouth
- mood change

Chronic

- Liver dysfunction
- Lymphomas



5. Ace sulfame potassium (Ace-K) :

- 200 times sweeter > sucrose
- sweet, clean taste
- non-caloric sweetener
- not metabolized => contributes no calories
- stable under high temperatures
- Beverages (containing it) can be pasteurized => without loss of sweetness
- approved by FDA => non alcoholic beverages.
- major advantage => its synergy with other sweeteners, including nutritive and non-nutritive types.
- **ADI- 15 mg / kg / d**

Brand names – Sunett & Sweet one

Advantages

- Calorie free
- No evidence of carcinogenicity, mutagenicity, cytotoxicity and teratogenicity
- Excellent shelf life
- used in candies, canned food and alcoholic Beverages

Disadvantages

- Headache



6. NEOTAME

- Newest of low calorie sweeteners
- 8000 times sweeter > sucrose
- ADI- 2 mg / kg / d
- baked foods, chewing gum, frosting, frozen desserts, gelatins, jams, jellies, processed fruits, puddings, toppings, soft drinks and syrups.
- **TOXIC EFFECTS**
- Headache
- Hepatotoxicity (high doses)

CHARACTERISTICS OF AN IDEAL SWEETENER

- **organoleptic** and **functional** properties analysis of each single sweetener clearly => **none** of the currently known sugar substitutes comes close to => **taste and functional** properties of **sucrose**.
- Most exhibit => differences => taste properties, e.g., **sweetness lag**, lingering **aftertaste** or **bitterness**, lack of **bulking** properties, **stability** problems during storage and **competitive prices**.

Tastes like sugar	Very low or no calories
As sweet as or sweeter than sucrose	Tooth decay is prevented
Pleasant taste without any aftertaste	Useful in reduction of weight
Colorless and odorless	Diabetes management
High solubility	Non toxic
Stable in all processing conditions	Easily availability
Cost effective	

CHARACTERISTICS OF AN IDEAL SWEETENER

- In 1969, sale of **cyclamate** was **banned** by the **Food and Drug Administration** in the US .
- In 2017, **sucralose** was **most common** sugar substitute used in the manufacture of foods and beverages .
- had 30% of the global market .
- As of 2018, there is no strong evidence that
 - **non-sugar sweeteners are either unsafe or**
 - **result in improved health outcomes.**

Artificial Sweeteners SIDE EFFECTS

ASPARTAME

Saccharin

Sucralose

Migraines

Headaches

Dizziness

Altered taste buds

Cancer

Hypothyroidism

Breathing Problems

Lung Problems

Toxic Liver

Toxic Kidneys

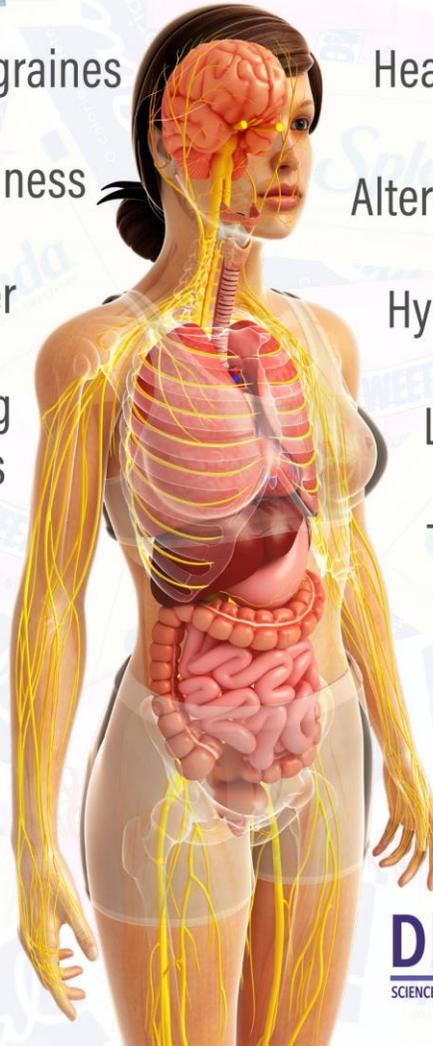
Diarrhea

Eczema

Bloating

Nerve Damage

Nausea



DR. OSBORNE

SCIENCE - FUNCTIONAL MEDICINE - COMMON SENSE - COMPASSION

How Healthy Are SUGAR SUBSTITUTES?



THANKS