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DEPARTMENT OF FOOD TECHNOLOGY

23FTT204- BIOCHEMISTRY & NUTRITION

UNIT 1- CARBOHYDARTES

TOPIC 3 - SWEETNESS: STRUCTURE-ACTIVITY RELATIONSHIP AND SWEETNESS INDEX; DEXTROSE EQUIVALENT; SUGAR ALCOHOLS.

SAR :

Laszlo B. Kier, a renowned medicinal chemist, proposed the concept of Structure-Activity Relationship (SAR) of sweetness in the 1970s. It describes how the chemical structure of a molecule affects its sweetness.

Key concepts:

1. AH-B-X model: A sweetness molecule has three essential components:

   - AH (hydrogen bond donor): usually a hydroxyl (-OH) or amino (-NH2) group

   - B (hydrogen bond acceptor): typically a carbonyl (C=O) or ether (C-O-C) group

   - X (hydrophobic region): a non-polar region, often an alkyl chain or ring

2. Sweetness receptor: The sweetness molecule binds to a specific receptor on the tongue, triggering a sweet sensation

3. Stereochemistry: The 3D arrangement of atoms in the molecule affects sweetness; small changes can significantly impact sweetness intensity

4. Functional groups: Specific groups, like hydroxyl or amino groups, contribute to sweetness

5. Molecular size and shape: Larger molecules or those with specific shapes may not fit the sweetness receptor, reducing sweetness

Understanding SAR of sweetness helps in:

- Designing new sweeteners

- Modifying existing sweeteners for improved taste

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- Predicting sweetness intensity of molecules

sweetness index :

The sweetness index is a measure of the relative sweetness of a substance compared to sucrose (table sugar). It's a way to quantify the sweetness intensity of different compounds.

The sweetness index is usually expressed as a numerical value, with sucrose set as the reference point (index = 1). Other substances are then compared to sucrose and assigned a sweetness index value based on their relative sweetness.

Here are some examples of sweetness index values for common substances:

- Sucrose (table sugar): 1
- Fructose: 1.2-1.5
- Glucose: 0.6-0.8
- Honey: 0.8-1.2
- Aspartame: 150-200
- Stevia: 200-300
- Saccharin: 300-500

A higher sweetness index value indicates a sweeter substance. This index helps biochemists and food scientists understand and compare the sweetness of various compounds, which is useful in food production, flavor development, and nutritional research.

Dextrose equivalent:

The importance of reducing sugars in the Maillard reaction during baking has been mentioned above. Dextrose is a monosaccharide and a reducing sugar. Starch is a polysaccharide, it is made up of about 10,000 dextrose units. The way in which the units are linked leaves only one at the end of the chain with a reducing capability so starch is not regarded as a reducing compound. As the starch molecule is broken up in glucose processing progressively shorter molecules are formed and each has a reducing

element. The ultimate of the process would be only dextrose molecules but normally the reaction does not go this far.

In an attempt to indicate how far the conversion from the starch has gone the concept of dextrose equivalence is used. This is a measure of the reducing power of the syrup. Thus if one hundred grams of dry solid from a glucose syrup has a dextrose equivalent (DE) of 42 it means that the solids act in reducing terms as if they were 42 grams of dextrose. The carbohydrate molecules present other than dextrose may be maltose, dextrins, oligosaccharides, polysaccharides, etc. The larger the molecule the lower the solubility and the lower the sweetness.

Using the enzyme isomerase it is possible to make the conversion from starch produce some fructose in addition to dextrose. The result is a 'glucose' which is significantly sweeter than normal glucose syrups. These syrups are more nearly like invert syrup and are used extensively in soft drink manufacture but have little value in biscuit making. They are called high-fructose syrups but the level of fructose is not higher than in invert syrup.

Sugar Alcohols

Sugar alcohols are also know by the name polyols and can be classified as carbohydrates. They are naturally occurs in many fruits and vegetables, but they are widely consumed in sugar-free and reduced-sugar foods. The sweetness of sugar alcohols varies from 25% to 100% comparing to the table sugar sucrose. The reason sugar alcohols are used in sugar-free foods because they are slowly and in-completely absorbed in the body and use almost zero insulin to be converted into energy. Plus sugar alcohols partially passes into the bloodstream, through the small intestine and the rest passes from low intestine into the large intestine is fermented by colonic microbes.Sugar alcohols are found in a vast array of sugar-free food products items like candy, gum, ice cream, baked good, and fruit spreads. They can also be found in oral hygiene products like toothpaste, mouthwashes and breath mints; they are also found in medicines like cough syrups and lozenges; and most importantly they can be found in lots of sports nutrition products like protein powders, pre-workout supplements, and low-carb products.Sugar alcohols are classified by chemical structure into three groups, these groups are:

1. Monosaccharide- derived sugar alcohols.

2. Disaccharide -derived sugar alcohols.

3. Polysaccharide-derived sugar alcohols mixture.

The Sugar Alcohols			
Type	Calories per Gram	Approximate Sweetness (Sucrose = 100%)	Typical Food Applications
Sorbitol	2.6	50-70%	Sugar free candies, chewing gums, frozen desserts and baked goods
Xylitol	2.4	100%	Chewing gum, gum drops and hard candy, pharmaceuticals and oral health products, such as throat lozenges, cough syrups, children's chewable multi vitamins, tooth pastes and mouth washes, used in foods for special dietary purposes
Maltitol	2.1	75%	Hard candies, chewing gum, chocolates, baked goods and ice creams
Isomalt	2.0	45-65%	Candies, toffee, lollipops, fudge, wafers, cough drops, throat lozenges
Lactitol	2.0	30-40%	Chocolates, some baked goods (cookies and cakes), hard and soft candy and frozen dairy desserts
Mannitol	1.6	50-70%	Dusting powder for chewing gums, ingredient in chocolate flavored coating agents for ice cream and confections
Erythritol	0-0.2*	60-80%	Bulk sweetener in low calorie foods
Hydrogenated Starch Hydrolysates	3	25-50%	Bulk sweetener in low calorie foods, provide sweetness, texture and bulk to a variety of sugarless products