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A Review on Non Nutritive Artificial Sweetener Aspartame

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Abstract: In recent years, sensitivity to sweeteners, such as aspartame, saccharine, xylitol and D-sorbitol during childhood and adolescence has increased. More sugar consumption means more calories consumed, which can contribute to disorders like obesity, diabetes, and cardiovascular problems in the human body. However, the healthy use of the sweeteners has been challenged. In the human diet, multiple sweeteners are added to replace sucrose. They had their own constraints and concerns, however, particularly in terms of their taste and their long-term health effects. Artificial sweeteners, sometimes known as sugar substitutes, are widely used in the processed food, dairy, and pharmaceutical industries. Increased consumer understanding of the adverse health effects of eating excess added sugars has contributed to a rise in sucrose substitution in foods and beverages. The primary goal of this review is to cover the various types of sweeteners, their history, synthesis, metabolism, chemical structure, applications, toxicity, therapeutic uses, health advantages, and hazardous effects.

Keywords: Sweeteners, sugar substitute, calorie, non nutritive sweeteners, Saccharide sweeteners, Non-saccharide sweetener

I. INTRODUCTION

Sweeteners: - This is a substance, particularly one other than sugar, used to sweeten food or drink.

Types of sweetener

1. Natural sweeteners
2. Artificial sweeteners

1. Natural sweeteners: These are the sweeteners, without added chemicals or fancy machinery that exist or are created by nature. Wild, on-hybridized fruits and the natural sugars and starches in living vegetables, trees, seeds, nuts, and roots are the only sugars that are suitable for eating. Natural sweeteners are considered as follows: Honey, Maple Syrup, Molasses and Xylitol (1).

2. Artificial sweeteners: Sugar replacements are also referred to as artificial sweeteners; alternative sweeteners or non-sugar sweeteners are substances found in foods and drinks to replace sugar. Nutritional sweeteners, which add a certain energy value (calories) to food, and non-nutritional sweeteners, which are often called high-intensity sweeteners because they are used in very limited amounts, do not add any energy value to food, can be divided into two broad categories. The most common are: Aspartame, Sucralose, Saccharin, Neotame, Sodium cyclamate (2).

Aspartame

During a series of studies on novel stomach ulcers treatments in 1965, scientist G. D. Searle discovered aspartame. Aspartame was found by accident during the production of tetrapeptide. In 1981, the Food and Drug Administration (FDA or USFDA) approved aspartame as an artificial sweetener. To retain sweetness and other related qualities, aspartame is combined with other sweeteners such as saccharin (3). Aspartame is a phenylalanine and aspartic acid-based methyl ester dipeptide. Aspartame (APM) is an artificial non-saccharide sweetener used as a sugar substitute in a variety of foods and beverages. Mixing aspartame with acesulfame-k or sodium saccharin, sodium cyclamate, and glucose or sucrose, for example, improves the stability and lowers the cost of packing and stocking.

Aspartame is the most often discussed sugar substitute that has a similar flavor to sugar. This is extremely stable at high temperatures and has low water solubility. The rate of aspartame solubility is proportional to temperature (4).

When regular table sugar is replaced with low- or no-calorie sugar in food products, the body receives fewer calories, which aids in weight loss. Because high-sugar diets can cause dental decay, dentists recommend sugar replacements to help alleviate the problem. People with diabetes have blood sugar variations. Using sugar replacements or artificial sweeteners in place of table sugar in the diet permits blood sugar levels to be more stable (5). Aspartame is a common artificial sweetener used in a variety of processed foods.

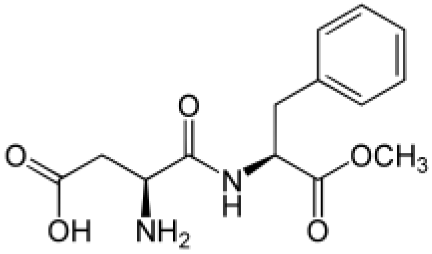

Figure - Structure of Aspartame

Saccharin

Fahlberg and Remsen discovered saccharin in the year 1879 at John Hopkins University (Baltimore). Fahlberg discovered this by accident while researching toluene sulfonamide oxidation processes. During World Wars I and II, when there was a sugar scarcity, saccharin was frequently used (6). Saccharin was banned in 1981 after rats developed bladder cancer after receiving an overdose of the sweetener. There has been no conclusive evidence of a link between saccharin consumption and the risk of cancer in people (7).

Saccharin is a calorie-free artificial sweetener with no food energy. This is the first and one of the oldest sugar substitutes, having been utilised in the processed food and beverage sectors for over a century. Because of its slight bitter and metallic flavour, saccharin is commonly coupled with other artificial sweeteners such as aspartame (8). Saccharin has 300 times the sweetening power of sucrose. Saccharin is not digested after eating; it is eliminated unchanged from the body through the kidneys. Excessive intake or ingestion of saccharin results in severe headaches, breathing difficulties, skin eruptions, and diarrhoea (9).

The chemical oxidation of ortho toluene sulfonamide with reactive chemical agents such as permanganate of potash, tetraoxochromic acid, and electrochemically to matching carboxylic acid is required for the synthesis of sugar substitute saccharin. Saccharin is produced by dehydrating the ortho isomeric component (10).

Saccharin can be found in a wide range of foods, including carbonated soft drinks, tabletop sweeteners, and a few desserts. This sweetener masks the taste of other substances that aren't pleasant in oral hygiene solutions. Saccharin is utilised as a nickel deposition in electrolytes, in addition to being a sugar alternative (11).

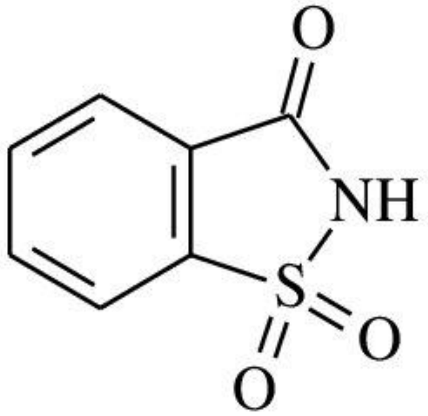

Figure- Structure of Sachharine

Sorbitol

Sorbitol, commonly known as hexitol, is a mannitol isomer. The planar orientation of the hydroxyl group on the second carbon differs amongst the molecules, resulting in different properties for each (12).

It's a polyol (C6H14O6), which is a natural sugar alcohol. It's usually an odourless, noncariogenic white crystalline powder with a molecular weight of 182.17 g/mol, a relative sweetness of 60% when compared to sucrose, a solubility of 2350 g/L, and a pH of roughly 7.0. It has a wide range of applications in the food sector, including sweetener, moisturiser, texturizer, and softener. Because its metabolic pathway is not insulin-dependent, it can also be employed in diabetic dietetic diets (low energy and nonmetabolizable). Sorbitol output in the world is expected to reach around 500,000 tonnes per year. Because sorbitol has a 60 percent relative sweetness (to sucrose) and is 20 times more soluble in water than mannitol, it is preferred in many applications. The majority comes from glucose catalytic hydrogenation, which is deemed “Generally Recognized as Safe” by the FDA. Sorbitol is one of the top 12 high-value-added intermediate compounds that may be made from renewable biomass.The concentration of nutrients in the culture medium, ambient variables, and new biotechnological processes such as cell permeabilization and immobilisation may all influence the biosynthesis of such a biotechnological product. Sorbitol can be produced using low-cost chemical techniques such catalytic hydrogenation of glucose at high temperatures and pressures. The sorbitol is collected and purified after the catalytic hydrogenation process; however, this is a costly step since, in addition to the severe circumstances, it requires highly pure sugar substrates and expensive chromatographic purification processes. Sorbitol is commonly used as a humectant (moisture conditioner) on printing rolls, leather, and inks, as well as a stabiliser for vinyl resins, varnishes, and lacquers, and in antifreeze combinations with glycerol or glycols (13-16).

The catalytic conversion of cellulose to sorbitol has been described in several researches. Ru and Pt were the metal catalysts that promoted both hydrolysis and hydrogenation (17). The conversion of cellulose to sorbitol could be successfully catalysed by a catalytic system containing molecular acids like H2SO4, HCl, or heteropolyacids mixed with supported metal catalysts like Pt, Pd, and Ru (18-20).

Because of its low calorific value, stability, and plasticizing properties, as well as the fact that it does not cause dental cavities, this polyol is commonly employed as a substitute for sucrose and other sugars (21).

Sorbitol's subsequent stability in oil-in-water emulsions is greatly influenced by its thermal treatment. This feature is critical in the production of cosmetics (22).

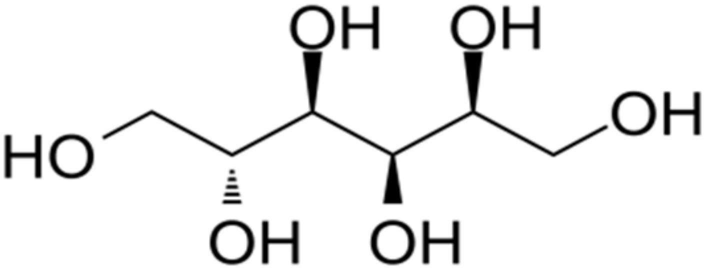

Figure- Structure of Sachharine

Xylitol

Xylitol has a long history of use as a sweetener, owing to its 100 percent relative sweetness to sucrose, making it the sweetest polyol ever described in a food context. Low quantities of xylitol can be found in a range of fruits and vegetables. The main application for xylitol has been in chewing gum due to its acceptability as a way to reduce the risk of tooth cavities. The regular consumptionof xylitol helps to mineralize teeth and minimises the risk of dental cavities (23). Xylitol was shown to be the best candidate polyol in a research of complete sucrose replacement with polyols in sponge cakes, owing to its ability to match the sweetness and flavour. Physical parameters such as specific volume and light intensity were likewise comparable in cakes made using xylitol instead of sucrose (24). Xylitol has also been found to work well in the production of hard candies, chocolate, ice cream, and baked products, indicating that it is a suitable sugar substitute (25-27).

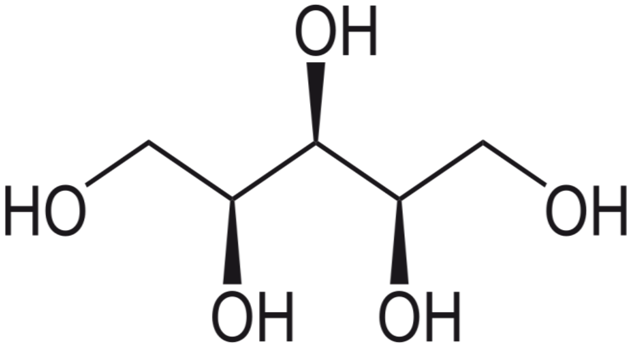

Figure- Structure of Xylitol

Mannitol

Mannitol is a hexitol that is also known as mannite. It has a sweetness of 50-60% that of sucrose. Because it is non-hygroscopic, it is used in sugar-free coatings and as a dusting agent in production to prevent stickiness on product surfaces. It's commonly employed as a bulking and dusting agent in chewing gum, as well as in mint confectionery. The negative heat associated with mannitol solution, which results in a cooling effect in the mouth, according to O'Donnell and Kearsley (28) makes it suitable for these applications. Mannitol is also utilised as a sucrose substitute in sugar-free chocolate coatings and cake frostings, and tests have discovered that it performs differently in bakery items than sugar. Mannitol, for example, slowed dough spreading in cookies, resulting in an unsatisfying product that scored poorly in sensory tests (29). However, in another trial of sucrose replacement in burger buns, up to 50% mannitol replacement resulted in a good product. The inability of bakers' yeast to ferment polyols influenced specific volume and crumb structure (CO2 production), but a decrease in Maillard reaction linked with sucrose in the control buns resulted in greater lightness in the mannitol-containing product (30).

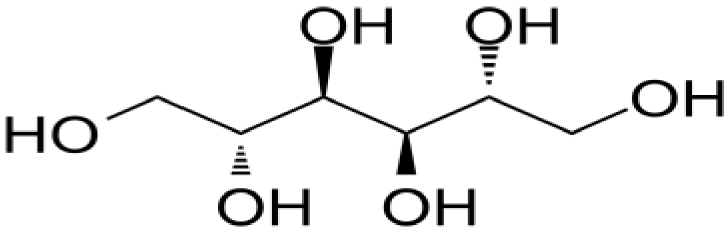

Figure- Structure of Mannitol

Erythritol

Erythritol is the only 4-carbon polyol that is regularly used as a sweetener. It's also found in fruits and vegetables like melons, peaches, and mushrooms, as well as fermented foods like wine, sake, and soy sauce. Erythritol has a relative sweetness of 60%, is temperature stable, and is pH stable in both acidic and alkaline environments. It is hygroscopic and does not contribute to Maillard browning (31). Because of its beneficial characteristics, erythritol is widely employed in the food sector. Recently in a study found that erythritol to be superior to xylitol and sorbitol for dental plaque suppression and risk reduction, underlining its potential in oral health applications (32). Studies on the use of this polyol to replace sucrose in baked goods have indicated that it works well for partial sucrose replacement, while total sucrose replacement can have negative impacts on product qualities. In a Danish cookie trial, 50 percent of the sucrose could be replaced with erythritol while the cookies' physical and sensory qualities remained same. Furthermore, there was no difference in hedonic score between the control and the 50% erythritol substituted cookies (33). A comparable study on chiffon cakes found that substituting 50 percent erythritol for sugar had no effect on physical qualities. The cakes made with 75% erythritol were acceptable, although the crust colour and sweetness were different from the cakes made with 100% sucrose (34). There are few complexes and lignads which possess certain characteristics of sweeteners and or toxicity (35,36). In a trial of muffins with complete sucrose substitution by different polyols, erythritol came in last as a contender for sucrose replacement at 100 percent. This was because to its effect on starch gelatinization in the dough batter, which resulted in short and firm muffins (37).

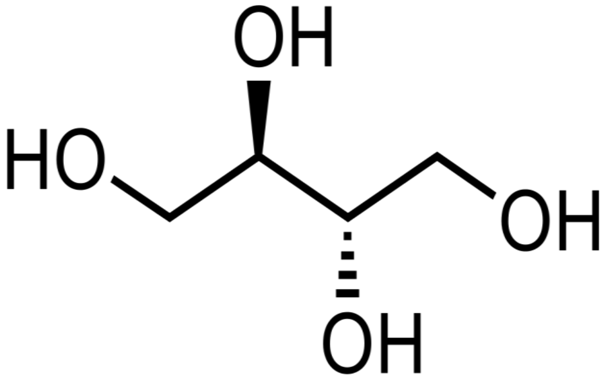

Figure- Structure of Erythritol

II. CONCLUSION

Sugar has been restricted in the diet of diabetics because it increases caloric intake and can lead to obesity, which is a risk factor for various chronic diseases. Natural sweeteners have made it possible to provide consumers with a sweet flavor without the calories that a high-sugar diet entails. Every year, the prevalence of diseases such as diabetes, obesity, and heart attacks rises. Sugar consumption increased as a result of processed foods, candies, and soft drinks, causing people to be increasingly concerned about their health. As a result, sugar replacements or artificial sweeteners are becoming more popular. These sugar replacements are used in a variety of processed foods and alcoholic beverages in several countries. There have been numerous sugar alternatives developed, and current research calls for the development of more calorie-free and safe artificial sweeteners from industrial food waste.

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