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Sugar Substitutes: Benefit or Burden

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Abstract

The ubiquitous presence of sugar in our daily diet poses a considerable impact on both dental and overall health. The consensus is clear—an excess of sugar is far from ideal. Moreover, controversial conjectures have emerged, suggesting a pivotal role of excessive sugar intake in certain degenerative diseases. In response to these concerns, artificial sweeteners, also known as sugar substitutes or low-calorie sweeteners, have become increasingly appealing to consumers. Artificial sweeteners, characterized by their non-nutritive nature and high-intensity sweetness, offer a viable alternative to traditional sugar-laden products. These substitutes present an opportunity for individuals to indulge in the sweetness they crave without compromising dental health or overall well-being. Their role in the food industry is pivotal, granting manufacturers the ability to craft a diverse array of palatable sweet foods and beverages. Importantly, the availability of a variety of safe sugar substitutes proves beneficial for consumers, allowing for the enjoyment of sweet flavors while prioritizing oral hygiene and general health. In navigating the complex landscape of dietary choices, the adoption of artificial sweeteners emerges as a pragmatic approach to strike a balance between satisfying sweet cravings and maintaining a health-conscious lifestyle. As research continues to unfold, the consumption of these sugar substitutes represents a contemporary solution to the age-old challenge of reconciling taste preferences with health considerations.

Keywords: Sugar, sugar substitute, oral health, dental caries

INTRODUCTION

Dental caries is a complex ailment, widely acknowledged as multifactorial in nature. The prevailing concept highlights the interplay of three key elements—the host tissue (tooth), microflora with cariogenic potential, and a suitable local substrate, primarily the diet, as integral factors for the initiation of the caries disease process. According to the World Health Organization (WHO) 2003, dental caries remains a significant issue, impacting 60–90% of school children and adults globally. In India, the prevalence of caries is alarming, with rates reaching 83.4% among 15-year-olds and 83–86% in the 35–44 years age group. With a heightened focus on health and fitness in recent years, there has been a surge in awareness regarding the implications of energy imbalance, driven by factors such as urbanization, sedentary lifestyles, and the excessive consumption of sugary and fatty foods [1]. This shift is contributing to rising obesity rates, a primary factor in the surge of type II diabetes, potentially positioning India as the diabetic capital of the world by 2030. As health consciousness grows, there is an increasing demand for food products that promote better health, leading consumers to seek a greater variety of low-calorie options. In response to this

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demand, sugar substitutes have gained prominence. These additives replicate the taste of sugar but typically offer lower food energy, being approximately 200 times sweeter than sugar. Sugar substitutes can be either natural or synthetic, with the latter commonly referred to as artificial sweeteners [2]. The food and beverage industry is adapting to this health-conscious trend by replacing sugar or corn syrup with artificial sweeteners in various products. Despite the significantly lower production costs of artificial sweeteners compared to natural alternatives, manufacturers enjoy substantial profit margins in this growing market as shown in Table 1.

CLASSIFICATION OF SUGAR SUSBSTITUES

Based on their Origin

1. Natural sugar substitute (Table 2)
2. Artificial sugar substitute (Table 3)

Based on the Therapeutic Uses

Dental Care

While liquid formulations are well-suited for children, a notable drawback is that many of them incorporate sucrose—a factor that promotes dental decay. Unlike sugar, sugar substitutes do not undergo fermentation by the microflora present in dental plaque [3]. Recognizing the adverse impact of sucrose on dental health, medical professionals are advised to advocate for sugar-free medications, which utilize sugar substitutes, whenever feasible as shown in Table 2.

Diabetes Mellitus

Individuals dealing with diabetes encounter challenges in managing their blood sugar levels. Opting for artificial sweeteners as a replacement for sugar enables them to diversify their diet. While certain sugar substitutes do provide energy, they undergo a slower metabolism, contributing to the maintenance of more stable blood sugar levels over an extended period [4].

Table 1. Classification of sugar substitute as caloric or noncaloric.

a. Caloric/Nutritive sweetener	b. Non-caloric/Non-nutritive sweetener
1. Polyalcohols/sugar alcohols • Xylitol • Sorbitol 2. Hydrogenated starch hydrolysates • Lycasin • Palatinit 3. Coupling sugars • Sorbose • Palatinose	1. Cyclamate 2. Saccharin 3. Sucralose 4. Neotame 5. Aspartame

Table 2. Natural sugar substitutes (plant origin).

	Substitutes
Brazzein	Glycyrrhizin
Mannitol	Glycerol
Miraculin	Hydrogenated starch
Monatin	Hydrolysates
Monellin	Inulin
Pentadin	Isomalt
Sorbitol	Lactitol
Stevia	Mabinlin
Tagatose	Maltitol
Xylitol	Maltoligosaccharide
Mannitol	Glycerol
Miraculin	Hydrogenated starch

Table 3. Artificial sugar substitute.

	Substitutes
Acesulfame potassium	Neohesperidin
Alitame	Dihydrochalcone
Aspartame	Neotame
Cyclamate	Saccharin
Dulcin	Sucralose
Glucin	

Reactive Hypoglycemia

People experiencing reactive hypoglycemia generate surplus insulin following the rapid absorption of glucose into the bloodstream. This leads to a decrease in their blood glucose levels below the necessary threshold for physiological functioning. Consequently, akin to individuals with diabetes, they need to avoid high-glycemic foods such as white bread and frequently opt for artificial sweeteners as a substitute [5].

To Assist in Weight Loss

Certain individuals opt to control their caloric intake by substituting high-energy sugar or corn syrup with alternative sweeteners that possess minimal or no caloric content, commonly known as sugar substitutes. This choice enables them to maintain their regular dietary preferences while facilitating weight loss and averting issues linked to an excess of calorie consumption [6].

Based on Non-Therapeutic Uses

As Sugar Substitute

Research conducted with taste-test panels revealed that the flavor of aspartame closely resembles the taste of sugar. Consequently, it is employed as a substitute for sugar in a variety of food products [7].

Enhances and Extends Flavours

Aspartame possesses the capability to enhance and prolong fruit flavors, such as cherry and orange, in both foods and beverages. For instance, in chewing gum, aspartame imparts a sweet and more enduring flavor as compared to gum sweetened with sugar [8].

Avoiding Processed Foods

People might choose to replace highly processed white sugar with less-refined alternatives such as fruit juice or maple syrup.

Cost

Many sugar substitutes are cheaper than sugar as shown in Table 3.

ACCEPTABLE DAILY INTAKE

The United States and other nations with substantial artificial sweetener consumption have established standards and regulations. Acceptable Daily Intakes (ADIs) are determined based on ongoing safety research, defined by the WHO as the amount of a substance individuals in a specific population can be exposed to daily throughout their lives without significant health risks [8]. ADIs are calculated by dividing the maximum dose from animal studies that did not show adverse effects. For instance, if a study finds that a 500-mg dose in animals is non-toxic, the ADI is calculated by dividing this number by 100, resulting in a 5 mg ADI.

ADIs for different substances may change based on new research, potentially leading to reductions or, in extreme cases, removal from the market. Cyclamate, an artificial sweetener, was banned in the U.S. in 1970 due to studies indicating its carcinogenic potential. Currently, saccharin has an ADI of 5 mg/kg/day, acesulfame-K has an ADI of 15 mg/kg/day (supported by the EU with a recommended ADI

of 9 mg/kg/day), sucralose has an ADI of 5 mg/kg/day, and neotame has an ADI of 18 mg/kg/day (confirmed by The Joint FAO/WHO Expert Committee on Food Additives at 2 mg/kg/day in 2003). Aspartame has an ADI of 50 mg/kg/day in the U.S. and 40 mg/kg/day in the EU. To illustrate, a 150-pound person could reach the ADI by consuming nearly twenty 12-ounce cans of aspartame-sweetened soft drinks daily over a lifetime [9]. This calculation does not consider other sources such as tabletop sweeteners or artificially sweetened foods.

CALORIC SUGAR SUBSTITUTES

Caloric sugar substitutes constitute a category of sweeteners encompassing ingredients that can serve as substitutes for both the physical bulk and sweetness found in sugar. These products, often referred to as "sugar replacers" or "bulk sweeteners," encompass sugar alcohols, also known as polyols. Examples of polyols include sorbitol, mannitol, xylitol, isomalt, erythritol, lactitol, maltitol, hydrogenated starch hydrolysates, and hydrogenated glucose syrups [10].

Additionally, two recently introduced sweeteners, trehalose and tagatose, function similarly to polyols despite being categorized as sugars rather than sugar alcohols. Polyols and other bulk sweeteners find application in food products where both the volume and texture of sugar, along with its sweetness, are crucial factors. Such products include sugar-free candies, cookies, and chewing gum [11].

NON-CALORIC SUGAR SUBSTITUTES

These alternatives to sugar are commonly referred to as alternative, artificial, high-intensity, or non-nutritive sweeteners. They serve as effective replacements for sugar's sweetness, offering minimal to no calories. Apart from the calorie reduction, these sugar substitutes have the added benefit of not contributing to tooth decay. This makes them valuable in dietary strategies for individuals managing conditions such as obesity or diabetes. Sugar substitutes, also known as artificial sweeteners, contribute minimal to zero calories and carbohydrates and do not elevate blood sugar levels. Opting for sugar substitutes can aid in regulating both carbohydrate and energy intake [12].

Non-Caloric Sugar Substitutes Approved by the FDA

Acesulfame K, Aspartame (Nutrasweet/Equal), Neotame, Saccharin (Sweet n’ Low), Stevia (various brands), and Sucralose (Splenda) are examples of sugar substitutes. These alternatives provide a sweet flavor without causing a rise in blood glucose levels or adding extra calories. Opting for sugar substitutes serves as a strategy to manage and restrict carbohydrate intake. By incorporating sugar substitutes or opting for low-sugar foods and beverages, individuals can create more flexibility in their diet to include a variety of other healthy carbohydrates.

PUBLIC HEALTH SIGNIFICANCE

Polyols are hydrogenated carbohydrates employed as substitutes for sugar. They are characterized by being non-cariogenic, meaning they are tooth-friendly and do not contribute to tooth decay. Additionally, polyols exhibit low glycemic properties, which can be advantageous in managing conditions such as diabetes and cardiovascular disease. They also possess low-energy and low-insulinemic attributes, potentially aiding in obesity management. Furthermore, polyols are low-digestible, offering potential benefits in colon health. Their osmotic qualities make them colon-hydrating, acting as a laxative and purifying agent [13].

CONCLUSION

The debate surrounding the consumption of artificial sweeteners remains contentious, with evidence pointing to a spectrum of side effects ranging from minor inconveniences like headaches to more severe concerns, including the potential risk of cancer. Recent studies on specific sweeteners have raised questions about their effectiveness in weight loss, suggesting a counterintuitive association with weight gain instead. The extensive literature available on artificial sweeteners can be challenging for the general public to navigate, especially considering the conflicting viewpoints among researchers.

Given the complexity of the research landscape, it becomes crucial for occupational health nurses and other healthcare providers to stay abreast of the latest findings related to artificial sweeteners. Their role extends beyond simple awareness to actively informing clients about the potential risks associated with the use of these sweeteners. This involves distilling complex scientific information into accessible language, providing individuals with the tools to make informed decisions about their dietary choices.

In this context, fostering an open dialogue between healthcare providers and clients becomes imperative. Addressing concerns, disseminating accurate information, and facilitating a nuanced understanding of the risks associated with artificial sweeteners empower individuals to make choices aligned with their health goals. As the field continues to evolve, ongoing vigilance and communication are essential to ensure the public receives balanced and up-to-date information regarding the use of artificial sweeteners.

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