Dr. Serafín Murillo.
Máster en educación en diabetes y Doctorado en Medicina.
Nutricionista en Hospital Sant Joan de Déu.
Profesor asociado en la Universitat de Barcelona.

Sweeteners and diabetes

Sweetness is one of the primary tastes, naturally produced by foods rich in simple carbohydrates, that is, sugars. As a result, sweeteners are defined as all those substances that create a sweet taste when they come into contact with the taste buds distributed across the tongue.

The so-called sugar substitute sweeteners are a class of food additives used with the aim of enhancing the sweet taste of food products without adding or by reducing the energy content or the effect on blood glucose levels of the foods.

Sugar substitute sweeteners are a type of food additive used to enhance the sweetness of food products without adding or by reducing the energy content or the effect on the glycemia of foods. The use of sugar substitute sweeteners is continually increasing among consumers, both in people with diabetes and the general population (1). Similarly, these sweeteners are increasingly found in a wide range of products, with the aim of reducing caloric intake or minimizing the impact on blood glucose levels. However, the results of some studies published in recent years show inconclusive findings regarding these potential benefits on body weight or other health markers (2, 3).

TYPES OF SWEETENERS

There are various ways to classify sweeteners based on their origin, production method, or sweetening power. One such classification is the following (4):

- **Natural or Caloric Sweeteners:** These are sweeteners naturally present in foods, such as sucrose (or table sugar), fructose (found in fruits), or lactose (found in milk and some dairy products). They provide about 4 kcal per gram and affect blood glucose levels.

- **Intense or Non-Caloric Sweeteners:** Also known as artificial sweeteners, these are typically synthetic compounds with a high sweetening power. That is, a small amount produces a strong sweet taste. They provide no energy and do not directly affect blood glucose levels.

Sweetening Power: Defined as the amount of sugar (dissolved in water) needed to achieve the same sweetness as one gram of a given sweetener. This is the measure of a sweetener's intensity.

- **Sugar Alcohols or Polyols:** Also known as bulk sweeteners, these compounds are derived from natural sugars, in which the molecule is modified by adding an alcohol group. They can also be found naturally, though in very small amounts, in fruits and vegetables, contributing to their sweetness.

  The molecular modification alters their absorption, so their energy content is between 2 and 2.5 kcal per gram, and though lower than natural sugars, they still affect blood glucose levels.

SWEETENERS ON FOOD LABELS

The goal of food labeling should be to provide consumers with quality information. However, it is essential to consider how each sweetener is listed on food labels (5):

- Natural Sweeteners: In addition to the classic terms like sugar or sucrose, they may appear on ingredient lists as glucose, dextrose, glucose syrup, maltose, oligofructose, fructose syrup, molasses, or inverted sugar, among other forms.

- Intense Sweeteners and Polyols: They are typically indicated by the letter "E" followed by three numbers, representing the food additive code.

EFFECTS ON BLOOD GLUCOSE LEVELS

The use of intense sweeteners does not cause short-term changes in blood glucose levels. However, some studies have »

CHARACTERISTICS OF INTENSIVE SWEETENERS AND POLYOLS

CODE	NAME	TYPE OF SWEETENER	SWEETENING POWER	CODE	NAME	TYPE OF SWEETENER	SWEETENING POWER
E-420	Sorbitol and sorbitol syrup	Polyol	4	E-957	Thaumatin	Intensive	E-957
E-421	Mannitol	Polyol	2	E-959	Neohesperidin DC	Intensive	1500
E-950	Acesulfame potassium	Intensive	160-220	E-960	Stevia	Intensive	300
E-951	Aspartame	Intensive	180-200	E-961	Neotame	Intensive	8000
E-952	Cyclamic acid and its sodium and calcium salts	Intensive	30-50	E-965	Maltitol and maltitol syrup	Polyol	1
E-953	Isomaltitol	Polyol	0.5	E-966	Lactitol	Polyol	0.5
E-954	Saccharin and its sodium, potassium, and calcium salts	Intensive	300	E-967	Xylitol	Polyol	1
E-955	Sucralose	Intensive	600	E-968	Erythritol	Polyol	0.75

SWEETENING POWER: THIS IS DEFINED AS THE AMOUNT OF SUGAR (DISSOLVED IN WATER) NEEDED TO ACHIEVE THE SAME SWEETNESS AS ONE GRAM OF A GIVEN SWEETENER. IT IS THE METHOD USED TO MEASURE A SWEETENER'S INTENSITY

» shown long-term alterations with habitual use. Nonetheless, these effects are not yet well established (2).

In the case of polyols, determining their effects on blood glucose levels is complex. These sweeteners are derived from modifying natural sugars by adding an alcohol group to the molecule, resulting in poorer absorption of the compound.

It is generally established that polyols have an absorption rate of 50%. However, this value is merely the average absorption of each sweetener. Furthermore, some polyols, such as erythritol, though almost fully absorbed (90%), are excreted without being metabolized, resulting in a very low effect on blood glucose levels. For this reason, erythritol is considered very low in energy, providing only 0.2 kcal per gram. »

ABSORPTION, FERMENTATION, AND EXCRETION OF POLYOLS

	ABSORPTION (%)	FERMENTATION (%)	EXCRETION (%)
ERYTHRITOL	90	10	90
XYLITOL	50	50	< 2
SORBITOL	25	75	< 2
MANNITOL	25	75	< 2
ISOMALTITOL	10	90	< 2
LACTITOL	2	98	< 2
MALTITOL	40	60	< 2

Mofificado de Livesey 2003 (6).

IN THE CASE OF POLYOLS, DETERMINING THEIR EFFECTS ON BLOOD GLUCOSE LEVELS IS COMPLEX. THESE SWEETENERS ARE DERIVED FROM THE MODIFICATION OF NATURAL SUGARS, WHERE AN ALCOHOL GROUP IS ADDED TO THE MOLECULE, RESULTING IN POORER ABSORPTION OF THE COMPOUND.

» Sweeteners like xylitol or maltitol have an absorption rate of 40% up to 50%, which is consistent with the norm of accounting for a 50% glycemic effect. However, other sweeteners, like sorbitol, have a lower absorption rate of 25%.

SIDE EFFECTS

The use of intense sweeteners and polyols, as well as many other food additives, is continually subject to safety concerns. In our environment, the European Food Safety Authority (EFSA) continuously evaluates each authorized sweetener[7].

For example, in December 2023, EFSA published a report reevaluating the safety of erythritol (E-968), indicating both its safe use and the absence of effects on blood glucose levels.

However, the quantity consumed must be considered for any food additive, including sweeteners. The acceptable daily intake (ADI) is established for this purpose.

This is especially important for polyols, as one of their side effects is digestive symptoms such as abdominal pain, bloating, gas, or even diarrhea. The onset of these symptoms depends on the dose consumed and the type of sweetener, as some of these sweeteners are not absorbed and can ferment in the digestive tract, causing the previously mentioned symptoms. Even erythritol has an established acceptable daily intake, recently set at 0.5 g of erythritol per kg of body weight.

The other polyols have an acceptable daily intake ranging that goes from 20 up to 80 grams, although problems can arise at lower doses in children or people with digestive issues. In recent years, the use of sweeteners has been associated with alterations in gut microbiota, poorer appetite regulation, increased risk of type 2 diabetes mellitus, and even an increased risk of disease and mortality from cardiovascular problems.

In 2023, the World Health Organization (WHO) published a recommendation regarding the use of these intense sweeteners in the general population. It advised against using intense sweeteners as a method to achieve weight loss or reduce the risk of associated metabolic diseases. This recommendation emphasized observational clinical trials over intervention studies, which did find positive effects on body weight or the reduction of some cardiovascular risk factors. Due to the lack of consensus, the WHO issued a conditional recommendation, placing more importance on avoiding potential associated side effects.

This recommendation did not apply to individuals already diagnosed with diabetes, as in these cases, the benefit of using these sweeteners on glycemia outweighed the potential risks. D

CONCLUSIONS:

In summary, it is important to understand the characteristics of each sweetener to anticipate its possible effects on glycemia, as well as to be aware of the appropriate usage amounts to avoid side effects.

REFERENCES:

1. Future Market Insights. Market insights on lowcalorie sweeteners covering sales outlook, demand, forecast and up-to-date key trends. 2023. www.futuremarketinsights.com/reports/low-caloriesweeteners-market.
2. World Health Organization. Use of non-sugar sweeteners: WHO guideline. 2023. www.who.int/publications/i/item/9789240073616
3. Iizuka K. Is the Use of Artificial Sweeteners Beneficial for Patients with Diabetes Mellitus? The Advantages and Disadvantages of Artificial Sweeteners. Nutrients. 2022;14(21):4446.
4. Diabetes a la Carta. Los edulcorantes de los alimentos en la diabetes. https://diabetesalacarta.org/wp-content/uploads/2017/05/edulcorantes-alimentos.pdf
5. Boletín Oficial del Estado. Real Decreto 2002/1995, de 7 de diciembre. Última actualización publicada en 10 de diciembre de 2020. https://www.boe.es/buscar/act.php?id=BOE-A-1996-767
6. Livesey G. Health potential of polyols as sugar replacers, with emphasis on low glycaemic properties. Nutr Res Rev. 2003;16(2):163-91.
7. Agencia Europea de Seguridad Alimentaria. Edulcorantes. https://www.efsa.europa.eu/es/topics/topic/sweeteners