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Short Communication

Difference between Monosaccharides, Disaccharides and Polysaccharide: Carbohydrates Study

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Abstract

Carbohydrates the general names of sugars are monomer (monosaccharides), dimers (disaccharides), trimer (trisaccharides), oligomers (oligosaccharides) and polymers (polysaccharides) derived from sugars (sucrose, Latin for sugar).A monosaccharide or simple sugar is an aldehyde or ketone with at least two hydroxyl groups. Thus the two simple members of this class of compounds are 2 and 3-dihydroxypropanal (glycerol aldehyde), 1 and 3-dihydroxypropanone (1 and 3-dihydroxyacetone). Aldehyde sugars are classified as aldehydes. Those who have a ketone agent are called ketosis. Depending on the length of the chain, sugars are called triose (3 carbon), tetrose (4 carbon), pentose (5 carbon), hexose (6 carbon), and so on. Hence, 2 and 3-dihydroxypropanol (glycerol aldehyde) is an aldotriose. While 1 and 3-dihydroxypropanone is a ketotriose.In this review we concluded that carbohydrates are divided into 4 groups, monosaccharides, disaccharides, oligosaccharides, polysaccharides. The chemical formula of carbohydrates is C_x (H_2O) y. So simple carbohydrates have the formula C_x (H_2O) where y is three or more. Sugar is a carbohydrate that is easily absorbed by our body while the body takes more time to absorb complex carbohydrates.

Keywords: Sugar, Carbohydrates, Oligosaccharide, Ketotriose

INTRODUCTION

Sugar, also known as saccharose, sucrose or by the chemical name α-D-glucopyranosyl, is a carbohydrate extensively used in the food industry and homemade\food preparation.

Formula and structure

The sucrose chemical formula is $C_{12}H_{22}O_{11}$ and the molar mass is 342.30 g mol^{-1}. The structure is a disaccharide formed by two subunits, one of glucose and one unit of fructose. The crystal structure is monoclinic V,2018. Its chemical structure can be written as below, in the common representations used for organic molecules (Figure 1).

Formulas for different sugars

However, there are many different sugars besides sucrose (Jansonn 1989).

Other sugars and their chemical formulas include:

Arabinose: $C_5H_{10}O_5$
Fructose: $C_6H_{12}O_6$
Galactose: $C_6H_{12}O_6$
Glucose: $C_6H_{12}O_6$
Lactose: $C_{12}H_{22}O_{11}$
Inositol: $C_6H_{12}O_6$
Mannose: $C_6H_{12}O_6$
Ribose: $C_5H_{10}O_5$
Trehalose: $C_{12}H_{22}O_{11}$
Xylose: $C_5H_{10}O_5$

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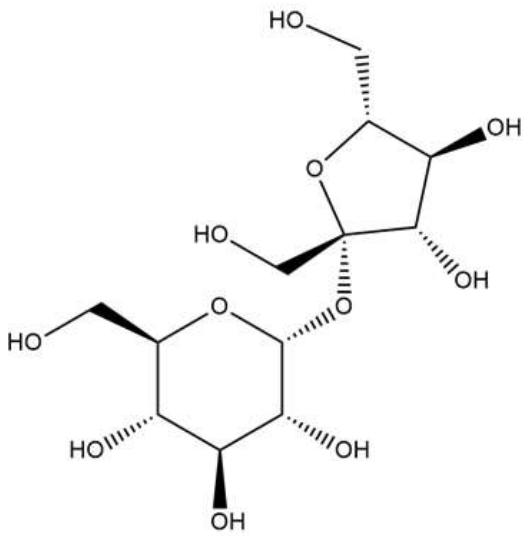

sucrose

Figure 1. Show formula of sucrose.

Many sugars share the same chemical formula, so it is not a good way to distinguish between them. The ring structure (Cerna M, 2003) location and type of chemical bonds, and three-dimensional structure are used to distinguish between sugars (Figure 2).

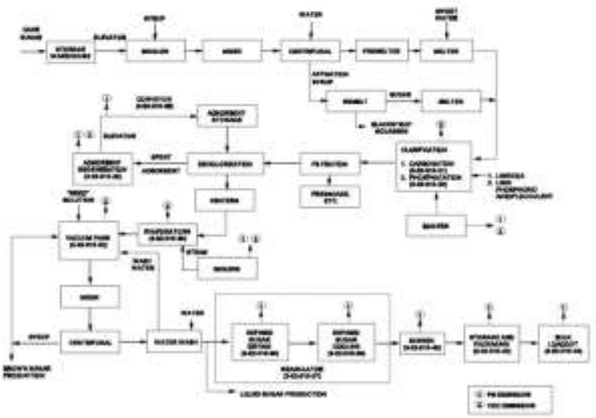

Figure 2. Simplified process flow diagram for refined sugar production. (Source classification codes in parentheses.

Occurrence: Sucrose is extracted from sugar cane or sugar beet. It can also be found in many plants, nectars and participate in the metabolism of many mammas, insects and birds.

Preparation: In industries, it is not synthesized. It is mostly extracted from sugar cane or sugar beet. There have been some attempts for developing strategies for synthesizing sucrose, but it is not economically advantageous.

Physical properties: Sucrose is white, odorless and sweet taste crystalline solid. It is highly soluble inwater (2000 g/L) and other polar solvents (Zhao Y, 2019). Its density is 1.587 gmL^{-1}. The sucrose doesn't have melting point, it decomposes up to 186°C.

Chemical properties: The sucrose is formed by two subunits of other very known sugars: fructose and glucose. One of them is a six member heterocycle (glucose ring) while the another one is a five member heterocycle (fructose ring), both rings are linked by a glycosidic linkage. Its highly solubility in water is due to the presence of several hydroxyl groups in the molecules, which made of this compound a polar structure (Copikova J, 2006). Another important characteristic is, sucrose doesn't have melting point, instead it decomposes up to 186°C, forming caramel in a reaction that is very used by the food industry.

Uses: Sucrose is the main ingredient of the modern sweet production. It is used in houses for the preparation of desserts and another important use is as preservation agent in the food industry. It can also be added in some medicines, pills and syrups.

Health effects/safety hazards: Sugar is not a dangerous substance, however is associated to multiple health prob lems when consumed in excess, for example: Tooth deca y, high glycemic index, diabetes and obesity (Herget S, 2008). Sucrose and sucralose are both sweetners, but they aren’t the same. Here's a look at how sucrose and sucralose are different.

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Sucrose *vs* sucralose

Sucrose is a naturally occurring sugar, commonly known as table sugar. Sucralose, on the other hand, is an artificial sweetener, produced in a lab. Sucralose, like Splenda, is trichlorosucrose, so the chemical structures of the two sweeteners are related, but not identical.

The molecular formula of sucralose is $C_{12}H_{19}C_{l3}O_8$, while the formula for sucrose is $C_{12}H_{22}O_{11}$. Superficially, the sucralose molecule looks like the sugar molecule. The difference is that three of the oxygen-hydrogen groups attached to the sucrose molecule are replaced by chlorine atoms to form sucralose. Unlike sucrose (Wang J, 2021), sucralose is not metabolized by the body. Sucralose contributes zero calories to the diet, compared with sucrose, which contributes 16 calories per teaspoon (4.2 grams). Sucralose is about 600 times sweeter.Than sucrose. But unlike most artificial sweeteners, it doesn't have a bitter aftertaste.

About sucralose

Sucralose was discovered by scientists at Tate and Lyle in 1976 during the taste-testing of a chlorinated sugar compound. One report is that researcher Shashikant Phadnis thought his coworker Leslie Hough asked him to taste the compound (not a usual procedure), so he did and found the compound to be extraordinarily sweet compared with sugar. The compound was patented and tested, first approved for use as a non-nutritive sweetener in Canada in 1991 (Albalasmeh AA, 2013). Sucralose is stable under a wide pH and temperature ranges, so it can be used for baking. It is known as E number (additive code) E955 and under trade names including Splenda, Nevella, Sukrana, Candys, SucraPlus, and Cukren.

Health effects

Hundreds of studies have been performed on sucralose to determine its effects on human health. Because it's not broken down in the body, it passes through the system unchanged. No link has been found between sucralose and cancer or developmental defects (Usoltseva RV, 2016). It's considered safe for children, pregnant women, and nursing women. It's also safe for use by people with diabetes; however, it does raise blood sugar levels in certain individuals.

Since it's not broken down by the enzyme amylase in saliva, it can't be used as an energy source by mouth bacteria (Deller RC, 2013 and Chen S, 2011). In other words, sucralose does not contribute to the incidence of dental caries or cavities.

However, there are some negative aspects to using sucralose. The molecule eventually breaks down if cooked long enough or at a high enough temperature, releasing potentially harmful compounds called chlorophenols. Ingesting these alters the nature of our gut bacteria, potentially changing the way the body handles actual sugar and other carbohydrates, and possibly leading to cancer and male infertility (Qiaorun Z, 2022 and Shashkov AS, 2019).

Also, sucralose may increase insulin and blood glucose levels and decrease insulin sensitivity, all effects that people with diabetes are trying to avoid.

At the same time, since the molecule isn't digested, it's released into the environment contributing to further pollution and public health problems (Figures 3 and 4).

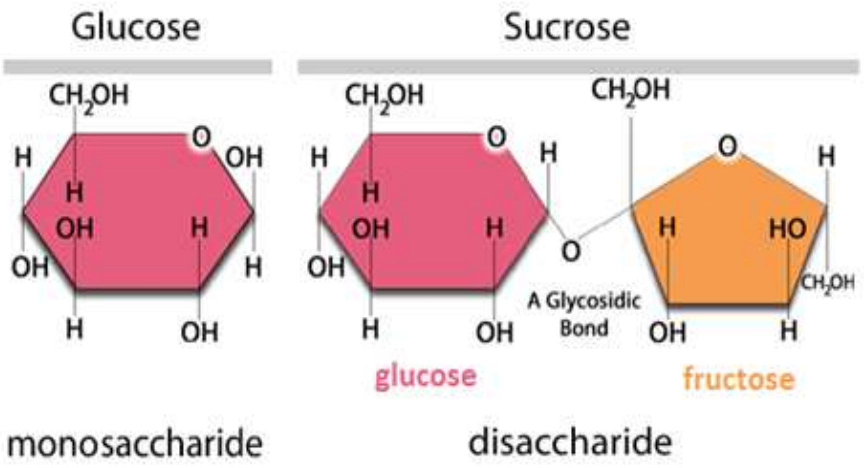

Figure 3. Simple difference between monosaccharide and disaccharide.

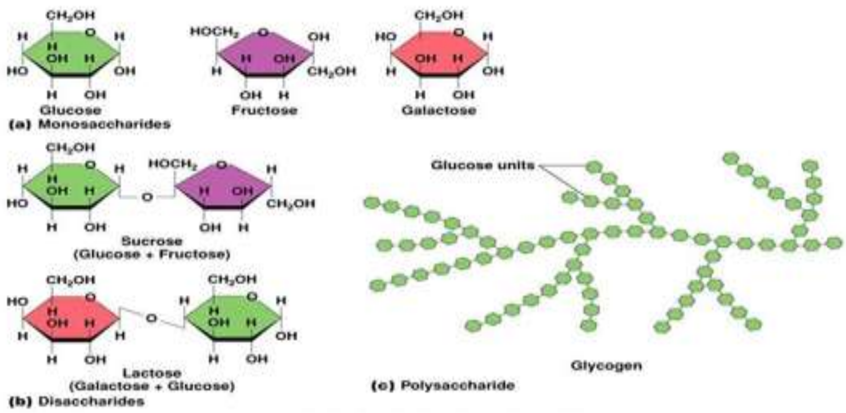

Figure 4. Examples of monosaccharides, disaccharides and polysaccharide.

Among these monosaccharides and disaccharides are known as simple carbohydrates and are also called sugars. Because the word saccharide is derived from a Greek word meaning sugar, people are confused between sugar and carbohydrates. Another confusing factor is the naming of simple carbohydrates. Simple carbohydrates have names ending in -uz. In medical terms, blood sugar is called glucose monosaccharide, milk sugar is called lactose disaccharide, and table sugar (the sugar we eat daily) is called sucrose disaccharide.

Glucose is a simple sugar or monosaccharide. This energy source is based on carbohydrates in your body. Monosaccharides are made up of a unit of sugar and therefore cannot be broken down into simple compounds. They are the building blocks of carbohydrates. In foods, glucose is often attached to another simple sugar to form polysaccharide or disaccharide starches such as sucrose and lactose. It is often added to processed foods in the form of dextrose, which is extracted from cornstarch. Glucose has less sweetness than fructose and sucrose.Froctose, or "fruit sugar," is a glucose-like monosaccharide. It is found naturally in fruits, honey, agave and most root vegetables. In addition, it is usually added to processed foods in the form of high fructose corn syrup. Fructose is made from sugar cane, beet sugar and corn. High fructose corn syrup is made from cornstarch and contains more fructose than glucose compared to regular corn syrup. Of these three sugars, fructose has the sweetest taste but has the least effect on your blood sugar. They have different digestion and absorption. Your body works differently to digest and absorb monos accharides and disaccharides. Because monosaccharides are now in their simplest form, they do not need to be broken down before your body can use them. They are absorbed directly into your bloodstream, mainly in the small intestine and to a lesser extent in your mouth. On the other hand, disaccharides such as sucrose must be broken down into simple sugars before they can be absorbed. When sugars are in their simplest form, they are metabolized differently.

CONCLUSION

Sucrose is a disaccharide, it must be eliminated before your body can use it. The enzymes in your mouth break down some of the sucrose into glucose and fructose, and the acid in your stomach breaks it down a little more. However, most sugar digestion occurs in the small intestine. The enzyme sucrose, made by the lining of your small intestine, breaks down sucrose into glucose and fructose. They are then absorbed into your bloodstream as described above. The presence of glucose increases the amount of fructose that is absorbed and also causes the release of insulin. This means that more fructose is used to produce fat than when this type of sugar is eaten alone. Therefore, eating fructose and glucose may be more harmful to your health than eating them alone. This may explain why added sugars such as corn syrup with fructose are associated with various health problems.

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