



FOOD PROCESSING

Cocoa Processing: Sugar-free Chocolate

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Introduction

Chocolate is made of fermented cocoa seeds (cocoa solids and cocoa butter) mixed mainly with sugar, and ingredients in lower quantities that are added to enhance flavor and texture, such as milk, lecithin, vanilla, or others (Figure 1). The fat content can change from 30%-40% and the sugar content from 20%-50% in weight, depending on the type of chocolate. Therefore, cocoa-based products are rich in fat and sugar, which can have negative effects on health if the consumption is regular and in high amounts.

The World Health Organization recommends limiting the intake of food and beverages with added free sugars and maintaining sugar consumption to less than 10% of total energy intake¹. A high consumption of free sugars contributes to an increase in the risk of dental cavities, overweight and obesity. In addition, type 2 diabetes is a chronic disease characterized by elevated levels of glucose in the blood, often related to a poor diet, overweight or obesity. It occurs when the body develops insulin resistance resulting in poor metabolism of sugars. Over time it

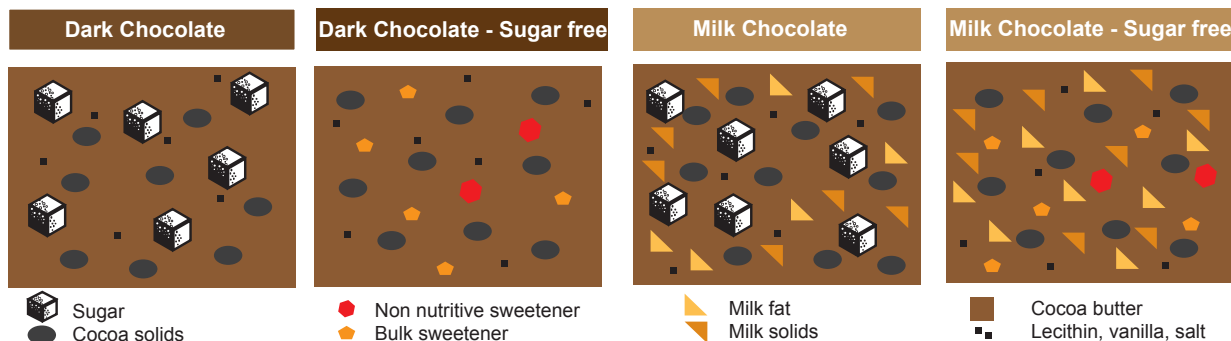


Figure 1. Schematic of food ingredients used in dark and milk chocolate with or without sugar.

can lead to serious damage of human organs, such as heart, blood vessels, eyes, kidneys, and others². People who have been diagnosed with diabetes should limit the consumption of free sugars and some foods that have a high sugar content. To overcome problems related to added sugar consumption, sugar-free products have been developed.

The goal of this document is to explain the options available for replacing sugar in chocolate processing, including high intensity sweeteners and other ingredients that provide texture and flavor.

How to replace sugar in chocolate

Chocolate is mainly a suspension of sugar and cocoa solids, in cocoa butter. Sugar is an important ingredient that not only provides sweetness but also physical properties, such as texture, viscosity, and mouthfeel, to cocoa products. When sugar needs to be replaced, it is important to identify ingredients that will suffice both functions. For example, the amount of sugar added in a 60% dark chocolate formula corresponds to 40% in weight, which means that in a 10 kg of final product, 4 kg of sugar is added. The way that sugar is replaced is by finding a non-nutritive sweetener that provides enough sweetness, and other ingredients or fillers that provide texture, viscosity, and mouthfeel. Figure 1 describes an example of the ingredients used in dark and milk chocolate and their sugar-free alternatives.

What is a non-nutritive sweetener?

Non-nutritive sweeteners are known as sugar replacers. These are ingredients that are sweet to the taste but are not digested and absorbed in the body as sugar is, so they don't provide calories. For example, aspartame is an artificial sweetener made from amino acids (protein derivatives) that scientists found have a high sweet potency, 180-200 times higher than sugar.

Non-nutritive or high intensity sweeteners refer to products used in a small quantity to produce an intense sweetness compared to sugar. Examples of non-nutritive sweeteners used in sugar-free foods with their corresponding sweetness potency are listed in Figure 2.

What is stevia?

Stevia rebaudiana is a plant native to South America. Its leaves have been used to sweeten drinks for many years. Stevia is one of the highest intensity sweeteners used in sugar-free products. Steviol glycosides are the natural stevia components that provide the sweetness, and they are extracted and purified to obtain the non-nutritive stevia sweetener that is commercially sold. These purified glycosides are accepted by several regulatory bodies around the world to be safe for human consumption, including FDA, Codex Alimentarius, EFSA, and others (Table 1, page 3). The consumption of stevia glycosides supports a reduction of blood glucose, sugar, and energy intake³.

What is a bulk sweetener?

Bulk sweeteners or fillers are products added to chocolate with less or no sweetness comparable to sugar. They are nutritive and provide calories but have no major effect in the blood glucose levels. The main bulk sweeteners are polyols (e.g., maltitol, erythritol, sorbitol), low-digestibility carbohydrates (inulin, polydextrose, resistant maltodextrin), or sweet proteins (e.g., milk protein)⁴. The limitation of the use of polyols as food ingredients is that they may have a laxative effect when consumed in high quantities. Maltitol is the main bulk sweetener currently used in sugar-free chocolates. It is obtained from corn starch by adding an alcohol group to maltose. By doing this, maltitol is not broken down and is absorbed as glucose in the blood as sugar does⁵.

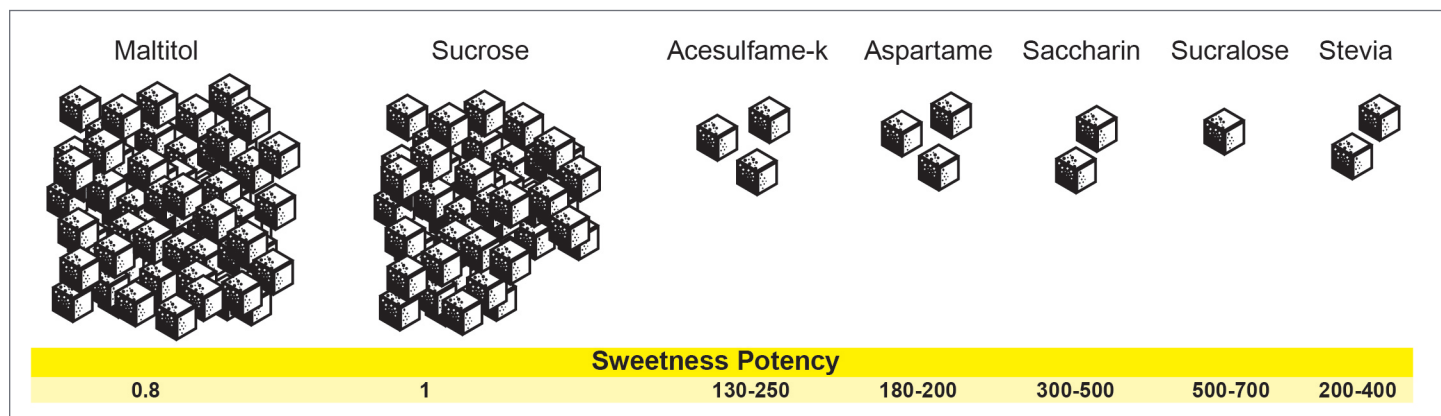


Figure 2. Sweetness potency of bulk and high intensity sweeteners, compared to sugar.

Table 1. Regulations and standards that provide guidelines on the use of food ingredients.

Name	Description	Reference
Codex Alimentarius	Standards for cacao and related products	6
Code of Federal Regulations (CFR)	CFR for cacao products	7
Food and Drug Administration (FDA)	List of substances used in food generally recognized as safe (GRAS)	8
European Food Safety Authority (EFSA)	Use of sweeteners in Europe	9
European Commission (EU)	Rules and specifications for the use of additives	10

How to formulate a sugar-free chocolate

This is an example for a formulation of 1 kg of 60% sugar-free dark chocolate:

- 500 g Cacao nibs (50%)
- 397 g Maltitol (39.7%)
- 99 g Cacao butter (10%)
- 3 g Pure stevia leaf extract (0.3%)
- 1 g Lecithin (0.1%)

This recipe contains 60% cacao; that includes cacao solids and cacao butter. It replaces 40% of sugar with a bulk sweetener (maltitol) and a high intensity sweetener (stevia extract). It is important to know the exact composition of the non-nutritive sweetener, as some sweeteners are mixed with fillers and the sweetness potency can be affected.

Is it safe for human consumption?

Food ingredients are safe for human consumption when they are used in the right doses. Even water can be harmful if consumed in excess. There are regulations that guide food processors on how to use food ingredients and additives, according to the country in which the food products are produced or sold. Table 1 shows a list of entities that provide specific information regarding each of the ingredients used in chocolate making.

Food products can be labeled as “sugar-free” if a serving size, usually 30-50 g for cocoa products, provides less than 0.5 g of sugar. Also, according to European Union legislation, if a chocolate contains more than 10% in weight of polyols (maltose, erythritol), it shall be labeled as “excessive consumption may produce laxative effects”. These are examples of regulations that are related to sugar-free products.



Takeaway key points

- High intensity sweeteners do not raise the level of glucose in the blood.
- Removing sugar from chocolate requires formulating with a high intensity and a bulk sweetener.
- Regulations and standards ensure that food additives are safe for human consumption and are properly labeled.

References

1. World Health Organization. *Guideline: Sugars intake for adults and children*. (World Health Organization, 2015).
2. Diagnosis and classification of diabetes mellitus. *Diabetes Care* **37**, (2014).
3. Samuel, P. *et al.* Stevia Leaf to Stevia Sweetener: Exploring Its Science, Benefits, and Future Potential. *J Nutr* **148**, 1186S-1205S (2018).
4. Selvasekaran, P. & Chidambaram, R. Advances in formulation for the production of low-fat, fat-free, low-sugar, and sugar-free chocolates: An overview of the past decade. *Trends in Food Science and Technology* vol. 113 315–334 Preprint at <https://doi.org/10.1016/j.tifs.2021.05.008> (2021).
5. Saraiva, A., Carrascosa, C., Raheem, D., Ramos, F. & Raposo, A. Maltitol: Analytical determination methods, applications in the food industry, metabolism and health impacts. *International Journal of Environmental Research and Public Health* vol. 17 Preprint at <https://doi.org/10.3390/ijerph17145227> (2020).
6. Codex Alimentarius. Standards Codex Alimentarius FAO-WHO. <https://www.fao.org/fao-who-codexalimentarius/codex-texts/list-standards/en/>.
7. Food and Drug Administration. SCOGS (Select Committee on GRAS Substances). <https://www.cfsanappsexternal.fda.gov/scripts/fdcc/?set=SCOGS>.
8. Code of Federal Regulations. CFR - Title 21. <https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcr/CFRSearch.cfm?CFRPart=163>.
9. European Food Safety Authority. EFSA | Science, safe food, sustainability. <https://www.efsa.europa.eu/en>.
10. European Commission. EU Rules. https://food.ec.europa.eu/safety/food-improvement-agents/additives/eu-rules_en.

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