
STEVIA PLANT - ALTERNATIVE SWEETNER IN FOOD TECHNOLOGY

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Abstract: Food and Agricultural Organization as a “sweeteners” consider products used for sweetening derived from sugar crops, cereals, fruits or milk, or that are produced by insects. Sweeteners, as an additive, have important role for technological functions of food, especially in providing texture, bulk and color, and also as preservative agents. Regardless the numerous sweeteners, alternative sweeteners to sucrose are in main focus for implementation in food industry. Nowadays Food and Agricultural Organization and World Health Organization Food standards, Codex Alimentarius Commission (2018) accepted list of 27 food additives that have the functional class “sweetener”. Nowadays, alternative sweeteners and their application in food technology are in main focus of scientist. Stevia plant stands for one of the most important natural intense sweetener, since stevia glycosides are almost 400 times sweeter than sucrose. Extracts of stevia represents a powerful tool for reducing sugars in food and beverages, which can be acceptable substitutes to full sugar versions of this products. Regarding the data of Euromonitor international, new food products containing stevia grew 10% from 2016 to 2017. The biggest increment in stevia use was noticed in categories of snacks, juice drinks, dairy, carbonated soft drinks and confectionery. Barriocanal et al. (2008) highlighted that safety studies reported no negative side effects of stevia use. Can be expected that in recent future use of *S. rebaudiana* as sweetener would be extended to almost all the world’s countries, regarding all discovered beneficial health effects.

Keywords: alternative sweetener, stevia, food technology, health

1. INTRODUCTION

When you think of sugar, first association is white crystals with sweet taste. Sugars as fructose, sucrose, glucose are found in various amounts in fruit and vegetables, lactose and galactose in milk and maltose, in lower extent, is found in cereals. Also, in food technology, sugars (both natural and artificial) are used for improving products taste.

In order to produce sugar, two major sugar crops are used: sugar beets and sugar cane. In some countries, sugar cane is eaten raw in minor quantities and also is used in the preparation of juices and for animal feed (FAO¹, 2018). Another sugar and syrups source is sap of certain species of maple trees, from sweet sorghum when cultivated explicitly for making syrup and from sugar palm.

FAO list of sugar crops (2018) exclude sugar beets, cultivated solely as a fodder crop and red or garden beets that are classified as vegetable crops. Nowadays, larger quantities of cereals (mainly maize) used to produce sweeteners derived from starch. Important source of sugar is derived product, molasses, also obtained with various degrees of sugar content. This by-product obtained from the extraction of sugar is called bagasse in the case of sugar cane, and beet pulp in the case of sugar beets.

FAO under the name “sweeteners” includes products used for sweetening that are derived from sugar crops, cereals, fruits or milk, or that are produced by insects. Into this category is included a varieties of monosaccharides and disaccharides that can be in a crystallized state as sugar, or in thick liquid form as syrups. Sweeteners, as an additive, also have important role for technological functions of food, especially in providing texture, bulk, and color but also as preservative agents.

Sweeteners can be divided in to three categories: artificial, nutritive and natural intense sweeteners. Artificial or non-nutritive sweeteners are often used as an alternative to sugar and they are energy (kilojoule or calorie) free. U.S. FDA² officially approved use of five artificial sweeteners (saccharin (E954), acesulfame K (E950), aspartame (E951), neotame (E961) and sucralose (E955)). Nutritive sweeteners are based on different types of carbohydrates, for e.g. fructose, isomalt (E953), mannitol (E421), sorbitol (E420), polydextrose (1200), thaumatin (957) and others. In the class of natural intense sweetener well known is stevia, in industry is also called high-intense sweetener.

Regardless the number of sweeteners, alternative sweeteners to sucrose are in main focus for implementation in food industry. Various interested groups are included into this topic, from consumers, nutritionists, doctors to media and many others... Alternative sweeteners provide food and beverage choices to control caloric, carbohydrate, and/or

¹ FAO - Food and Agricultural Organization

² FDA – Food and Drug Administration

sugar intake; assist in weight maintenance or reduction; aid in the management of diabetes; assist in the control of dental caries; enhance the usability of pharmaceuticals and cosmetics; provide sweetness in times of sugar shortage; and assist in the cost-effective use of limited resources (O'Brien-Nabors, 2012).

Important is to say that ideal sweetener does not exist, and scientist all the time are looking for the new with improved characteristics. Therefore, number of the sweeteners increased substantially over the last three decades. Regarding the list of FAO and WHO³ Food standards, Codex Alimentarius Commission (2018) accepted list of 27 food additives that have the functional class “sweetener”.

All sweeteners can be divided into four broad groups: low-calories sweeteners, reduced-calorie sweeteners, caloric alternatives and multiple ingredient approach. Special attention of this article is directed to a low-calories sweeteners and especially at steviol glycosides.

2. STEVIA REBAUDIANA (BERTONI)

Candyleaf plant (*S. rebaudiana* Beratoni) or just Stevia is a shrubby plant that belongs to the family *Asteraceae*. It is autochthonic for South America and well-known for over a century for its sweet taste in Paraguay and Brazil (Image 1). In this countries is known, for more hundreds of years, for its use in food preparation and as a medicine.

Sweet taste of the leaves comes from the group of ten steviol glykosides. Extracts from the leaves of *Stevia rebaudiana* B. since 1970s have been used in Japan as a commercialized sweetener, but nowadays its use is spread to Asian and South America's countries. In the United States and Europe, stevia is a more contemporary addition to the marketplace (Carakostas et al., 2012). Initially, crude extracts of stevia leaves were sold as dietary supplements or traditional herbal preparations (Abdel-Rahman et al., 2011).

Numerous of studies have been discussed about safety of steviol glycosides regarding its toxicological, biological, and clinical effects on living beings. Global regulatory organizations, such as the Joint FAO/WHO Expert Committee on Food Additives (JECFA), recently (2005) give stevia their safety stamp of approval.

Nowadays stevia can be found in foods and beverages worldwide in more than 150 countries all over the world.

In Europe, steviol glycosides are classified as food additives (E 960), and thus their use as a food sweetener (and not a natural product) is regulated under the European Parliament and Council Regulation (EC) No 1333/2008 on food additives, and the only ingredient usable is steviol glycosides purified at 95% (Ciriminna, Meneguzzo, Pecoraino, & Pagliaro, 2018).

Hazard assessment of uses of stevia by regulatory agencies and scientific bodies

All sweeteners are carefully studied and reviewed by numerous scientific and regulatory bodies before they start to be used in food technology. Their safety, regarding the effects on health, are evaluated and confirmed.

Many researches in order to assess the use and safety of steviol glycosides has been done extensively since the 1970s by a number of regulatory agencies and scientific bodies including JECFA, EFSA⁴, the US Food and Drug Administration (USFDA) and Health Canada.

In 2009, WHO and JECFA established full ADI (Allowed Daily Intake) of steviol glycosides, expressed as steviol of $4 \text{ mg kg}^{-1} \text{ body weight day}^{-1}$. The last summary report of WHO (2016) confirmed reported the same ADI, but steviol includes nine leaf-derived steviol glycosides and, as well, any mixture of steviol glycoside compounds derived from *Stevia rebaudiana* Bertoni, provided that the total percentage of steviol glycosides is not less than 95%.

EFSA in 2010, complying with JECFA specifications that steviol glycosides are not carcinogenic, genotoxic or associated with any reproductive/developmental toxicity established the same value of ADI for steviol glycosides, expressed as steviol equivalents.

US FDA is 2016, submitted a Generally Recognized Notice for steviol glycosides from *Saccharomyces cerevisiae* as a safe, for use as a general purpose sweetener in foods, excluding infant formula and products under USFDA's jurisdiction at levels determined by good manufacturing practices, as well as use as a table top sweetener.



Image 1. *Stevia rebaudiana*

³ WHO - World Health Organization

⁴ EFSA – European Food Safety Authority

3. STEVIA APPLICATION IN FOOD

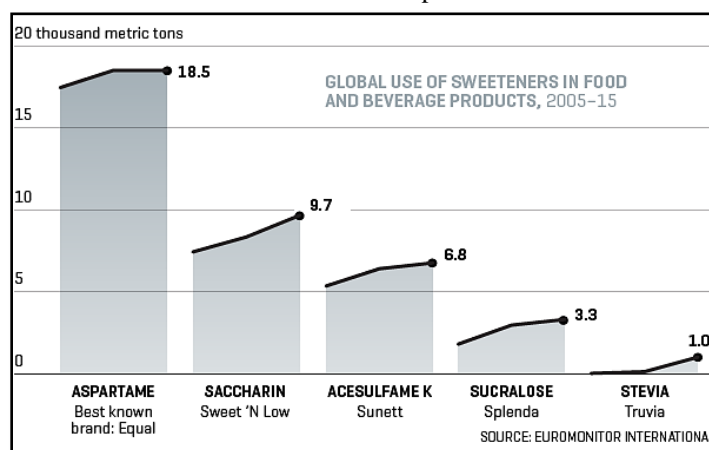
Stevia ingredients can be found in a variety of foods and beverage applications, where they can replace some or all of the sweetness of sugar or other sweeteners without compromising on taste. Many global brands of beverage during the period 2012 and 2017 launches more than 1500 global new product with stevia. Among them ready-to-drink teas, sweetened coffee beverages, carbonated soft drinks, flavored waters, juices and alcoholic beverages.

Stevia can be used in varieties of products. Some of them are yogurt, ice-cream, flavored milk and chocolate and confectionery. Surprisingly the biggest increment of stevia use was found in yogurt industry. For e.g. in 2016, 273 dairy products were launched globally with stevia and of those, 70% were yogurt (Mintel 2017).

Baked goods with stevia over the last couple of years become very popular. It is considered as a great choice to reduce amount of sugar in these goods, since it remains stable throughout the baking process. It also contribute to the goods crispness, cell structure, browning, tenderization and shelf stability.

In chocolate, one of the main ingredients is sugar (30-70%). Some researches of replacement sugar with stevia in chocolate were already done by authors Aidoo, Afoakwa, and Dewettinck, (2015), Belščak-Cvitanović et al. (2015) then Azevedo, Ferreira, Luccas, and Bolini, (2016) etc. Main conclusion is that due to the specific taste of stevia, taste formation of chocolate could be modified. So, its usage should be based on the new taste formulation, regarding the other ingredients.

Regarding the data of Euromonitor international (Graph. 1) in the period 2005-2015 use of stevia in food and beverage products increased while decrement was noticed in aspartame use.



Graph. 1. Global use of sweetener in food and beverage products.

Amount of new food products containing stevia grew from 2016 to 2017 for 10%. The biggest increment was noticed in categories of snacks, juice drinks, dairy, carbonated soft drinks and confectionery.

4. EFFECTS ON HEALTH

Till now, there is no evidence that use of all steviol glycosides present in *S. rebaudiana* can poses any public health and safety risks. It is expected that all steviol glycosides will be hydrolyzed completely to steviol by gut microflora (Food Standards Australia New Zealand, 2017).

The candyplant leaves contain glycosides of the diterpene steviol such as stevioside and rebaudiosides A which are up to 400 times sweeter than sucrose (sugar), releasing almost no calories in the body and not affecting blood sugar levels, thereby helping in calorie reduction. The glycosides, furthermore, do not undergo fermentation in the mouth thus causing no tooth attack and cavity formation (Talevi, 2018; (Ciriminna et al., 2018).

Sugar and fat intake and linked excess of energy (calories) present the most significant contributors to rising obesity and obesity-linked diseases, including type 2 diabetes and heart disease. The WHO (2015) recommends that adults and children should reduce their intake of sugar to less than 10% of total calories, and recommends a further reduction to below 5% for additional health benefits.

Stevioside actively counteracts high blood pressure, type 2 diabetes, arteriosclerosis and some forms of cancer due to its strong ability to scavenge reactive oxygen species, and hydroxyl and superoxide radicals in particular (Stoyanova, Geuns, Hideg, & Van Den Ende, 2011).

United States Centers for Disease Control and Prevention (CDC) reported that children have similar problem like adults with intake of calories, where more than a half of these comes from the beverages. CDC pointed out that boys

consume 16.3% of their daily calories from added sugars, and girls get 15.5% (WHO, 2017). Studies to date have shown replacing sugar-sweetened beverages with beverages sweetened with non-caloric sweeteners results in a reduction in energy intake, and modest weight loss, even if some calorie compensation occurs (US Department of Health and Human Services and US Department of Agriculture., 2015).

Other authors, as Urban, Carakostas, and Taylor (2014) says that extracts of *S. rebaudiana* previously sold as dietary supplements theoretically could have a higher allergenic potential than high purity stevia-based sweeteners. The reason is that crude extracts have a higher likelihood of containing allergenic substances common to the crude extracts of *Asteraceae* family. Since there is no enough data to support these theory, authors suggest that should be kept in mind that as a plant, coming from *Asteraceae* family, could have potential hypersensitivity effect. This is especially important for a people who have allergies from plants of *Asteraceae* family due to the possible cross-reactions to stevia-based sweeteners.

Also, standard genetic toxicity tests of use steviol, evaluated on many occasions in both *in-vitro* and *in-vivo* assays, showed predominantly negative results (Carakostas, Prakash, Kinghorn, Wu, & Soejarto, 2012).

New research data encourage bigger use of stevia, as an alternative sweetener, in diabetes treatment, cardiovascular disease, cancer, renal disease, obesity, inflammatory bowel disease and dental caries.

CONCLUSION

Stevia is a valuable ingredient to reduce sugars in dairy applications. As a sweetener, it has great potential to be widely used in regulation of body weight (diets) as low-caloric sweetener that due to its low cost is available to most consumers. Moreover, scientists have concluded that Stevia sweeteners are safe for people of all ages.

New study data indicate that high-purity stevia extract represents a useful tool in helping to reduce calories and sugar intake. Regarding the weight management challenges, stevia alone cannot solve it, but definitely is one tool in the toolbox of better health.

Should be expected that higher awareness of necessity for healthier lifestyle and changing daily habits will lead to launches of new products with stevia on the global market. Moreover, it is expected that use of *S. rebaudiana* as sweetener should be extended to almost all the world's countries regarding all discovered aforementioned beneficial health effects.

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