

Cancer Association of South Africa (CANSA)



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Fact Sheet on the Sugar Substitute Stevia

Introduction

Stevia is a sweetener and sugar substitute that is becoming very popular following the planned introduction of a tax on sugary drinks in many countries of the world because of the contribution of sugar to obesity.

[Picture Credit: Stevia]

The plant *Stevia rebaudiana* has been used for more than 1 500 years by the Guaraní peoples of South America, who called it ka'a he'ê ('sweet herb'). The leaves have been used traditionally for hundreds of years in both Brazil and Paraguay to sweeten local teas and medicines, and as a 'sweet treat'.



The legal status of stevia extracts as food additives and supplements varies from country to country. In the United States of America, stevia was banned in 1991 after early studies found that it might be carcinogenic (cancer causing). Following on additional studies, the United States Food and Drug Administration (FDA) approved some specific glycoside extracts of Stevia for use as food additives in 2008.

The European Union approved Stevia additives in 2011, and in Japan, Stevia has been widely used as a sweetener for many years.

[Picture Credit: Stevia Blossoms]



Stevia is a tender perennial plant grown as a vegetatively propagated annual. Parent plants brought indoors through winter provide rootable stems in spring. The seeds of Stevia are said to be very reluctant to sprout. Plants are usually grown from rooted cuttings taken from greenhouse-grown plants.

South Africa is said to be planning extensive cultivation of Stevia as from 2017 in frost-free areas especially in KwaZulu-Natal to supply the food and beverages industry with sufficient quantities of this sugar substitute.

According to **Mooradian** (2019) "... consumption of table sugar has been increasing despite the warnings of public health officials as to the potential adverse consequences of sugar consumption. The World Health Organization recommends restricting consumption of sugars to no more than 10% of daily caloric intake, with a proposal to lower this level to 5% or less for optimal health. Unfortunately substituting sugar with the currently available artificial sweeteners does not appear to have favorable clinical effects. Given the health-related concerns with the currently available sweeteners such as increased risk of obesity and type 2 diabetes there is renewed interest in identifying a safe and palatable sweetener. The sweet extracts of natural plants such as stevia and monk fruit as well as naturally occurring rare sugars have become attractive alternatives."

Samuel, P., Ayoob, K.T., Magnuson, B.A., Wölwer-Rieck, U., Jeppesen, P.B., Rogers, P.J., Rowland, I. & Mathews, R. 2018.

"Steviol glycoside sweeteners are extracted and purified from the *Stevia rebaudiana* Bertoni plant, a member of the Asteraceae (Compositae) family that is native to South America, where it has been used for its sweet properties for hundreds of years. With continued increasing rates of obesity, diabetes, and other related comorbidities, in conjunction with global public policies calling for reductions in sugar intake as a means to help curb these issues, low- and no-calorie sweeteners (LNCSs, also known as high-potency sweeteners) such as stevia are gaining interest among consumers and food manufacturers. This appeal is related to stevia being plant-based, zero calorie and with a sweet taste that is 50-350 times sweeter than sugar, making it an excellent choice for use in sugar- and calorie-reduced food and beverage products. Despite the fact that the safety of stevia has been affirmed by several food regulatory and safety authorities around the world, insufficient education about stevia's safety and benefits, including continuing concern with regard to the safety of LNCSs in general, deters health professionals and consumers from recommending or using stevia. Therefore, the aim of this review and the stevia symposium that preceded this review at the ASN's annual conference in 2017 was to examine, in a comprehensive manner, the state of the science for stevia, its safety and potential health benefits, and future research and application. Topics covered included metabolism, safety and acceptable intake, dietary exposure, impact on blood glucose and insulin concentrations, energy intake and weight management, blood pressure, dental caries, naturalness and processing, taste and sensory properties, regulatory status, consumer insights, and market trends. Data for stevia are limited in the case of energy intake and weight management as well as for the gut microbiome; therefore, the broader literature on LNCSs was reviewed at the symposium and therefore is also included in this review."

Stevia

Stevia rebaudiana Bertoni is a sweet and nutrient-rich plant belonging to the Asteraceae family. Asteraceae or Compositae (Sunflower family) is an exceedingly large and widespread family of flowering plants. The family currently has 32 913 accepted species names, in 1 911 genera and 13 subfamilies.

Stevia leaves contain steviol glycosides including stevioside, rebaudioside (A to F), steviolbioside, and isosteviol, which are responsible for the plant's sweet taste, and have commercial value all over the world as a sugar substitute in foods, beverages and medicines.

Among the various steviol glycosides, stevioside, rebaudioside A and rebaudioside C are the major metabolites and these compounds are on average 250 to 300 times sweeter than sucrose. Steviol is the final product of *Stevia* metabolism. The metabolised components essentially leave the body and

there is no accumulation. Beyond their value as sweeteners, Stevia and its glycosides possess therapeutic effects against several diseases such as cancer, diabetes mellitus, hypertension, inflammation, cystic fibrosis, obesity and tooth decay. Studies have shown that steviol glycosides found in Stevia are not teratogenic (an agent that can disturb the development of the embryo or foetus), mutagenic (a physical or chemical agent that changes the genetic material, usually DNA, of an organism and thus increases the frequency of mutations above the natural background level) or carcinogenic (cancer causing) and cause no acute and subacute toxicity. (Momtazi-Borojeni, *et al.*, 2016).

Ruiz-Ruiz, J.C., Moguel-Ordoñez, Y.B. & Segura-Campos, M.R. 2017.

The leaves of Stevia rebaudiana Bertoni has nutrients and phytochemicals, which make it an adequate source for the extraction and production of functional food ingredients. Preclinical and clinical studies suggest therapeutic and pharmacological applications for stevia and their extracts because they are not toxic and exhibit several biological activities.

Momtazi-Borojeni, A.A., Esmali, S-A., Abdollahi, E. & Sahebkar, A. 2017.

Stevia rebaudiana Bertoni is a sweet and nutrient-rich plant belonging to the Asteraceae family. Stevia leaves contain steviol glycosides including stevioside, rebaudioside (A to F), steviolbioside, and isosteviol, which are responsible for the plant's sweet taste, and have commercial value all over the world as a sugar substitute in foods, beverages and medicines. Among the various steviol glycosides, stevioside, rebaudioside A and rebaudioside C are the major metabolites and these compounds are on average 250-300 times sweeter than sucrose. Steviol is the final product of Stevia metabolism. The metabolized components essentially leave the body and there is no accumulation. Beyond their value as sweeteners, Stevia and its glycosides possess therapeutic effects against several diseases such as cancer, diabetes mellitus, hypertension, inflammation, cystic fibrosis, obesity and tooth decay. Studies have shown that steviol glycosides found in Stevia are not teratogenic, mutagenic or carcinogenic and cause no acute and subacute toxicity. The present review provides a summary on the biological and pharmacological properties of steviol glycosides that might be relevant for the treatment of human diseases.

Stevia Approved for Use in South Africa

Stevia, the natural alternative to sugar, has been approved for use in South Africa with the promulgation (10 September 2012) of new sweetener regulations (Regulations Relating to the Use of Sweeteners in Foodstuffs).

Regulation R733, Regulations Relating to the Use of Sweeteners in Foodstuffs, allows the use of extracts of *Stevia rebaudiana*, in composition and quantities in line with Codex standards, in food and beverages. Steviol glycosides can be used to a maximum level of 330mg/kg.

Stevia was declared GRAS (generally recognised as safe) in the United States in December 2008 by the United States Food and Drug Administration (FDA), it is believed to have close to 10% of the United States of America sugars and sweeteners market.

Kilojoule-free Stevia and Obesity



It looks like sugar, acts like sugar and tastes a lot like sugar. But stevia is a sweetener with no kilojoules, which is having a major impact on the food industry and some say could help to fight obesity and diabetes.

[Picture Credit: Processed Stevia]

Unlike other sugar substitutes, Stevia is an entirely natural product. Native to South America, it can be traced back thousands of years, to when the people of Paraguay and Brazil used it to sweeten foods.

Sold commercially in Japan for more than 40 years, it is only in recent years that it has been more widely available. But, it is rapidly catching on, with an increase of 400 percent sales in the United States of America between 2008 and 2015. Consumers are said to be drawn to its sugar-like qualities, with zero guilt.

Food scientists continue to explore ways to use stevia-based sweeteners. Proposed uses for high-purity stevia leaf extracts include soft drinks, canned fruit and jams, ice cream and other dairy products, cakes and desserts, and alcoholic beverages. Stevia is a natural-origin sweetener that is increasing the options for reduced sugar and reduced energy foods and beverages. Stevia shows promise as a tool to help lower energy intakes, which may lead to the reduction and prevention of obesity.

The backbone of all steviol glycosides is steviol, to which various glycoside (glucose) groups attach to form the variety of sweet compounds in stevia. Steviol glycosides pass through the upper gastrointestinal tract fully intact. Gut bacteria in the colon hydrolyse steviol glycosides into steviol by snipping off their glucose units. Steviol is then absorbed via the portal vein and primarily metabolised by the liver, forming steviol glucuronide, which is primarily excreted in the urine.

Research shows that there is no accumulation of stevia (or any component or by-product of stevia) in the body and that it passes through the body during metabolism. Energy from fermentation of glucose units (usually assessed as 2 kcal/g) is so low that it is minimal, and so, effectively, stevia can be said to provide zero kilojoules.

High-purity stevia leaf extract is not metabolised, so it provides zero kilojoules. (Ashwell, 2015; IOL).

Stevia and Breast Cancer

Stevioside is a diterpene glycoside found in the leaf of *Stevia rebaudiana*, a traditional oriental medicinal herb, which has been shown to have various biological and ethno-medicinal activities including antitumour activity. In a study, the researchers investigated the effects of stevioside on the cytotoxicity (cell toxicity), induction of apoptosis (cell death), and the putative (denoting a supposition or inference based on what was commonly believed, reputed, or deemed rather than on a direct evidence) pathways of its action in human breast cancer cells (MCF-7).

For the analysis of apoptotic pathway, measurement of reactive oxygen species (ROS) and assessment of mitochondrial transmembrane potential (MTP) were achieved. The research showed that stevioside

was a potent inducer of apoptosis and it conveyed the apoptotic signal via intracellular ROS generation; thereby inducing change in MTP and induction of mitochondrial mediated apoptotic pathway. Taken together, the data indicated that stevioside induced the ROS-mediated mitochondrial permeability transition and resulted in the increased expression of apoptotic proteins such as Bax, Bcl-2 and Caspase-9. Effect of stevioside on stress-related transcription factors like NF-E2-related factor-2 opens up a new vista for further studies. This is a first report on the mechanism of the antibreast cancer (in vitro) activity of stevioside. (Paul, *et al.*, 2012).

Stevia and Cancer

“Seventeen steviol derivatives, i.e., 2-18, and 19 isosteviol derivatives, i.e., 19-37, were prepared from a diterpenoid glycoside, stevioside (1). Upon evaluation of the cytotoxic activities of these compounds against leukaemia (HL60), lung (A549), stomach (AZ521), and breast (SK-BR-3) cancer cell lines, nine steviol derivatives, i.e., 5-9 and 11-14, and five isosteviol derivatives, i.e., 28-32, exhibited activities with single-digit micromolar IC(50) values against one or more cell lines. All of these active compounds possess C(19)-O-acyl group, and among which, ent-kaur-16-ene-13,19-diol 19-O-4',4',4'-trifluorocrotonate (14) exhibited potent cytotoxicities against four cell lines with IC(50) values in the range of 1.2-4.1 μ M. Compound 14 induced typical apoptotic cell death in HL60 (leukaemia) cells upon evaluation of the apoptosis-inducing activity by flow-cytometric analysis. These results suggested that acylation of the 19-OH group of kaurane- and beyerane-type diterpenoids might be useful for enhancement of their cytotoxicities with apoptosis-inducing activity.” (Ukiya, *et al.*, 2013).

Stevia and Diabetes Mellitus

The prevalence of diabetes is rapidly rising all over the globe at an alarming rate. India shelters the highest number of diabetics and is thus known as the 'Diabetes Capital of the World'. The chemical management of diabetes has side effects and hence this study was undertaken to assess the hypoglycaemic and hypolipidaemic effect of *Stevia rebaudiana* in patients with type 2 diabetes, non-insulin dependent diabetes mellitus (NIDDM), its nutritional composition and use as a sweetener substitute.

Chemical analysis of dried *Stevia* leaf powder revealed it to be a nutritious herb with a good iron and fibre content. Intervention trials in diabetics revealed that it significantly lowered fasting and post-prandial blood glucose levels. The serum triglycerides and VLDL-C levels were also significantly reduced.

Hence it can be said that *Stevia* can safely be used as an anti-diabetic herb, as a sweetener substitute and may help to prevent cardiovascular diseases in patients with long-standing diabetes. (Ritu & Nandini, 2016).

Therapeutic Effects of Stevia

Stevioside, an abundant component of *Stevia rebaudiana* leaf, has become well-known for its intense sweetness (250 to 300 times sweeter than sucrose) and is used as a non-kilojoule sweetener in several

countries. A number of studies have suggested that, beside sweetness, stevioside along with related compounds, which include rebaudioside A (second most abundant component of *S. rebaudiana* leaf), steviol and isosteviol (metabolic components of stevioside) may also offer therapeutic benefits, as they have anti-hyperglycaemic (anti high blood sugar), anti-hypertensive, anti-inflammatory, anti-tumour, anti-diarrhoeal, diuretic, and immunomodulatory actions.

Other Health Benefits of Stevia

Additional health benefits of Stevia include:

- Herb parts of Stevia are very low in kilojoules. Part by part, its dry leaves possess roughly 40 times more sweetness than sugar. This sweetness quality in stevia is due to several glycoside compounds including stevioside, steviolbioside, rebaudiosides A-E, and dulcoside.
- *Stevioside* is a non-carbohydrate glycoside compound. Hence, it lacks the properties that sucrose and other carbohydrates possess. Stevia extracts, like rebaudioside-A, are found to be 250 to 300 times sweeter than sugar. Besides, being a near-zero kilojoule food ingredient, Stevia extracts have several unique properties such as long shelf life, high temperature tolerance, non-fermentative.
- Further, Stevia plants have many sterols and antioxidant compounds like *triterpenes*, *flavonoids*, and *tannins*. Some of flavonoid polyphenolic anti-oxidant phyto-chemicals present in Stevia are *kaempferol*, *quercetin*, *chlorogenic acid*, *caffeic acid*, *isoquercitrin*, and *isosteviol*. Studies found that kaempferol can reduce risk of pancreatic cancer by 23%
- Chlorogenic acid reduces enzymatic conversion of glycogen to glucose in addition to decreasing absorption of glucose in the gut. Thus, it helps reduce blood sugar levels. Laboratory studies also confirm a reduction in blood glucose levels and an increase in the liver concentrations of glucose-6-phosphate, and of glycogen.
- Certain glycosides in Stevia extract have been found to dilate blood vessels, increase sodium excretion, and urine output. In effect, Stevia, at slightly higher doses than as sweetener, can help lower blood pressure.
- Being a non-carbohydrate sweetener, Stevia would not favour the growth of *Streptococcus mutans* bacteria in the mouth which is attributed to be a causative agent of dental caries and tooth cavities. On the other hand, certain compounds in Stevia have been found to inhibit caries causing bacteria in the mouth.
- In addition, being a herb, Stevia contain many vitals minerals and vitamins that are selectively absent in the artificial sweeteners.

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This Fact Sheet is intended to provide general information only and, as such, should not be considered as a substitute for advice, medically or otherwise, covering any specific situation. Users should seek appropriate advice before taking or refraining from taking any action in reliance on any information contained in this Fact Sheet. So far as permissible by law, the Cancer Association of South Africa (CANSAs) does not accept any liability to any person (or his/her dependants/estate/heirs) relating to the use of any information contained in this Fact Sheet.

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Stevia

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