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A review of biochemical and nutritional properties of *Stevia rebaudiana* Bertoni (Natural Sweetener)

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Abstract

Stevia as a bio-sweetener having no calories, and proved as not toxic for Human health, it is used in large quantity in industries and daily consumptions. About 300 times sweeter than sucrose. *Stevia* extracts, beside medicinal properties, contain a high level of sweetening compounds, known as steviol glycosides. This review is an effort to explore the possibilities of using *stevia* in commercial products, as well as to know the nutritional and biochemical contents present in *stevia* leaves, and use of *stevia* leaves as a basic constituent for many products for consumption.

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Introduction

Stevia, a natural sweetener plant having commercial and medicinal importance is consumed all over the world. Stevia with the botanical name *Stevia rebaudiana* Bertoni it is further define as a perennial shrub belongs to the Asteraceae Compositae family. Stevia plant is the native species to Paraguay and Brazil and it is often known as "the sweet herb of Paraguay". Whereas it has some other names which are "honey yerba" and "honey leaf" and by some other variations of these names. The fully developed plant grows to the height of 26 inches (65-centimetres) to the maximum height of 72 inches (180 cm) when grow under natural conditions in a fertile soil. The stevia require sandy soil and it require warm sunny conditions as well as the suitable natural environment of semi humid and subtropical temperature starting from 21 to 43°C and average 24°C (*Huxley, 1992*). From a health point of view, increase intake of products which are enriched with sucrose (sugar) increase the chances of development of chronic disease in human body. Diabetes and Obesity are ones of the major diseases of modern mankind *(Burke et al.*, 2003) Most of the artificial or synthetic sweetener have a high percentage of sweetness are produced by chemical synthesis in the laboratory without using any natural product. Modern researches suggested that most of the synthetic sweeteners are harmful and dangerous for human health *(Kim, Seo, and Cho, 2011)*. Stevioside is natural sweetener isolated from the leaves of plant Stevia rebaudiana Bertoni and it is up to 300 times sweeter than sucrose *(Ahmad and Ahmad, 2018)*. Dry leaves of stevia are sweeter approximately 10 to 15 times than sucrose *(Salvador-Reyes, Sotelo-Herrera, and Paucar-Menacho 2014)*. The worldwide demand of natural sweetener for zero calorie is increasing because of consumer awareness regarding the side effects of synthetic sweeteners on human body *(Kim et al., 2011)*. Not only the Stevia plant as a whole plant but also its extracts have been used for several years as a sweetener in Asia, South America, china, Japan, and in different other countries of the European Union. In Korea, Japan and Brazil Stevia leaves, stevioside and highly refined extracts are officially used as a sweetener alternate to synthetic sweetener *(Ahmad and Ahmad 2018)* Stevia rebaudiana is commercially cultivated in China, Japan, Brazil, Canada, USA, UK, Spain, Belgium, Australia, South Korea, Thailand, Israel and Taiwan *(Jain, Kachhwaha, and Kothari, 2009)* The product of stevia plant mostly use is its leaf and it is the most sweet part of the plant. Usually, in the commercial market they are present in the form of a green powder obtained by grinding of dried green leaves (Salvador-Reyes *et al.*, 2014).Besides the high percentage of stevioside content, stevia plant have good characteristics as a source of a good dietary fibre, protein, essential amino acids and minerals *(Abou-Arab et al., 2010)*. Stevia as a commercial product has been accepted by many countries which includes UK, China, Brazil, Malaysia *(Savita et al., 2004)*. The International Stevia Council on 14th of November in Brussels, Belgium has announced the final approval of the European.

Commission's Regulation to authorize the use of steviol glycosides as a noncaloric sweetener as a commercial product as a bio sweetener in the European market. In the year 2014 the European market for stevia was estimated at 100-150 tonnes and for the year 2014, stevia's global market was valued at USD 336 million, while industry specialists expect it to climb to USD 578 million by 2017.

Biochemical and nutritional aspects of stevia

The *stevia* is not only limited to its sweetness as well as the chemical & nutritional composition which is characterized by minerals, phytochemicals and amino acids and compound for great interest like phenols com(Chu, Chang, and Hsu, 2000) that contributes fully in the antioxidant activity in the stevia plant (Chatsudthipong and Muanprasat 2009). Unlike most of the sweetener used in food process stevia is best among them as it process nutritional values (Anton *et al.*, 2010). According to the studied literature citations by different authors, it is to be concluded that the stevia in drie3d leaves form are having following characteristics proteins (10-20 gram/100 grams dry matter) and dietary fibers (15 to 18.5

gram/100 grams dry matter), carbohydrates (35-62 grams/100 grams dry matter), which are important part in maintaining human health (Ibrahim, Abou-Arab, and Abu Salem 2010)It contain high ash content (6-13 gram/100 grams dry matter) this indicates that stevia have rich contents of minerals (potassium/ calcium/sodium/magnesium/ iron,). According to(Ibrahim *et al.* 2010) after extraction of stevioside, dried stevia leaves can be used as a valuable source of essential amino acids. Diterpene.

Carbohydrate

The stevia leaves are beneficial because there nutritional composition is made up of carbohydrates, crude fibre and proteins which promotes wellness and reduces the risk of certain diseases. In *S. rebaudiana* roots and leaves, inulin-type fructose oligosaccharides, a naturally occurring plant polysaccharide with important functional properties related to prebiotics, dietary fibre role lipid metabolism and diabetes control, have been isolated by (de Oliveira *et al.*, 2011).They obtained from the roots and leaves of the plant a yield of purified fructooligosaccharides of 4.6% and 0.46%, respectively. This indicates a possible application of extracts as a dietary supplement *(de Oliveira et al.,2011).*

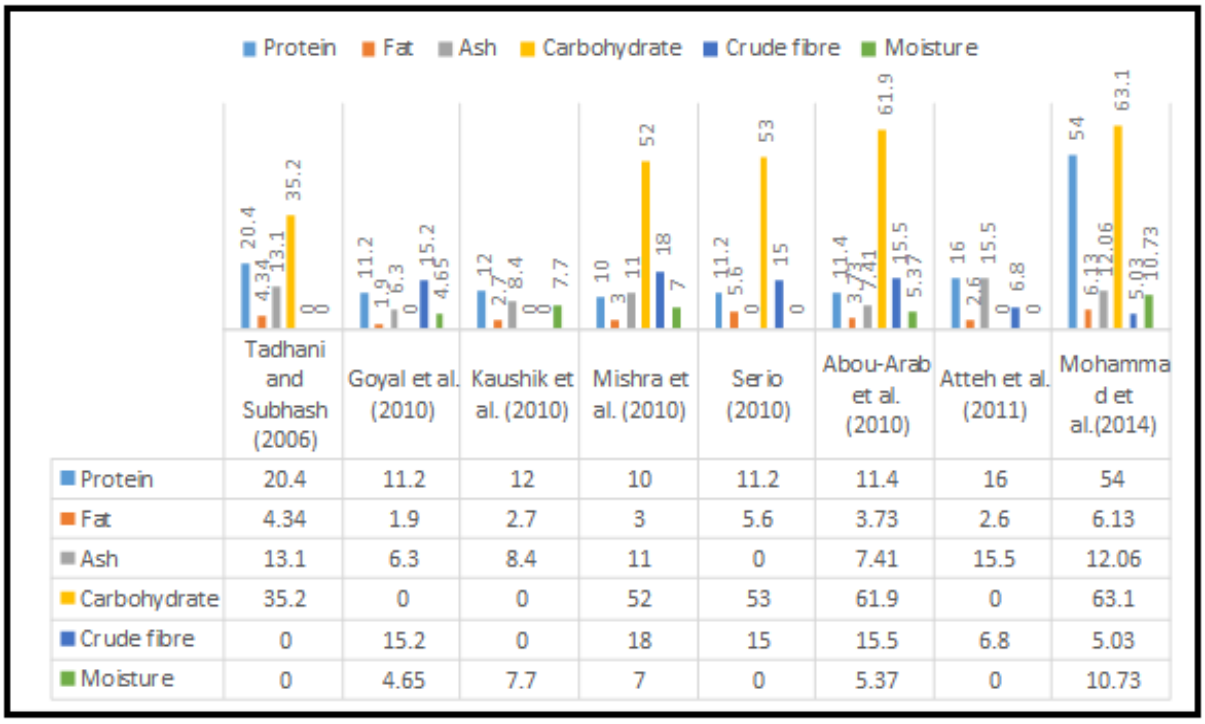
Protein

To know the quality of protein content of a food it is necessary to run total protein content as well the total amino acids present in that food (Siddique *et al.*, 2014) identified 9 amino acids in Stevia leaves, which are known, isoleucine, aspartic acid, glutamic acid alanine, as lysine, serine , proline, tyrosine and methionine *(Abou-arab, Abou-arab, and Abu-salem, 2010).*

Diterpene glycosides of *stevia*: Natural sweetener isolated from the Stevia rebaudiana leaves are steviol glycosides, and according to chemical composition are diterpenes, isolated and identified as stevioside, steviolbioside, rebaudioside A, B, C, D, E, F and dulcoside (Geuns, 2003). Diterpene glycosides were found in the highest percentage in the leaf of plant and make up 15% of the leaf chemical content which primarily depends on the cultivar (Cacciola *et al.*, 2011). In the stevia leaves, stevioside is the most common (4-13% w/w), and followed by rebaudioside (2-4% w/w), rebaudioside C (1-2% w/w) and dulcoside (0.4-0.7% w/w) (Makapugay, Nanayakkara, and Kinghorn,1984; Gardana, Scaglianti, and Simonetti, 2010; Jackson *et al.*, 2009; Cacciola *et al.*, 2011). *Stevia* is a good source of phytochemicals, such as: austroinulin, β-carotene, dulcoside, nilacin, rebaudi oxide, riboflavin, steviol, stevioside and thiamine*(Šic Žlabur et al., 2013).* The content and distribution of sweet glycosides, primarily stevioside and rebaudioside, considerably varies depending on the part of the plant (root, stem or leaf). Chloroplasts are important precursors for the synthesis of stevioside and steviol glycosides. Plant tissues without chlorophyll (roots and lower part of stems) do not contain or contain only minor amounts of these glycosides. After flowering of plant, the level of glycoside starts to decrease (Pól, Hohnová, and Hyötyläinen 2007). In general, stevioside gives the impression of slightly bitter taste, while rebaudioside A contributes to the typical sweet taste (similar to sucrose) (Singh and Rao, 2005).

Differences in taste are caused by more polar groups in rebaudioside A that enable the rebaudioside A better solubility and ultimately more similarity to taste of sucrose, unlike the molecule of stevioside. (Carakostas *et al.*, 2008) There are three molecules of glucose and one molecule of steviolaglycone (diterpene carboxyl alcohol) in the stevioside chemical composition (Brandle and Telmer, 2007) Diterpene content in stevia leaves depends on growing conditions (Pól *et al.*, 2007) and the application of agricultural techniques *(Genus, 2003).* The flavors of the most abundant glycosides, stevioside and rebaudioside A, vary considerably *(Kaushik et al., 2010)* primarily intended for people with diabetes *(Puri, Sharma, and Tiwari 2011)* Thus, during the thermal treatment (2 hours at 60°C) and pH in range 1 to 10, stevioside molecule indicates only a slight degradation, while signifi can't loss (5%) was measured at a temperature of 80°C and pH values

from 2 to 10(Abou-arab *et al.*, 2010) Stevioside and rebaudioside A are thermally stable at higher temperatures, and have wide application in the food and in the baking industry *(Šic Žlabur et al., 2013) (Abou-arab et al., 2010)*quoted termostability of stevioside even at temperature of 200°C, which allows a wide range of stevia commercial use Stevioside is even 300 times sweeter than sucrose with no caloric value and for that reason the stevia products are widely used as a sweetening agent Both, stevioside and rebaudioside A are very stable molecules in aqueous solution in the wide range of pH and temperatures (Ibrahim *et al.*, 2010).



	Tadhani and Subhash (2006)	Goyal et al. (2010)	Kaushik et al. (2010)	Mishra et al. (2010)	Serio (2010)	Abou-Arab et al. (2010)	Atteh et al. (2011)	Mohammad et al.(2014)
Protein	20.4	11.2	12	10	11.2	11.4	16	54
Fat	4.34	1.9	2.7	3	5.6	3.73	2.6	6.13
Ash	13.1	6.3	8.4	11	0	7.41	15.5	12.06
Carbohydrate	35.2	0	0	52	53	61.9	0	63.1
Crude fibre	0	15.2	0	18	15	15.5	6.8	5.03
Moisture	0	4.65	7.7	7	0	5.37	0	10.73

Table 1. Proximate analysis of dried Stevia rebaudiana leaves (g 100 g^{-1} dry weight basis).

Therapeutic values of *S. rebaudiana*: A Number of studies have been reported Leaves of *S. rebaudiana* has been recommended as a treatment against various Non-chronic and chronic diseases like, cancer, diabetes, cardiovascular disease, inflammatory bowel disease renal disease, obesity and dental caries. The effect of *Stevia* extract on 20 selected hypercholesterolemia women using oral dosage was studied and it was reported that 20 ml extract in dissolved in 200 ml glass of water can help in reducing the bad cholesterol LDL(Low density lipoprotein) (Sharma, Mogra, and Upadhyay, 2009), The effect of low level stevioside for causing toxicity was studied using TNEL Signal assay and DNA electrophoresis on the basis of data obtained the stevioside was found responsible in enhanced apoptosis which was iduced by serum deprivation and it was caused by increased expression of Cyotchrome c and Bax released in cytosol which suggested that stevioside affect the normal apoptotic condition (Takahashi *et al.*, 2012) Stevia can be use an alternate to sugar as it provide very few calories per gram then the ordinary sugar which is dissolved completely by the digestive system, consumption of stevia can reduce the carving of sweetener and fatty foods and very useful in weight loss.

Conclusion

The sweet herb *S. rebaudiana* (Bertoni) has a very valuable future because of its various characteristics and use throughout the world, where has various studies have reported the *stevia* promoting health issues both nutritionally and medicinally, researchers needs to work more on clinical trials of stevia to demonstrate the benefits and explore full potentials of the stevia.

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