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Stevia Rebaudiana Bertoni: Description and Chemical Composition

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Abstract – **Stevia rebaudiana Bertoni, an ancient perennial shrub of South America, produces diterpene glycosides that are low calorie sweeteners, about 300 times sweeter than saccharose. Stevia extracts, besides having therapeutic properties, contain a high level of sweetening compounds, known as steviol glycosides. (Stevioside and rebaudioside A) are the main sweetening compounds of interest beside rebaudioside B, C, D, Dulcoside and Steviolbioside. Stevia rebaudiana molasses (industrial waste of stevia) has a good potential to extract some steviol glycoside which can be taken as a source of carbohydrates with zero calories. This dissertation provides a general study on the chemical composition and functional properties of stevia molasses, different extraction methods were also applied to determine stevioside yield.**

Keywords – **Stevia Rebaudiana, Fatty Acids, Heavy Metals, Vitamins, Healthy Benefits.**

I. Introduction

Stevia rebaudiana Bertoni is a branched bushy shrub of the Asteraceae family, native to the Amambay region in the north east of Paraguay. It also occurs in the neighboring parts of Brazil and Argentina [1]. Presently its cultivation has spread to other regions of the world, including Canada and some parts of Asia and Europe [2-3]. S. rebaudiana Bertoni was botanically classified in 1899 by Moises Santiago Bertoni, who described it in more detail. Initially called Eupatorium rebaudianum, its name changed to S. rebaudiana (Bertoni) Bertoni in 1905. Currently, Stevia is well-known for its high content of sweet diterpene (about 4–20%) in dry-leaf matter [4], and the stevia glycosides are the compounds responsible for the sweet taste. Among the 230 species in the genus Stevia, only the species rebaudiana and phlebophylla produce steviol glycosides [5]. The sweet principle was first isolated in 1909 and only in 1931 was the extract purified to produce stevioside, the chemical structure of which was established in 1952 as a diterpene glycoside. Stevioside is described as a glycoside comprising three glucose molecules attached to an aglycone, the steviol moiety. During the 1970s, other compounds were isolated, including rebaudioside A, with a sweetening potency even higher than stevioside [6]. Steviol is the common aglycone backbone of the sweet stevia glycosides that have been analyzed by liquid chromatography coupled with UV, MS and ELS detection [7], one important class of low caloric sugar substitutes is known as a high-intensity sweetener, which is at least 50–100 times sweeter than sucrose. Nowadays, the most common high-intensity sweeteners in the world market are made of synthetic compounds. A frequent metallic aftertaste of such synthetic sweeteners does not provide the realistic taste of sugar. In addition, high concentrations of some types of synthetic sweeteners, such as saccharin, have been reported as being hazardous to health [8-9]. Although Stevia continues to be a rare plant in its native habitat, agricultural production in South America and Asia, and ornamental use in Europe and North America have made its occurrence in the world perhaps more common than it ever was in the past. S. rebaudiana Bertoni has attracted economic and scientific interests due to the sweetness and the supposed therapeutic properties of its leaf [5]. Glycosides responsible for the plants sweeteners and its extracts are used today as a food additive by the Japanese and Brazilians and as a non-caloric sweetener. In the U.S., however, its use is limited to supplement status only. It is commonly known as Stevia, Sweet leaf, Sweet herb of Paraguay [10]. Another study explained that the suitable natural climate is semi humid subtropical with temperature extremes from 21 to 43°C and average 24°C [11]. It is widely used in many parts of the world as sweetener and grown commercially in Central America, Korea, Paraguay, two French chemists in 1931 isolated the glycosides which is secondary metabolites responsible for the sweet taste of Stevia [12]. The chemical structure was established in 1952 as a diterpene glycoside.

II. Botanical Description

Stevia is a genus of about 200 species of herbs and shrubs in the sunflower family (Asteraceae). It grows up to 1 m tall. The plant is a perennial herb with an extensive root system and brittle stems producing small, elliptic leaves [24]. The leaves are sessile, 3–4 cm long, elongate lanceolate or spatulate shaped with blunt-tipped lamina, serrate margin from the middle to the tip and entire below. The upper surface of the leaf is slightly granular pubescent. The stem is woody and weak-pubescent at the bottom. The rhizome has slightly branching roots. The flowers are pentamerous, small and white with a pale purple throat. They are composite surrounded by an involucre of epicalyx. The capitula are in loose, irregular, sympodial cymes. The tiny white florets are borne in small corymbs of 2–6 florets, arranged in loose panicles. The fruit is a five-ribbed spindle shaped achene [25]. Stevia will grow well on a wide range of soils given a consistent supply of moisture and adequate drainage; plants under cultivation can reach up to 1 m or more in height [24].

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III. Acceptable Daily Intake (ADI)

Globally, scientists have concluded that Stevia sweeteners are safe for people of all ages. Stevia leaf or extracted forms like stevioside, rebaudioside A and steviol glycosides was approved by US FDA as a dietary supplement considered (Generally recognized as safe) rating in the US (GRAS Notification 287 for Steviol Glycosides with Rebaudioside A and Stevioside as Principal Components) as appears to have an adequate daily intake (ADI) of 25 mg/kg [31], (following 100-fold safety factor, commonly seen in ADI values) in rats which is around 7.9 mg/kg in humans. Another study also calculated the acceptable daily intake (ADI) of stevioside which is 7.9 mg/kg body weight. However, this ADI should be considered as a minimum value as the authors did not test concentrations of stevioside higher than 793 mg/kg body weight. The routine daily human consumption of 5 to 6 mg of Stevia leaf extract as a dietary sweetener per kg of body weight is safe [32]

IV. Composition of Stevia Rebaudiana Bertoni

A number of natural products have been isolated from S. rebaudiana Bertoni, more than 100 compounds have been identified from this species, the best known are steviol (ent - 13 - hydroxykaur - 16-en-19-oic acid and its glycosides) and its glycosides stevioside, rebaudioside AF, steviolbio- -side, dihydroisosteviol, rubusoside and dulcoside A. [25] analysed the leaves of S. rebaudiana on dry weight basis and calculated the energy value of 2.7 kcal g-1. Structurally, stevioside (13 - [2-O-ß Dglucopyranosyl-X-glucopyran-osyl) oxy] kaur-16-en-19- oic-acid ß-D- gluco- -pyranosyl ester) is a glycoside with a glucosyl and a sophorosyl residue attached to the aglycone steviol, which has a cyclopentanon hydrophenanthrene skeleton. Stevia is a nutrient rich herb containing substantial amount of other nutrients, like 80 to 85% water, protein, fiber, amino acids.

Table 1. Proximate analysis of dried Stevia rebaudiana leaves (g/100g dry weight basis).

Component	A. Gasmalla et al. [13]	Goyal et al. [1]	Kaushik et al. [30]	Mishra et al. [2]	Serio [29]	Abou-Arab et al. [1]	Atteh et al. [2]
Moisture	10.73	4.65	7.7	7	ND	5.37	ND
Protein	13.68	11.2	12	10	11.2	11.40	16.0
Fat	6.13	1.9	2.7	3	5.6	3.73	2.6
Ash	12.06	6.3	8.4	11	ND	7.41	15.5
Carbohydrate	63.10	ND	ND	52	53	61.9	ND
Crude fibre	5.03	15.2	ND	18	15	15.5	6.8

ND: Not determine.

Table 2. Fatty acid composition of Stevia rebaudiana leaves oil (g /100 g)

Fatty acids	Tadhani and Subhash [21]	Atteh et al. [33]
Palmitic acid (C16)	27.51	29.5
Palmitoleic acid (C16-1)	1.27	3.0
Stearic acid (C18)	1.18	4.0
Oleic acid (C18-1)	4.36	9.9
Linoleic acid (C18-2)	12.40	16.8
Linolenic acid (C18-3)	21.59	36.2

Table 3 .Water-soluble vitamins of Stevia rebaudiana leaves (mg/100 g dry base of extract).

Vitamins	Reference Kim et al. [39]
Vitamin C	14.97
Vitamin B2	0.43
Vitamin B6	0.00
Folic acid	52.18
Niacin	0.00
Thiamine	0.00

V. Health Benefits

Many plant glycosides have shown activity in cancer prevention, as well as antidiabetic, anti - obesity, antibacterial or antineoplastic effect. S. rebaudiana leaves contain noncariogenic and non-caloric sweeteners (steviol glycosides) whose consumption could exert beneficial effects on human health [3]. Stevia glycosides possess valuable biological properties. Regular consumption of these compounds decreases the content of sugar, radionuclides, and cholesterol in the blood [36], improves cell regeneration and blood coagulation, suppresses neoplastic growth and strengthens blood vessels. The toxicology of stevioside has been extensively studied, and related data, reassessed lately, indicated it to be non-toxic, nonmutagenic, and non-carcinogenic. It was also clearly demonstrated that high concentrations of the sweetener rebaudioside A, administered in the diet of rats over 90 days, were not associated with any signs of toxicity [3] and no allergic reaction have been observed when it is used as a sweetener [35]. Stevia is versatile herb with incredible sweetness that can be safely used in herbal medicines; tonics for diabetic patients and also in the daily usage products, Stevia leaves can be used because of its anti - fungal and anti- bacterial property. Mild stevia leaf tea offers excellent relief for an upset stomach. A wet Stevia leaf bag provides a cooling effect on eyes (similar to using cucumber). The leaves effectively tighten the skin and are good for wrinkles. Stevia has proved to give except ional benefits when used regularly in skin care. It also has a healing effect on blemishes, wounds, cuts and scratches. Low amounts of steviol does not induce cancer (in chronic experiments with rats fed stevioside during 2 years, no increase in tumor formation was found).

VI. Conclusion

This review showed that the stevia rebaudiana Bertoni contained some chemical compounds which can be used in food applications. Considerable amounts Amino acids and volatile compounds have been found in stevia leaves which can produce these compounds and used as supplement of food additives in many products such as beverages and diabetic food products.

Some researchers have claimed that steviol glycoside has health benefits as they have anti - hyperglycemic, antihypertensive, anti-inflammatory, anti-tumour, anti-diarrhoeal, diuretic, and immunomodulatory effects, another studies found that Toxicological studies have shown that stevioside does not have mutagenic, teratogenic or carcinogenic effects.

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