Hop and Medicinal Plants, Year XXIII, No. 1-2, 2015
ISSN 2360 – 0179 print, ISSN 2360 – 0187 electronic

A COMPREHENSIVE REVIEW ON STEVIA *(Stevia rebaudiana)* IN TERMS OF FOOD APPLICATIONS AND FUNCTIONALITY

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Abstract. In nowadays, is a strong and increasing interest among consumers and manufacturers for products that can be used to promote health and wellbeing, such as natural food supplements, herbal remedies and other products based on medicinal plants. This minireview paper, aim to present the potential of *Stevia rebaudiana* in terms of food applications and functionality. Furthermore an overview of already performed studies in literature about the Stevia-sweetener stevioside and rebaudioside A. is given.
Key words: ***Stevia rebaudiana*, Stevioside, Rebaudioside A; Low calorie sweeteners;**

Introduction

Medicinal plants are of great importance to the health of individuals and communities. Herbs with naturally healthy quality can be a valuable tool in the prevention and/or cure of several important pathologies in developed countries plagued by dramatic and serious increases in the occurrence of obesity, cardiovascular sidease, diabetes and cancer.

In a few countries stevia has been consumed as a food and medicine (ethnobotanical) for many years, including most notably Japan and Paraguay. Currently, stevia in leaf or extracted forms is permitted as a dietary supplement in the US, and under similar classifications in several other countries. Erroneous reports that stevia is widely used in western food and beverage products sold in Japan or South America has created a public impression that the sweetener has been held off the market in the US and Europe for arbitrary reasons. However, a number of prominent food safety and regulatory agencies from around the world have made their concerns

with stevia-based ingredients precisely known for many years (FDA, 2007, cited in Carakostas et al., 2008).

Botanical description and bioactive constituents

S. rebaudiana Bertoni (Fig. 1) was botanically classified in 1899 by Moisés Santiago Bertoni, who described it in more detail. Initially called *Eupatorium rebaudianum*, its name changed to *S. rebaudiana* (Bertoni) Bertoni in 1905.

Stevia is a genus of about 200 species of herbs and shrubs in the sunflower family (*Asteraceae*). It grows up to 1 m tall (Mishra, P., et al. 2010). The plant is a perennial herb with an extensive root system and brittle stems producing small, elliptic leaves. 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 (Lemus-Mondacaa R. et al., 2012)

The sweet principle of S. rebaudiana (Bertoni) 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 (Barriocanal et al., 2008, cited in Lemus-Mondacaa R. et al., 2012).

The medicinal value of these plants lies in some chemical substances that produce a definite physiological action on the human body. The most important of these bioactive constituents of plants are alkaloids, tannins and polyphenols (Edeoga et all., 2005, cited in Lemus-Mondacaa R., 2012). *S. rebaudiana* (commonly referred to as honey leaf, candy leaf and sweet leaf) is rich in terpenes and flavonoids. The phytochemicals present in S. rebaudiana are austroinullin, β-carotene, dulcoside, nilacin, rebaudi oxides, riboflavin, steviol, stevioside and thiamine (Jayaraman et al., 2008).

Fig 1 *Stevia rebaudiana* Bertoni leaves
(Source: Lemus-Mondacaa R., et. al., 2012).

Most steviol glycoside products sold today consist primarily of stevioside or rebaudioside A. Products containing a high level of rebaudioside A are also known as rebiana. Rebiana is a ‘‘common or usual” name for steviol glycoside ingredients comprised predominantly of rebaudioside A. The two glycosides are structurally very similar with rebaudioside A having one more glucose moiety as compared to stevioside (Fig. 2). All steviol glycosides are metabolized to steviol and it is the safety evaluation of steviol that is important for risk assessment (Roberts and Renwick, 2008)

Rebaudioside A has been approved for use as a sweetener in a number of countries, including Japan, China, and Brazil. Its unique properties will provide the food technologist with another tool to produce innovative foods and beverages to meet the demand of consumers for great taste without the calories of sugar (Pracash et al., 2008)

The biological activity for Stevia compounds has been studied by Tomita et al., 1997; they studied the bactericidal activity of a fermented hot-water extract from S. rebaudiana Bertoni towards enterohaemorrhagic Escherichia coli and other food-borne pathogenic bacteria. Other microorganisms like *Salmonella typhimurium, B. subtilis* and *S. aureus* has also been found to be inhibited by the fermented leaf extract (Debnath, 2008, and Ghosh et al., 2008, cited in Lemus-Mondacaa R., 2012).

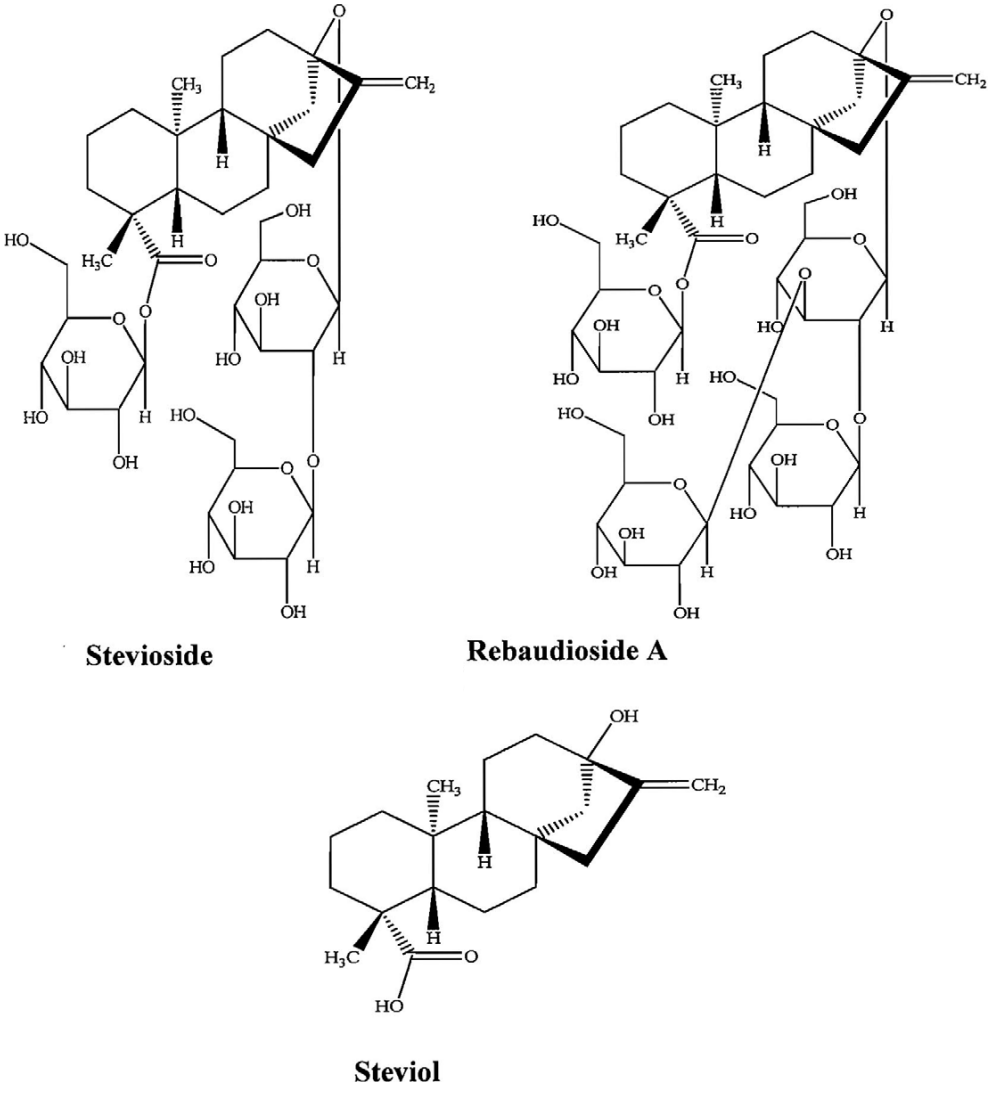

Fig. 2. Structures of steviol glycosides stevioside and rebaudioside A and their similar core and metabolite, steviol.
(Source: Carakostas, M.C. et al. 2008)

Studies have also shown the effect of harvest time, experimental site and crop age on the no-calories sweetener steviol glycosides (SG) and on the antioxidant propertiesof stevia leaf extract an experiment conducted over two growing seasons at two sites in the northestern plain of Italy. The result showed that all analyses factors played a important role in defining the SG profile and the antioxidant properties of stevia extract. A high level of fenols

(78.24 mg GAE g^{-1}DW by Folin-Ciocalteu method) and high antioxidant activity (812.6 μmol Fe^{2+} g^{-1}DW by FRAP assay) were observed. The strong antioxidant properties make very interesting the possibility of using stevia extract to improve functional properties (Tavarini et. al., 2013)

Stevia-sweetener-aplications and functionality in food

In 2008, a report from Carakostas et al. concluded that Stevia has been the food substance with ‘‘multiple personas” due to its historical status as an ethnobotanical in South America, as an approved food ingredient in Japan and as a counter-culture herbal ingredient in the US and Europe. This long history of use as therapeutic, food, herb and subject of research has both helped and hindered the development of stevia-based sweeteners in countries with strong food regulatory systems. The common perception that stevia’s long history of use was sufficient to substantiate its safety regardless of the scientific gaps remaining to be resolved led to a number of false starts in successfully bringing this natural sweetener onto the market in many countries, including the US.

In another research led by Clos et al. in 2008, which highlights the photostability of rebaudioside A and Stevioside in beverages it was shown that extensive stability studies were carried out on rebiana, all supporting good stability for use in all food and beverage applications, including conditions where rebiana-sweetened beverages were exposed to light found no significant photodegradation for either rebaudioside A or stevioside.

In a study on Stevia-sweetener in food: application, stability and interaction with food ingredients, in 2010 the research discovered that stability studies of stevioside in solutions of organic acids showed a tendency towards enhanced decomposition of the sweetener at lower pH values depending on the acidic medium. In a stevioside-sweetened coffee and tea beverage, practically, no significant chances neither in caffeine content nor in stevioside content could be noticed (Kroyer 2010)

One of the most valued research is relevant to the production of dried fruits presented a process to produce low-calorie dried fruit by removes high-calorie sugars from the fruit and replaces it with a natural low-calorie sugar restoring the sweetness of the fruit by introduces and analyzes a new process denominated dual-stage sugar substitution (D3S). As evidenced by researchers (Garcia-Noguera J. et al., 2010) this process aims to induce sugar substitution in strawberries. In a first stage, high-calorie sugars (sucrose, fructose and glucose) are partially removed from the fruit samples and in a second stage, low-calorie sugar (stevioside and

rebaudioside) is incorporated to the fruit to maintain its sweetness. The process was evaluated by studying the use of ultrasound application in one or both stages of the D3S process. Best performance of the process was obtained by subjecting the fruit samples to ultrasound in the sugar removal stage followed by immersion of the samples in Stevia-based solution without application of ultrasound in the sweetener incorporation stage. These operating conditions result in the highest sugar removal during the first stage, highest water loss during the process and highest sweetener incorporation during the second stage of the D3S process.

Sucrose-free milk chocolates sweetened with Stevia and containing different types of commercial inulin or polydextrose as bulking agents, were examined in relation to their physico-chemical, rheological and sensory properties. The researchers (Shah et. al., 2010) concluded that chocolate with inulin HP in combination with Stevia and polydextrose resulted in very similar physico-chemical and sensory characteristics in comparison to sucrose sweetened milk chocolate.

The functionality and stability of rebiana was demonstrated with a three-dimensional food matrix model representing the intended conditions of use in foods (Pariza et al., 1998, cited in Prakash et al., 2008). In conclusion, rebiana provides numerous benefits as a sweetener like: 200–300 times more potent than sugar, natural, non-caloric, possessed of a clean sweet taste with no significant undesirable, taste characteristics, stable in a wide variety of everyday foods and beverages, expected to be compatible with flavors containing aldehydes (Prakash et al., 2008).

Conclusions

This paper summarizes the information used to conclude that Stevia extracts, besides having therapeutic properties, contain a high level of sweetening compounds, known as steviol glycosides, which are thought to possess antioxidant, antimicrobial and antifungal activity. Stevioside and rebaudioside A are the main sweetening compounds of interest, they are thermostable even at temperatures of up to 200 °C, making them suitable for use in cooked food while being safe for human consumption. In this sense Stevia cultivation and production would further help those who have to restrict carbohydrate intake in their diet, to enjoy the sweet taste with minimal calories. It can be concluded by saying that *S. rebaudiana* has a great potential as a new agricultural crop since consumer demand for herbal foods is increasing.

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