A Review of Anti Diabetic Properties of Non-Caloric *Stevia rebaudiana* Bertoni

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**Abstract:** Diabetes is a chronic disease having its roots throughout the world. This disease occurs due to increase in the level of glucose in blood. *Stevia rebaudiana* is useful for the treatment of diabetes. It is native to South America having great potential for production of natural sugar. Its leaves produce non-caloric diterpene glycosides compounds, which are 300 times sweeter than sucrose. It is beneficial for the human health because it has low calorie and also has an anti-cancer, anti-microbial and anti-fungal properties. It is an important source of carbohydrates, crude fibre, protein, minerals and essential amino acids. Approximately, it has eight compounds which are the source of sweetness that is present in leaves. The two out of eight sweetness compounds include stevioside and stevioside A. Sweetness compound stevioside is more abundant than stevioside A in its leaves. In addition to its therapeutic properties, it has antihypertensive, anti-cancerous, antihyperglycemic and contraceptive properties. This plant doesn’t have mutation effect and help in secretion of insulin in body.

**Key words:** Diabetes treatment • Stevia • Alternate of synthetic sugar • Good Sugar

**INTRODUCTION**

In medical field, medicinal plants have a great importance. Diabetes is a worldwide problem. It is due to the deficiency of the insulin secretion and the tissues of insulin become less sensitive. It is a complicated disease because it also disturbs the protein, fats and carbohydrates metabolism. Bernad [1] is a scientist, who stated that this disease occurs due to the excessive production of glucose in the liver. It occurs all over the world but common in India. It is estimated that in 2025, about 57 million people will be affected from diabetes [2]. For controlling this disease, different treatments are available, but they do not have a great success. Medicinal plants are important in medical field because the drugs obtained from these plants have fewer side effects while the synthetic drugs are more effective for the human health. But now-a-days, wild plants and mostly those plants which are used for medicinal purpose has been affected by the man-made activities and world wild population status [3]. In these plants, *Stevia rebaudiana* Bertoni is one which is best for the diabetic patients. Stevia is a shrub. It belongs to family Asteraceae. There are 150-300 species in this genus. It is known as Bertoni in 1899 was discovered by Moises Bertoni [4]. Its seeds are infertile therefore it cannot be grown easily [5]. This plant is also known as “Honey leaf” due to its sweet taste. It is three hundred times sweeter than the sugar cane. Its leaves contain rebaudioside, diterpene glycosides and stevioside. Due to the stevioside, its content has great importance and has a good taste. For nutrition and herbal purpose, it is cultivated in South America, Malaysia, Philippine, Taiwan, Hawaii and Europe. Its products are utilized in the food as a functional ingredient that are good for the diabetic and diet conscious person [6].

Steviosides are three hundred times higher than common sugar. Therefore, it is required in low quantity. Rebaudioside-A is another glycoside in its leaves. Its sweetness is 400-times than sucrose [7].

Rebaudioside A is organoleptic as well as it has physicochemical properties. Due to its solubility in water its formulation is easy. Rebaudioside A has unique properties due to which, it is considered as an important on industrial level for its utilization as an organic sweetener [8].

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In addition to these, its leaf is a source of diterpene glycoside compounds which are sweeter than the sucrose. Its uses are safe for the diabetic patients because the above sweet compounds produced by its leaves can easily pass through the digestive process without any chemical breakdown. Diabetes is a major problem in India and other countries. Now, it is important to move the attention toward such natural sources which are acceptable for health. It has some therapeutic properties like antihypertensive, anti-cancerous antihyperglycemic and has contraceptive properties [9]. It is also beneficial for preventing the growth of fungi and bacteria. Now-a-days, stevia products are utilized by Israel, America, China, Korea, Japan, Argentina, Indonesia, Canada and Paraguay [10]. Annually 50 tons of stevioside are used in Japan with $220 million Canadian sales value [11].

Affects of Diabetes and its Mode of Action: Diabetes mellitus is a metabolic disorder because it affects all body organs. Therefore, health sector considers it as a nosological problem. It is a biochemical, physiological and anatomical disease which is caused by the disturbance of glucose level and low level of insulin production through the beta-cells in the pancreas. Long term disease creates the vascular complication including large and small blood vessels such as atherosclerosis, glomerulosclerosis and retinopathy. In Mexico, there is about 10% of the total population that is affected by diabetes. In 2012, NHSN (National Healthcare Safety Network) stated that approximately 6.4 million adults are affected by this disease [12]. In 1995, the WHO (World Health Organization) observed that there are about 30 million people suffering from this disease in all over the world but in 2014 the WHO provided the data in which it reported that about 347 million people are suffering from this disease. This institution estimated that in 2030 the infected people will be increased up to the 366 million worldwide [13].

In India, a large proportion of the population is suffering from the diabetes. So, they need such type of sugar which is free from the calories and cholesterol. For fulfilling the demand of the people, researchers did many researches for increasing the sugar supply, then they focused on the stevia which is a sweetner and chloestrol free plant [14].

Types of Sugars and Their Effects on Human Health: There are two types of sugars. One is natural sugar and other is synthetic sugar. Synthetic sugar has harmful effects on the human health. Now-a-days, due to the higher utilization of chemical sugar, many people are suffering in the chronic diseases such as diabetes, obesity, cardiac disease, blood pressure etc.

Stevia as an Alternate Source of Synthetic Sugar: For controlling these diseases, the scientists conducted numerous researches for the innovation of sweeteners that contain low calories and no side effects. Later, the scientists achieved their goal and introduced ‘Stevia’ which is natural non-caloric sweetener [15].

Botanical Description of Stevia: The botanical name of stevia is “Stevia rebaudiana bertoni”. It belongs to the “Asteraceae” family. It is perennial shrub which is cultivated in semi-humid subtropical areas. It is a wild plant of Paraguay and Brazil. The other name of this plant is “sweet herb of Paraguay”. This plant can be cultivated up to the height of about 26 to 72 inches. The fertile and sandy soil is more suitable for its growth [16].

First Commercial Level Cultivation of Stevia: For the first time, it came under the observation in European region when its unique characters were studied by the M.S. Bertoni from the Paraguayan Indians and Mestizos. Then, it was cultivated in England in 1942 but gave unsatisfactory yield. It is reported that first time it was cultivated on the economical level in paragay in 1964. Sumida was a scientist which did many efforts for the introduction of stevia in the Japan [17]. After that, it was cultivated as a crop in many countries including Brazil, Korea, Mexico, United States, Indonesia, Tanzania and Canada. China is the largest producer than other countries [18].

Inflorescence of Stevia: It has a woody stem above the ground which contains the paired leaf with the size of about 3-4 cm. It has axillary branches from nodes. It is a short-day plant, so its flowers are developed by increasing the length of dark period. Along with the day length, other factors which affect the floral development are plant genotypes, nutrients, heat and water stress. It has a compound inflorescence with the five tubular flowers having white colour. Its single stem has all reproductive stages because it has non-uniformity in the flowers. It has one seeded fruit which is known as achene having feathery pappus. It has both vegetative and reproductive stages [19]. For the improvement of its yield and rebaudioside-A, different methods of conventional breeding has been utilized [20].
Production Technology of Stevia: It can be cultivated by the seed or vegetative propagation but its rate of germination is not so high. On a commercial level, it can not be grown due to its high cost but on the small level it can be cultivated by clonal propagation method. It is perennial plant but in Canada it is cultivated as an annual plant. It can be cultivated in Feb or March and harvested in late summer. After the transplantation of crop, its floral development should be completed between 54-104 days if long day length provided. For its cultivation, 23°C is a suitable temperature. During its pollination and seed filling, if excessive rainfall occurs, its viability and production can be affected. If its seed is not stored at 0°C then its rate of germination can be reduced to about 50% over the 3 years [18].

Tissue Culture Cultivation a Better Method: Through the seed, its germination rate is approximately 50%. So, it can be cultivated through the stem cutting but it is very difficult method because it needs a large number of cuttings. Therefore, tissue culturing is an alternative method for its good cultivation [21].

Limitations for Growth in Stevia: Its growth is affected by the moisture content in soil, wind, photoperiod, intensity of temperature, day length and radiation. Its yield depends upon the genetic characteristic. However, there are some factors of environment and climate which affect its growth like the terpenes synthesis is affected by the both factors. However, stevia gives better growth in semi-humid climate and the suitable temperature for its growth should be from -6.0 to 43°C and the average is 23°C. The duration of sun light is an important factor because in long days the area of leaf, its dry weight and the length of internodes increase as compared to short days. Long days also increase contents of glycoside in leaves, but flowering decreases its content. In short nights, when flowering of its plant is delayed, glycoside starts to accumulate in its leaves [10].

Nutrient Value of Stevia: It is good source of carbohydrates, minerals, protein and crude fibre. According to the recommended value (6.5 grams per day) of FAO and WHO [22] for the adults, it contains the higher amount of essential amino acid [23]. The chemical morphology of this plant is not completely studied but for its chemical composition different species has been studied. Then the scientists observed that leaf is an important part of this plant. Because its leaves contain stevioside and rebaudioside which are the sources of sweetness. Only 18 species have these compounds out of 110 [24].

Steviol Glycosides Distribution in Plant Body of Stevia: The amount of steviol glycosides compounds depends upon plant organs, age of plant and developmental stages. The upper shoot section (leaves) contain the highest amount of steviol glycosides while the lower section contain the lowest glycoside compounds. Every organs contain different proportion of SGs compounds and its proportion is decreased according to this order: leaves, flower, stem, seed and root. In the leaves, the concentration of SGs compounds can be change according to the age of plant and stages of the plant development. It observed that the concentration of glycoside compounds are enhanced during the ontogeny in both mature leaves and stem upto the budding phase and flowering stage [25]. Nitrogen fertilizer is important for the yield, plant heigh, leaf gases exchange as well as steviol glycoside compounds. The amount of steviol glycoside compounds are postively correlate to the nitrogen fertilizer. If the nitrogen fertilizer dose is decreased then the amount of SGs compounds also decreases and vice versa. Due to the deficiency of nitrogen, the metabolic activities are distributed in the stevia plant [26].

Leaf the Sweetest Part of Stevia: Its leaf has a sweet taste due to the presence of diterpenoid glycosides compounds. Along with these compounds, it also consists of different types and numbers of sugars which are attached with the C-13 and C-19. The Stevia rebaudiana bertoni consists of large amount of steviol glycosides that contains the steviosides and rebaudiosides-A [27].

Names of Sweetness Compounds in Stevia Leaf and Their Discovery: In these compounds, stevioside is a source of sweetness in its leaves. Its chemical structure was discovered by Mosettig, Fletcher and their colleagues, in 1963 [28]. In addition to these, there are four additional compounds which cause the sweetness in its leaves, rebaudiosides -A, -B, -C and -D which belong to the diterpenoid glycoside family. In case of taste, rebaudiosides are sweeter and less bitter than the steviosides. It is reported that its flower-buds contain these glycosides compounds but not exist in its roots [29].
Rebaudiosides-a the Sweetest Compound in Stevia Leaf: From these glycoside compounds, rebaudiosides-A is a significant compound which is more sweeter than the other compounds. Along this, it is more stable and less bitter in taste than the stevioside. In 1987, Pederson [30] has reported that stevioside is a white crystalline powder which is obtained from its leaves. In 2006, it is reported that its fresh leaves contain 80-85% water. In addition to these glycosides, its leaves contain other substances such as ascorbic acid, b-carotene, chromium, cobalt, magnesium, iron, potassium, phosphorous, riboflavin, thiamine, tin and zinc [24].

Stevioside the Most Stable Sweetness Compound in Stevia Leaf: Stevioside is a stable compound which does not show the mutation and toxic effect on the human health. Therefore, it is used as a taste modifier and sugar substitute through out the world. It has an ability to stimulate the secretion of insulin from the pancrease for maintaining the glucose level in blood [31].

Introduction of Stevia’s Medicinal Use to Treat Diabetes by Kinghorn: In case of its medicinal uses, its importance has been introduced by the Kinghorn [32]. They reported that this plant is a source of non-caloric sugar that is beneficial for the diabetic patients. After the investigation, they observed that glucose level in blood can be maintained by these compounds. Stevioside has a property to stimulate the insulin secretion. Due to this property, stevioside is one which reduces the sugar level in both types of diabetes [33].

Extraction Methods of Steviol Glycosides: There are many methods for the extraction of steviol glycosides, but Ultrasound assisted-extraction method is suitable than the conventional method. Through this process, higher amount of steviol glycoside is obtained than the conventional method. This method takes less time for the extraction as compared to the conventional method. In this method, water is used as a solvent [34].

Doug Kinghorn’s Investigation Proved No Side Effects of its Leaf Utilization: Few years ago in India, its leaves were directly used as a sweetening agent in the tea and this tea was taken several times in a day without any side effect. In America, stevia products were banned because that time there was no any report about the safety of its utilization. But after investigation by Doug Kinghorn of the Herb Research Foundation and other researchers [35], it was proved that stevia has no side effects. It is a natural sugar with no calories. Now its products are used throughout the European countries [16].

Uses in Different Products as an Anti Diabetic Sugar: Its products can be utilized throughout the world. In Japan, it is utilized in different diets, soft drinks, teas, coffees etc. In South America, its leaves are used in drinks, drinks, soju, soy sauce, yogurt and other foods. In Bangladesh, it is used in the tea for the diabetic patients. In the different European countries, it is used as a supplement. In addition to this, it is used as an antihyperglycemic, antihypertensive and antiviral [36].

Diseases of Stevia Crop: There is no any attack of insects on this crop because it has the inherent sweetner which acts as a repellent. But different fungal diseases are identified such as root rot, leaf spot, powdery mildew, damping off, alternaria leaf spot and septoria leaf spot. So, the resistance sources are needed for making the resistance varieties against these disease [10].

CONCLUSIONS

From all above discussion, it is concluded that stevia could be used as an alternate source of synthetic sugar as it does not add calories to food so it could be used by diabetes patients without harming their blood glucose level.

REFERENCES