THE BIOSWEETNER- *STEVIA REBAUDIANA* AN OVERVIEW

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Abstract

In recent scenario with changing lifestyles of people the most adverse impact of this is coming on the diets of the people. More and more people are eating junk food and above that the most consumed thing in today's time has become sugar. It consumed in daily life in tea, coffee, carbonated drinks etc. and is slowly deteriorating the health of the people. Sugar in general is harmful to the body. Excessive consumption of sugar causes diseases like diabetes and also adversely affects our liver and kidneys. So in order to find a healthy alternative to sugar many researches are going on and in those researches one of the most effective plant that can be used as a substitute for sugar is *Stevia rebaudiana*. The researchers suggest that the leaves of this plant is about 200 times sweeter that the commercial sugar and the leaves are completely calorie free and do not cause any sudden rise in the blood sugar level. This paper will discuss the nature, morphology and chemical composition of *Steviarebaudiana*. Stevia not only proves to be a good substitute for sugar but also has added health benefits like regulation of blood sugar level and help in reducing hypertension. In this paper the physiological impact of this plant on humans will also be discussed along with its usefulness for human beings.

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Introduction

With fast paced lives of people in the 21st century the most significant change has come in the diets of the people. The intake of sugar has increased a lot in today's time. This excessive usage of sugar is making people more prone to diseases like diabetes and is generally also unhealthy for the health of the people. For many decades the search for the healthy alternative to sugar has been sought after. The scientists have come up with artificial sweeteners like aspartame, alitame etc. Though these artificial sweeteners may act like a substitute of sugar but still they too have their own side effects and excessive use of these may lead to health related complications. To find a solution to this now the science has turned to the ancient wisdom of herbs. Stevia rebaudiana common to the native South American culture is a plant that has been locally used as a substitute for sugar since a long time ago by the native people. The leaves of stevia are sweet in taste and are used in traditional South American dishes in place of sugar. Apart from being a healthy alternative stevia has added health benefits like it reduces excess glucose level in blood keeping it in balance. It is also known to reduce hypertension and shows anti-bacterial and anti-inflammatory activities. Therefore stevia is a very healthy option that can replace sugar. In countries like Japan where white sugar is banned, stevia is used as sweetener in many dishes and even the commercial soft drinks.

Morphology of the Plant: *Stevia rebaudiana*

Taxonomical classification

Kingdom- Plantae

Phylum – Angiospermeae

Class –Asterids

Order- Asterales

Family- Asterceae

Genous- Stevia

Species - rebaudiana

Stevia rebaudiana is a perennial plant which is of short to average height, growing up to 65 to 80 cm. This plant has sessile, oppositely arranged leaves. There are different species of Stevia that exist in the world, out of all Stevia rebaudiana is the sweetest of all. The sweetness in stevia is due to compounds named steviol and rebaudiol. Stevia is a sturdy plant and it is very easy to grow. Stevia is native to South America hence it is well suited for a semi-humid subtropical climate.To grow well stevia plant requires neutral to slightly acidic soil with pH range 6.5 to 7.5. The best suited soil for growing stevia is well-drained red soil and sandy loam soil. Excessively alkaline and saline soils should not be there if stevia has to be cultivated. Though Stevia is native to South America but still it has been successfully cultivated many Indian states like Rajasthan, Maharashtra, Kerela and Orissa. Diterpene glycosides are the group of natural sweeteners that have been extracted from Stevia.

Common Names of Stevia rebaudiana:

Commonly Stevia is also known as sweet leaf of Paraguay,sweet-herb, honey yerba, honey leaf, candy leaf.

Different Species of Stevia:

Some commonly found species of Stevia are as follows:

1) ***Stevia ivifolia:***

The height of stevia plant is measured at2 feet approx.The steam of this plant has tiny shaggy hair like structure but the steam is erect. The plant is branched at the top level because it is corymboseled. The leaves of stevia are rhomboid-lanceolate and sessile from upper region. The flower initially show white color and are in fastigiated corymbs, involucre & florets. Flowers are also glandular & downy.

2) ***Stevia ovate:***

This specieof stevia is also of similar height that is 2 feet tall and the steam is also erect. However the leaves of this species are oval, toothed and shaped like a wedge at the base. The upper leaf of stevia is oblong. The color of flower-heads is also white and showcompact fastigiated corymbs.

3) ***Stevia purpurea***:

This species of stevia palnt is quite tall as compared to other two species. Its height is measured at 18 inch. The steam however is similar with tiny hair on the steam which is erect and is heavily branched. The leaves are lanceolate, alternate, channeled, narrowed near stalk and forked at the top.Howeverthe flower of this species are purple in color and has fastigiated corymbs.

4) ***Stevia rebaudiana:***

It is an annual herb of height ranging from 1- 1½ feet. The stem is erect and it haspuberulous leaves which are arranged in opposite manner. The flowers are crenulate, very small, white in color and present in a corymb Leaves have a sugary flavor hence it considered sweetest among all stevia.

5) ***Stevia salicifolia:***

This plant is a shrub that grows upto 18 inches in height. The leaves are opposite, narrow, lanceolate, very shortly stalked and almost connate. Flowers are white in spreading corymbs**.**

6) ***Stevia serrata:***

This plant is almost 18 inch in height. The stem is errect, branched with hairy leaves which are alternately arranged.Flowers are white or pink and are arranged in fastigiated corymbs.

Chemical Composition of stevia

For assessing the chemical constituents the useful part of the plant is taken which in case of Stevia are its leaves. There are more than 110 species of stevia present in the world but amongst all of these only 18 species are known to have sweet leaves.The major components responsible for the sweet taste of stevia leaves are the glycosides such as dulcoside A, rebaudiosides A and E, steviolbioside, and stevioside.These glycosides are mainly compounds of the diterpene derivative steviol. S. rebaudianaBertoni, the sweetest species, contains in its leaves all of the eight ent-kaurene glycosides with stevioside being the major constituent.Stigmasterol, b-sitosterol, and campesterolare also present in significant amount in Stevia rebaudiana which is the sweetest of them all. It also contains steviol, a product formed by enzymatic hydroxylation within the plant. The leaves of S.rebaudianaBertoni contains various compounds that have a sweet taste. Such compounds are - rebaudiosides A, D and E,

stevioside, dulcosides A and B.The S. rebaudianaBertoniis a complex mixture of eight diterpenenic glycosides: stevioside, steviobioside, dulcoside, and rebaudiosides A, B, C, D, and E. Along with these eight components some other components include - triterpenes, stigmasterol, labdane diterpenes, tannins, volatile oils,stevioside and rebaudioside A.Out of all the glycosides, rebaudioside A has the sweetest taste also it is shows most stability. Some of the sweetest components include RebaudiosideE which is as sweet as stevioside,rebaudioside D is equally sweet sarebaudioside A. Also other types of glycosides present in this are less sweet than stevioside. Since stevia is a natural sweetener and is puely herbal therefore is does not have any side-effect and doesn't even have calories. The intensity of sweetness is 200 times more in stevia as compared to regular sugar and possess stability towards heat upto the temperature of 198 degree Celsius. Even though is can be used as flavor enhancers still it does not pose threat of cavity or plague in the mouth.

According to various researches done on this plant it was found that the major ingredient constituting stevia is water which amounted to 80%-85%. Other than the above mentioned constituents there are few others thatultimately make up the composition of stevia. These other components are - magnesium, iron, potassium, ascorbic acid, b-carotene, riboflavin, thiamin, chromium, cobalt, phosphorous, tin and zinc. Some of the chemicals include - chlorophyll, cynaroside, quercitrin, scooletin, chorogenic acid apigenin, austroinulin, avicularin, b-sitosterol, caffeic acid, compesterol, caryophyllene, centaureidin, , daucosterol, di-terpene glycoside, dulcosides A and B, foeniculin, formic acid, gibberellic acid, isosteviol, kaempferol, kaurene, lupeol, gibberellin, indole-3-acetonitrile, isoquercitrin, luteolin, polysatachoside, quercetin, stigmasterol, umbelliferone and xanthophyllus. Stevia is used extensively all aroung the globe as a natural sweetenerthatdoen not contain any calorie. However due to excessive sweetness there is a bitter taste that is experienced by many humans when consuming stevia. Also it was found that the sweetness potential of stevia was equal to the sweetness levels of 10% sucrose solution at pH 3.0 or 7.0.

Physiological and Pharmacological action

In earlier times Stevia leaves were used by the Indians in medicines and also to even sweeten the beverages. The dried leaves were also chewed directly as a sweet treat by many people. Stevia was used consistently on a daily basis because it has no side-effects. However since the leaves are directly used either in powdered form or into pieces it did not mix well into the drinks. It often left residue in the drinks at the end and even left a green colour on to the utensils. Another difficulty faced by people in using Stevia was the peculiar aroma that came from the leaves. Later the solution for this problem was devised that if the leaves were properly processed then it eradicated the unpleasant smell from the leaves powder. Not only in India, has Stevia also been used as a sweetener in Brazil and Paraguay since hundreds of years. From past many centuries the stevia leaves are used in Paraguay as Kaajhee for the preparation of a special tea called the yerva mate tea. The use was not just limited to this tea rather the leaves were used to sweeten many other types of food and beverages. They used stevia for preparation of medicinal tonics for diseases like obesity, hypertension, cardiac arrest, lower uric acid and to cure heart-burn. They use of stevia is not limited to being a sweetener is is also a diuretic tonic, hypoglycemic and a cardio tonic that is the reason why it is extensively used to cure many diseases

like hypertension, fatigue, depression, obesity and even sweet cravings and other infections.

Traditional preparation:

Stevia is apotent substitute of sugar. Traditionally it was found that one fourth spoon of stevia leaf powder was capable of substituting one spoon of common sugar.

Stevia has proved highly effective in treating hypertension and high blood-pressure problems. Also stevia contains high amount of anti-oxidants and hence it can help in decreasing cholesterol levels, lipoprotein cholesterol and triglyceride from the body. However it helps in increasing the amounts of high density lipoprotein cholesterol which is useful for the body. It was also found that stevia had the potential to decrease the resistance of cardio-vascular diseases because it exhibits hypolipidaemic effect. The major properties of Stevia include the following - anti-inflammatory, anti-microbial, anti-bacterial, anti-fungal, anti-viral,hypoglycaemic, hypotensive, anti-yeast, cardio-tonic, diuretic, and a vasodilator. Stevia has added benefit as compared to other artificial sweeteners that it shows stability even at high temperatures and also has pH range of 3-9.

Medicinal Use of Stevia:

1) Hypoglycemic/Hyperglycemic action -

Many studies suggest that since stevia gives nourishment to the pancreas, hence they help in restoring normal pancreatic functions and thereby it helps the people with diabetes with proper regulation of blood sugar level. It is also helpful in cases of hypoglycemia as it helps maintain optimum glucose level in blood without dropping it suddenly. In semi controlled clinical reports one also encounters this action reported a 35.2% fall in normal blood sugar levels 6-8 hours following the ingestion of Stevia leaf extract.

2) Cardiovascular Action -

The first study was carried out in the year 1978 to check the cardiovascular action of stevia. It was found that stevia can be used a tonic for cardio vascular actions which helped in regulating the high blood pressure, heart rate etc. Such cardio-pulmonary indications were first studies here. however no hypoglycemic action was observed in this study.

3) Antimicrobial Action -

An extensive research performed on stevia exhibited that various microbes such as Pseudomonas aeruginosa, Proteus vulgaris and Streptococcus mutans failed to survive in the presence of stevia as the constituents present in it are non-nutritive in nature. Stevia is largely used to prepare mouth washes and toothpates due to its natural sweetening properties which does not have any side-effects.

4) Effects on skin -

A study found that the liquid extracts of Stevia show properties that can be used to cure skin problems. Stevia in liquid form can help in clearing the skin and reduce problems likeseborrhea, dermatitis, acne,eczema, etc. Placed directly in cuts & wounds, more rapid healing, without scarring, is observed. Smoother skin, softer to touch is claimed to result from the frequent application of Stevia poultices & extracts.

5) **Hypertension** –A study done on rats revealed that stevia is useful in treating high blood pressure also its exhibits cardio-tonic actions when the blood pressure is normal to regulate the heart beat.It was also studied that stevia was able to treat both hypertensive and normotensive animals by exhibiting vasodilatory actions. Hence it was concluded that stevia could be used to reduce high

blood pressure. Also it enhanced the diuretic and natriuretic effects in animals.

Other Uses

1. Since it is a natural sweetener hence it can be used by diabetic patients and also by people suffering from high blood pressure.
2. It also prevents any cavity infections and helps in weight loss.
3. it has various uses because of properties like - anti-inflammatory, antibacterial and antiseptic.
4. It can be used as a tonic to cure various problems like digestive issue, skin problems, dermatitis and eczema.
5. As compared to other artificial sweeteners stevia does not have any neurological or renal side effects.

Recent Studies on *Stevia rebaudiana:*

A study done by Adesh A. B. et. al. on stevia rebaudiana suggested that Among all species of stevia, stevia rebaudiana is one which can be utilized by diabetics. Stevia not only imparts the sweet taste but also maintain the normal sugar level and also suitable for high blood pressure patients. Along with that the least quantity can produce sufficient sweetness because it is about 200 times sweeter than table sugar. Due to its sweetening property it has wide range in home-made recipes, in soft drinks, in ayurvedic formulations and allied Industries. It is calorie free and non toxic, hence is a great substitute to sugar.

Another study by Madan et. al. suggests that stevia though is a very useful plant but still there is a need for more research in finding the toxicity or potential of the same through excessive consumption. One of the active compounds in the stevia leaf called rebaudioside still needs to be studied in depth for its pharmacological actions in the body. The ADME studies which means Absorption, Distribution, Metabolism and Excretion related studies on stevia are still not as elaborate and hence need in depth work. This paper suggests that safety of stevia for human consumption is still controversial and hence authentic research is still required to draw any concrete solutions.

Goyal et. al did a study on stevia and concluded that Stevia found its application various areas of the world as a non-caloric sugar substitute. This research quotes many reports of researches done on animals and humans that show that the safety of stevia is not yet completely determined. This research also suggested that in USA this plant is still not used in bulk as a dietary supplement because yet this has not been approved by the FDA. It is suggested that mild to moderate use as a supplement should be safe, but increased use for other pharmacological effects may not be warranted. This plant still needs to be studied extensively to draw any concrete conclusions regarding its consumption.

Conclusion

Through this study it can be concluded that sugar is not good for health and excessive and prolonged consumption of sugar may lead to various health complications like diabetes, liver related issues etc. Many researches are done to find an alternative to the white sugar and all the modern science has come up with is the chemical artificial sweeteners like aspartame etc which themselves pose threat to health of people when used in excess. Therefore to find a healthier and more natural substitute for sugar Stevia rebaudiana is studied. This plant is native to South America and its leaves have distinct sweet taste. The studies have found that leaves of stevia are 200 times sweeter that the sugar which is commonly used. Apart from being a natural sweetener Stevia also has many health benefits like regulating the blood sugar level and reducing hypertension and in general also it is

good for overall health of the body. The chemical constituents of stevia are discussed in the paper and the most important compounds responsible for the sweet taste of stevia are stevioside and rebaudioside. Although substantial research is present to prove the existence of these compounds but still no evident researches have been done on assessing the potential toxicity of the stevia plant. Many researches are still going on to assess toxicity of the plant but substantial results were not obtained. There is still a lot of scope of more research in this area to provide substantial evidence that stevia is safe for consumption and if there is any toxicity it can be worked upon to be minimized. Hence it can be concluded that though stevia is a very useful plant but still there is need for more extensive research in this area.

References

1. Adesh B.A., Gopalakrishna B., Kusum A.S. & Tiwari O.P. (2012). An Overview on Stevia: A Natural Calorie free Sweetner. International Journal of Advances in Pharmacy, Biology and Chemistry. Vol. 1(3).
2. Tiwari, Shashank, and Shreya Talreja . "A Pharmaceutical Importance of *MurrayaKoenigii*- A Complete Study"*Indian Journal of Public Health Research & Development, November 2020, Vol. 11, No. 11.276-283*
3. Curi R, Alvarez M, Bazotte RB. 1986. Effect of Stevia rebaudiana on glucose tolerance in normal adult humans. Braz J Med Biol Res 19(6):771–774.
4. Goyal S. &Samsher, & Goyal, R. (2009). Stevia (Stevia rebaudiana) a bio-sweetener: A review. International journal of food sciences and nutrition. 61. 1-10. 10.3109/09637480903193049.
5. Tiwari S, Talreja S. Importance of *Cinnamomum Tamala* in the Treatment of Various Diseases. Pharmacogn J. 2020;12(6)Suppl:1792-6.
6. Hossaine M.F. et. al. (2017). Cultivation and Uses of Stevia (Stevia rebaudianaBertoni): A Review. African Journal of Food, Agriculture, Nutrition and Development. Vol.17
7. Kinghorn AD. 1987. Biologically active compounds from plants with reputed medicinal and sweetening properties. J Nat Prod 50(6):1009–1024.
8. Tiwari Shashank, Talreja Shreya, "Human Immune System and Importance of immunity Boosters on Human Body" *Journal of Global Trends in Pharmaceutical Sciences*, 2020; 11 (4): 8641 - 8649
9. Tiwari, Shashank & Talreja, Shreya. (2020). A Review on Use of Novel Drug Delivery Systems In Herbal Medicines. Ciencia and Engenharia/ Science and Engineering Journal. 24. 190-197.
10. Kumar, Rakesh & Sharma, Saurabh & Sharma, Mohit. (2014). Growth and yield of natural-sweetener plant stevia as affected by pinching. Indian Journal of Plant Physiology. 19. 10.1007/s40502-014-0085-8.
11. Madan K. et. al. (2010). Stevia rebaudiana (Bert.) Bertoni- A Review. International journal of Natural Products and Resources Vol. 1 (3), pp- 267-286.
12. Ranjan, Rahul & Jaiswal, J. & Jena, Jitendra. (2011). Stevia as a Natural Sweetner. International Journal of Research in Pharmacy and Chemistry. 1. 1199-1202.
13. Tiwari, S., Talreja, S. Do you think disease and disorder are same?–here is the comparative review to brash up your

knowledge. *J. Pharm. Sci. & Res*. Vol. 12(4), 2020, 462-468.

14. Tiwari Shashank et al. An overview on coronil drug, *: Journal of global trends in pharmaceutical sciences.*(2020), 11(3), pp: 8242-8247
15. Selamoglu, Zeliha. (2017). Stevia Rebaudiana: A Potential Boon for Human Health. SM Journal of Medicinal Plant Studies.
16. Sharma N, Kaushal N, Chawla A, Mohan M, Sethi A, Sharma Y. 2006. Stevia rebaudiana—A review. AgrobiosNewslett 5(7):46–48.
17. Payzant, John Donald, Laidler James Kenneth, Ippolito Robert Maurice (Alberta Reaserch Council, Can.), Method of removing off flavor from sweetener extracted from Stevia rebaudiana, Can.Pat. Appl. CA 2185510 AA, 14 Mar 1998: 6.
18. Yamazaki Takeshi, Flores Hector E, Shimomura Koichiro, Yoshihira Kunitoshi (Dep. Plant Pathol., Pennsylvania State Uni. University Park, PA 16802, USA), Examination of Steviol glycosides production by hairy root & shoot cultures of *Stevia rebaudiana*, J Nat. Product, 1991; 54(4): 986-992.
19. Vanek Tomas, Nepovim Ales, Valicek Pavel (Institute of Organic Chemistry & Biochemistry), Determination of Stevioside in plant material & fruit Teas, Academy of Science of Food composition and Analysis, 2001; 14(4): 383 – 388.
20. Tiwari, Shashank, and Navneet Batra. "Oral drug delivery system: a review." *Am. J. Life. Sci. Res* 2.1 (2014): 27-35.
21. Melis, M.S., Effects of chronic administration of *Stevia rebaudiana*on fertility in rats, Journal of Ethanopharmacology, Nov 1, 1999; 67 (2): 157 – 161.
22. Cornara, L., Bonon, M., Tateo, F., Serrato, Valenti G., Mariotti, M.G., Trichomes on vegetative & reproductive organs of *Stevia rebaudiana*(Asteraceae) structure & secretory products, Plant Biosystems, 2001; 135 (1): 25-37.
23. KonishimaTakio, Takasaki Midari (Kyoto Pharmaceutical University, Kyoto 607 – 8414, Japan), Cancer – Chemopreventive effects of natural sweeteners & related compounds, Pure and Applied Chemistry, 2002; 74 (7): 1309 – 1316.
24. Terai Tadamasa, Ren Huifeng , Mori, G.O., Yamaguchi Yoshihito, Hayashi Tetsuhito (Department of Applied Chemistry, Osaka Institue of Technology , Osaka 535 – 8585, Japan), Mutagenecity of steviol& its oxidative derivatives in Salmonella typhimurium TM 677, Chemical & pharmaceutical Bulletin, 2002; 50(7): 1007 – 1010
25. Gamkrelidze, K.H., Zarnadzen, Gogoberidze M., Chelidzen(S.Durmishidze institute of biochemistry & bio technology, Georgian academy of science, GA USA), Induction of callusogenesis&organagenesis in *Stevia rebaudiona*leaf & shoot, Bulletin of Geogian academy Sciences, 2001; 164 (1): 147-150.
26. Al' Fonsov, V.A., Bakaleinik, G..A., Gubaidullin, A.T; Kataev, V.E., Kovylyaeva ,G.I., Konovalov, A.I., Litvinov, I.A., Strobyking, I. Yu., Styrobykin, S.I, Litvinov I.A., Andreeva, D.V., Korochkina M.G (Arbuzov institute of organic and physical chemistry Kazan Research Centre, Russian Academy of Sciences, Kazan, Russia), Chemistry

&structure of diterpenes of the Kaurane series II Reduction of isosteviol, Russian Journal of General Chemistry, 2000; 17(6): 953-960.

27. Tiwari, Shashank, Sachin Saxena, and Rohit Kumar. "Process Scale Up of Ibrufen Tablet." *Journal of Pharmaceutical Sciences and Research* 3.10 (2011): 1525.
28. Shenming Shan, Jiang Xian Zhi, Jin Sen, Chen Liang, Chen Mu Chuan(The Key Lab of Ministry of Education for Cell Biology &Tumour Cell Engineering, Xiamen University, Xiamen 361005, Peop. Rep. China), Biological effects of *Stevia rebaudiana*induced by carbon ion implantation, ZhiwuXuebao, 2000; 42(9): 892 -897.

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