Review Article

Stevia (*Meethi patti*): Prospects As An Emerging Natural Sweetener

Parashar Bharat[1], Yadav Virendra[1*], kainth Amrita[1], Sharma Love[2] and Thomas Binny[3]

[1]Department of Pharmaceutics, Manav Bharti University, Solan, Himachal Pradesh, India.
[2] Department of pharmaceutics and drug research, Punjabi university, Patiala, Punjab, India.
[3]Indraprastha Apollo Hospitals, New Delhi, India.

ABSTRACT

Studies revealed that Stevia has been used throughout the world since ancient times for various purposes for example, as a sweetener and a medicine. We conducted a systematic literature review to summarize and quantify the past and current evidence for Stevia. As we know that the leaves of Stevia plants have functional and sensory properties superior to those of many other high-potency sweeteners, Stevia is likely to become a major source of high-potency sweetener for the growing natural food market in the future. Although Stevia can be helpful to anyone there are certain groups who are more likely to benefit from its remarkable sweetening potential. These include Diabetic patients, those interested in decreasing caloric intake, and children. Stevia is a small perennial shrub that has been used for centuries as a bio-sweetener and for other medicinal uses such as to Lower Blood Sugar, Weight Loss, Microorganism Inhibitor, Oral Tonic Digestive Aid and skin care. Its white crystalline compound (stevioside) is the natural herbal sweetener with no calories and is over 70-400 times sweeter than white sugar.

Keywords: Stevia Leaves, Rebaudioside, Stevioside, Medicinal Use.

INTRODUCTION

In the last couple of decades, growing concern about health and life quality has encouraged people to exercise, eat healthy food and decrease the consumption of food rich in sugar, salt and fat. Omission of added sucrose in foods increases the relative proportion of polymeric carbohydrates that may have beneficial effect for a balanced food intake as well as for human health. In addition, there has been an increase in the demand by consumers for food with functional properties. Changes in eating habits and lifestyle are mainly due to incessant search for health. In the past, food science was concerned with the development of food for human survival, a goal that was substituted by the concept of production of quality food. More recently, the main concept has become to use food as a means of promoting health and welfare, while reducing the risk of disease**.** The food industry has responded to this demand and as a consequence, there has been a fast growing increase in diet foods and beverages available to consumers in many markets of the world. With increased consumer interest in reducing sugar intake, food products made with sweeteners rather than the sugar have become popular. Sweeteners are alternative substances to sugars, which give food a sweet taste and are used to partially or totally replace sucrose. The discovery of great number of sweeteners during the last decade has triggered the development of sugar free products, particularly for diabetic, obese people and for dietetic purpose. 2 Sweeteners such as nutritive (Polyols) and nonnutritive/ intense sweeteners (Artificial and natural) have become alternatives to replace sucrose and have been widely used in various food products. Natural sweeteners are mainly plant constituents. Plants have contributed to about 75 highly sweet compounds. These sweet compounds fall mainly within the terpenoid, flavonoid and protein compound classes, although altogether nine districts structural group**s** of potently sweet molecules have been derived from plants. So far, highly sweet compounds have not been documented as these occurred in lower plants, insects or native organisms and the taxonomic distribution of plants, known to biosynthesize highly sweet compounds, is random within the angiosperm super order as classified according to Dahlgren. Several highly sweet plant constituents are used commercially as sucrose substitutes in one or more countries. The plant secondary metabolites of most widespread interest in this regard are Steviol glycosides i.e. Stevioside and Rebaudioside A, constituents of the Stevia

rebaudiana bertoni. These two products, made from Stevia rebaudiana are widely available in Japan, with Stevioside approved as a sweetener in Brazil and having limited use in Korea too. In India, the use of artificial sweeteners in food products has not been very common so far when compared with the majority of western countries. However, over the past decade, there has been a steady increase in many Indian retail foods that are labeled as diet and /or light. Contrary to the situation on the late 1980s when only people with health problems (e.g. diabetes or high blood cholesterol) used to buy these products, many Indians have now started to consume low calorie foods and are eating less sugar and fat as part of their main diet. Given the reasonably sound track record of plant constituents and particularly Stevia rebaudiana (Stevioside glycoside) as “Intense” sweetening agents and because of the great public demand for natural food ingredients, particularly for diabetic and dietetic applications, FSDU, PFA has worked on the prospects of Steviol glycosides as sugar substitute. This comprehensive document on Stevia rebaudiana have included aspects for legal regulations of various countries, marketing and economic issues, status of stevia in India, commercial extraction, practical application of Stevioside in foods and beverages stability and Organoleptic studies , estimation of Stevioside when present in food or other samples. As well as botanical field and literature studies, chemistry, toxicological, mutagenicity, pharmacological properties, electrophysiological and behavioral methods for natural sweetener detection using Mongolian Gerbil and Cariogenicity study on Stevioside and Rebaudiana A.

Definition

Stevia Stevia Rebaudiana

Stevia is a herb with incredible sweetening property. Its ability to sweeten is rated between 70 to 400 times that of white sugar. Typically it has a mild licorice like taste and is completely natural in its biochemical profile.

Synonyms: Sweet herb
sugar leaf
honey leaf**.**

Parts used: Leaves

Fig.1

Background

Stevia is a plant indigenous to mountainous regions of Brazil and Paraguay. For centuries this herbal sweetener has been used by native cultures to counteract the bitter taste of various plant base medicines and beverages. Stevia rebaudiana (Bertoni) was rediscovered by Europeans in Paraguay in 1888 by Dr. M. S.

Bertoni. He later botanically described and named the plant (1905) in honor of Paraguayan chemist Dr. Rebaudi. Historically the natives of Paraguay and Brazil have been using the leaves of stevia as a sweetening essence for tea. Half a century later the British tried to cultivate it as a replacement for sugar, but the idea never materialized. Three decades later in 1971. Japanese brought the seedling of stevia from Brazil and six years later Japan marketed a sweetener extracted from the stevia leaves Stevia rebaudiana has been carried to too many countries since first described by Bertoni and has subsequently been grown in latitudes well north of its native tropic of Capricorn latitude. Stevia products are used commercially extensively in Japan, using locally grown and imported (mainly from China) dried stevia leaves where (at over 2000 tonnes refined products) they make up over 40% of the non-sucrose sweeteners (the others being fructose, syrups, honey etc.) and 5 to 6 % of the total sweetener market. In most other countries where it is used it is mainly used directly by consumers, rather than commercially. Domestic consumers utilize dried leaves, liquid extracts, crystals or powder to their drinks and cooking as an herbal supplement. The main Stevioside producing countries are China and Paraguay with adjacent parts of Brazil. China is a main supplier to Japan, who is the main commercial producer and user of Stevioside. Paraguay or Brazil is the main center for the production and distribution of Stevia products direct to consumer via the health food and herbal product outlets and by direct order sold around the worlds. There are the numbers of processors in Paraguay and Brazil who have company plantation of 2 to 300 hectors or more as well as numerous small holders suppliers.

Description

Stevia is a small perennial shrub with green leaves that belongs to the aster (asteraceae) or chrysanthemum family of plants. They grow primarily in the Amambay mountain range of Paraguay but over 150 various species of stevia including Stevia eupatoria, Stevia ovata, Stevia plummerae, S.rebaudiana, Stevia salicifolia and Stevia serrata have been identified around the globe**.** The distribution range of this taxon extends from Southwestern U.S.A to Northern Argentina, through Mexico, Central America, the South American Andes and the Brazilian highlands. Eight sweet ent-kaurene glycosides viz Stevioside, Rebaudiosides A-E, Ducloside A and Stevioside have been identified from Stevia rebaudiana Bertoni. High concentrations of these sweet principles accumulate in the leaves of this specie, with yields of over 10 % w/w of Stevioside, the most abundant representative of this series, having been reported. Extracts of S. rebaudiana are currently used commercially in Japan for sweetening variety of products including pickled vegetables seafood, soft drinks, and soy sauce and confectionary products. In addition, S. rebaudiana sweetening preparations were recently approved for sale in Brazil. The use of S.rebaudiana as a sweetener can be found in many parts of Central and South America, where these species are indigenous, as well as in Japan. Stevia rebaudiana is the only species at present which posses an inordinate ability to sweeten. Its common form is known as Stevioside, a fine white powder extracted from the leaves of the plant**.**

Status of Stevia in India

Stevia is a natural herb native of Paraguay, cultivated as a cash crop in number of countries. There appears to be no large-scale mechanized production of stevia due to difficulties in producing the crop through seeds. In India cultivation of stevia as a crop is still restricted to the research level. However Department of Ayurveda, Yoga & Naturopathy, Unani, Siddha and Homoeopathy **(**AYUSH) Government of India has sanctioned proposals for the prospects of S.rebaudiana cultivation in various states like West Bengal, Uttrakhand, Haryana and Punjab.

Cultivation

Stevia is self-incompatible in nature; hence propagation through seeds is a difficult proposition. Therefore, vegetative propagation or micro propagation is the means of propagation of stevia. Chalapathi (1996) standardized the vegetative propagation technique using stem cuttings. The 15 cm length of cuttings was found to be optimum and pretreatment of cuttings with Paclobutrazol at 50-100 ppm resulted in good sprouting and rooting. Ashwini (1996) standardized the micro propagation technique. Stevia can be grown on a wide range of soil with pH range from slightly acidic to neutral, but soil should not be saline **.** A field experiment was conducted at University of Agricultural Sciences, Bangalore to study the effect of length of stem cuttings and growth regulators on vegetative propagation of Stevia (Stevia rebaudiana bertoni). The sprouting percentage and shoot growth of sprouted

cuttings were significantly higher with 15 cm cuttings compared to 7.5 cm cuttings. Pretreatment of cuttings with 3-Indolbutyric acid (IBA) or anaphthapene acetic acid (NAA) or their mixture caused injury to callus tissue due to higher concentration and resulted in very poor sprouting even compared to control. The direct planting of stem in main field was found to have a limited success. Two accessions of S.rebaudiana were successfully introduced in the experimental farm at the Institute of Himalayan Bioresource Technology (IHBT), Palampur in 2000. Cultivation trial of these accessions was conducted during 2001-03. Overall crop performance was satisfactory for both the accessions and they were least affected by biotic and abiotic factors like high rainfall, frost, and infestation by insects and disease. Quantitative differences were found in Stevioside content of the two accessions, ranging between 6 and 8%. Accession 1 was superior in Stevioside content and Accession 2 was superior in leaf biomass. Higher content of Stevioside was found in the regenerated crop in January, during the second year of plant growth. With improved management practices, there is further scope for improvement in Stevioside content. A laboratory-scale process was developed for the extraction of Stevioside up to 63% purity. Although the crop is self-incompatible in its breeding behavior, the prevalence of two diverse accessions has facilitated seed production under Palampur conditions. This has triggered the production of plant material for its introduction amongst interested growers in large numbers.

Cultivation Parameters for Stevia Production in India

Altitude : 1300m msl

Soil characteristic : Clay loam in texture, low in carbon (0.2%), high in total nitrogen (0.15%), medium in available P2O5 (0.18%), pH 5.6

Commercial Extraction of Steviol Glycosides

Most of the commercial processing of stevia leaves occurs in Japan and there are dozens of patents describing methods for the extraction of Steviol glycosides categorized into those based on solvent solvent plus a decolorizing agent, adsorption chromatography ion exchange and selective precipitation of individual glycosides. The most favored extraction processes involve four steps: aqueous or solvent extraction, ion exchange, precipitation or coagulation with filtration, then crystallization and drying. New methods based on ultra-filtration have been disclosed recently**.**

Traditional Method

The traditional method of use by the Paraguayan Guarani Indians was to dry the leaves and to use them to sweeten tea and medicines or to chew the leaves as a sweet treat. Stevia was regularly used in drinks many times a day, not just occasionally, with no side effects.

Improved Method

The use of dried leaves (pieces or powder) is not unacceptable in domestic cooking but it does leave sediment in clear drinks etc and can also leave a green color. There can also be an unpleasant aroma associated with the dried leaves. Appropriate processing of the dry herb can remove this aroma, which is due to specific leaf compounds (not Stevioside). Aqueous extracts of the leaves obtained by boiling leaves in water followed by cooling and straining (filtration). Crystalline powders and extracts are preferred in the commercial situation as they have a fixed known sweetening value. There are a number of patented refining processes registered in Japan. They generally use four basic steps:

1. Dissolving the sweetener in boiling water or in other solvent.
2. Ion – exchange separation.
3. Filtration with precipitation / coagulation.
4. Crystallizing and drying

Methanol appears to be used in most of the extraction and purification process, presumably to improve extraction efficiency and to facilitate the separation of individual Steviosides. This use of methanol however raised the questions regarding safety aspect of the stevia extracts. More recent processing methods used water filtration procedures and do not use methanol and so produce a more natural product. Newer factories in Brazil used only water extraction procedures and claim 96% purity of the product e.g. Stevia Crystals. Boiling water extraction can achieve 93 – 98 % extraction of Stevioside. The purification and separation of the various glycosides can be achieved with resin adsorption and ion exchange methods. Reverse osmosis, ultrafilteration and nanofilteration can also be used. Some extraction methods have been designed to maximize R-A percentage. The need to separate the various Steviosides could diminish as the ratio of R-A %: Stevioside

% in the leaves is increased by plant breeders from under 0.8:1 to over 1.2:1. In pure (crystalline) form the Stevioside mix will be 250-300 times sweeter than sugar and therefore could be valued at $75 - 90 /kg (cost of equivalent sweetening quantity of sugar at $300/tonne). Most primary processing of stevia leaves is carried out in China, Japan, Korea, Brazil or Paraguay, where factories are located near original growing areas. Factories in Japan (and Korea) now import leaves for processing, as growing of stevia has almost ceased in Japan. The most common processes used for extracting Steviol glycosides from the leaves consist of

- Soaking leaves in warm/hot water to dissolve the glycosides (in batches)
- Filtering the resultant liquid (often after adding a precipitation agent)
- Concentration by vacuum evaporation
- Resin exchange to separate the glycosides into high and low R-A fractions
- Ion exchange purification (sometimes)
- Evaporation and spray drying or, less frequently, crystallization to produce the stevia powder/crystals. Some secondary processing may be undertaken, especially in Japan, to further separate high R-A fractions or to convert Stevioside to Rebaudioside or some other glycoside to improve taste quality. This process is very similar to the extraction process of raw sugar from sugar cane**.**

Steviol Glycosides

The Joint Expert Committee on Food Additives (JECFA) committee in its fifty-first meeting (1999) stated that Before the substance is reviewed again specifications should be developed to ensure that the material tested is representative of the material of commerce. Further information was required on the nature of the substance that was tested, on the metabolism of the Stevioside in humans and on the activity of Steviol in suitable studies of Genotoxicity in- vivo. JECFA in its 63rd meeting (2004) at Geneva has noted that Steviol glycosides are natural constituents of the plant Stevia rebaudiana bertoni which contain at least ten different glycosides, the major constituents being Stevioside and Rebaudioside A. The material evaluated at that meeting contains not less than 95% glycosylated derivatives of Steviol, primarily Stevioside, Rebaudioside A and C and Dulcoside A, with minor amounts of Rubausoside, Steviolbioside and Rebuioside B, D, E and F. In the same meeting the JECFA has brought out a detailed tentative specifications of the Steviol glycosides which includes

- Stevioside
- Rebaudioside A
- Rebaudioside C
- Dulcoside A

JECFA has allotted a temporary ADI of 0 to 2 mg/kg bw for Steviol glycoside (expressed as Steviol) on the basis of the NOEL for Stevioside (970 mg/kg bw/day or 383 mg/kg bw/day, expressed as Steviol in the two years) after a study on rats and using a safety factor of 200. This safety factor incorporates a factor of 100 for inter and intra species differences and an additional factor of 2 because of the need for further information. The committee noted that this temporary ADI only applies to products complying with the specifications. New tentative specifications were prepared, accompanied by a chemical and technical assessment. JECFA also recommended for the collection of following information for commercially available products:

- Analytical data on distribution and concentration of all components Steviol glycosides, including those that were not identified in the tentative specifications.
- Method of analysis for the determination of all components Steviol glycosides, including those that were not identified in the tentative specifications.
- The nature and concentration of the fractions that do not contain Steviol glycosides.
- The quantities of residual solvents from isolation & purification steps of the manufacturing process.
- The hydrolytic stability of the Steviol glycoside in acidic foods and beverages.

Chemical Name

The following are the chemical names for the principal and secondary Steviol glycosides:

Stevioside: 13-[(2-O-β-D-glucopyranosyl-β -D-glucopyranosyl) oxy] kaur-16-PM-18-oic acid β-Dglucopyranosyl ester.

Rebaudioside: 13-[(2-O-β-D-glucopyranosyl-3-β-Dglucopyranosyl- β-D-glucopyranosyl]

oxy.kaur-16-PM-18-oic acid β-Dglucopyranosyl ester.

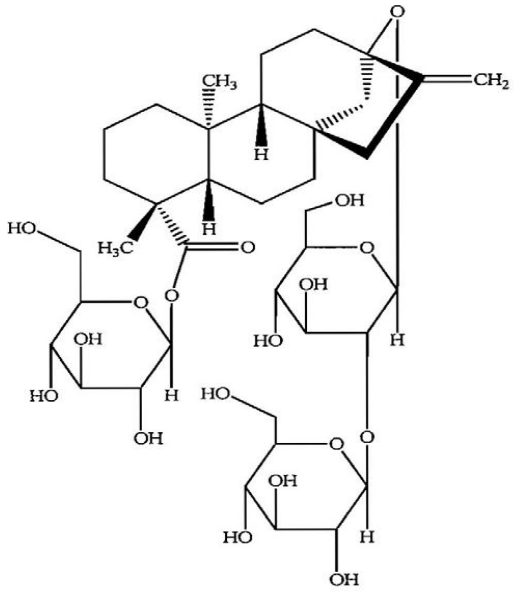
Rebaudioside C: 13-[(2-O-α-L-rhamnopyranosyl-3-O--β-Dglucopyranosyl-β- D-glucopyranosyl -β- D-glucopyranosyl-β-D-glucopyranosyl] oxy. kaur-16-PM-18-oic acid β-D- glucopyranosyl ester.

DulcosideA: 13-[2-O-α-L-rhamnopyranosyl-β-Dglucopyranosyl] oxy. kaur-16-PM-18-oic acid β-D- glucopyranosyl ester.

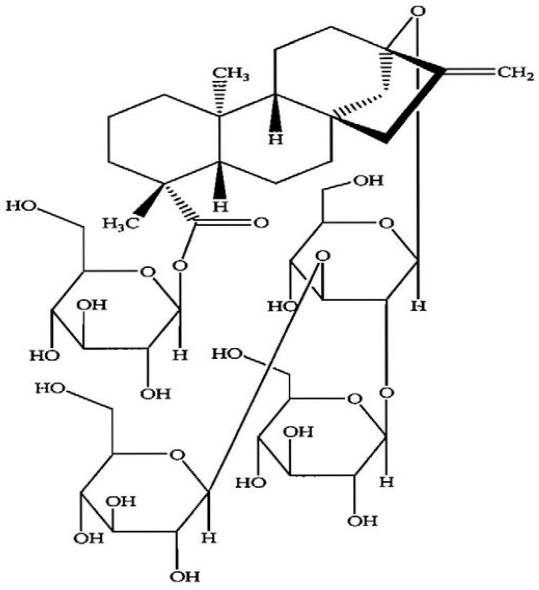
Chemical formula

The following are the chemical formulas for the principal and secondary Steviol glycosides:

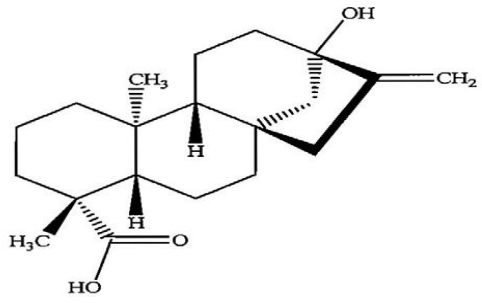
Stevioside :	C38H60O18
Rebaudioside A :	C44H70O23
Rebaudioside C :	C44H70O22
Dulcoside A :	C38H60O17



Stevioside



Rebaudioside A



Steviol

Fig. 2

Description

White crystalline powder, odorless or having a slight characteristic odour about 200-300 times sweeter than sucrose

Uses of Stevia

Need of intense sweeteners

In early days, honey and fruits have been used for their sweetness. It is only in the 14th century that sugar was refined and considered as a

special food item. The main source of sugar for long has been cane sugar with beet sugar contributing a small percentage. The production of cane sugar has been of the order of 262 million tonnes and that of beet sugar 19,500 tonnes in India. These sugars along with sweetening qualities also have been found to contribute calories, which can lead to obesity or may act as a risk factor for some chronic diseases such as diabetes mellitus, hypertension and cardiovascular diseases. In a sweet-toothed society, in which sugar and chemical sweeteners are considered unsuitable for health, the interest is now focused on natural sweeteners**.** Hence the craving for sweetness led man to discover several forms of alternative intense sweeteners, which have made possible to offer consumers the sweet taste without the calories. Intense sweeteners add to food a taste that is similar to that of sucrose and is generally several hundred to several thousand times sweeter than sucrose. Most of them do not contain any calories, and those that do contain calories, are used in very small amounts because of their, concentrated sweetening property**.**

Non-nutritive sweeteners serve a number of purposes.

They are used to expand food and beverage choices for those who must or want to control calories, carbohydrate, or specific sugar intake. A significant number of people in affluent countries are overweight, and obesity is frequently cited as a serious health problem.

- Assist weight control or reduction.
- Aid the management of Diabetes.
- Assist the control of Dental caries.
- Enhance the usability of pharmaceuticals and cosmetics. As these are often superior top sugars in making the unpleasant taste of drugs.
- Provide sweetness when sugar is not available.(e.g. in various countries during world war I and II)
- Assist the cost effective use of limited resources.

There are three distinct traditions for using Flavor Enhancement

Stevia whole leaf or whole leaf extract is combined with other herbs to enhance the flavor and nutritive value of other herbs. Stevia is traditionally considered nutrient rich containing calcium, phosphorous alongwith moderate source of protein.

Herbal Tea

Stevia is appropriate for use in conjunction with a variety of other herbal teas. One can mimic the South American practice of combining stevia with verba mate, lapacho, and other native herbs, or one can experiment with stevia in altering the taste parameters of any number of traditional teas**.**

Steviol glycosides

Steviol glycosides (the purified extract) are good alternative to sugar in nearly all of its uses and can replace all or some of the Sugar. Unlike some man-made chemical sweeteners Steviol glycosides can be used in conjunction with other sweeteners (e.g., sugar, fructose, intense sweeteners) and they act as a flavor enhancer as well as a sweetener. They have been used in other countries for many years (e.g. Japan for more than 35 years). Food products containing stevia extracts, which have been successfully produced and consumed includes:

- Aerated soft drinks, mineral waters and cordials etc
- Juices and juice drinks
- Ice creams, yoghurts, milk and other dairy products
- Sauces, chutneys, pickles
- Biscuits, cakes and pastries
- Preserved fruits, jams and spreads
- Processed and frozen vegetables and meats
- Confectioneries, chocolate
- Cereals and muesli bars.
- Other stevia-containing products have included toothpastes, chewing gums and medicinal tablets. It is often recommended for inclusion in weight loss diets and for diabetic foods and as part of diets to combat a range of chronic disorders and infections. The largest consumers of stevia include Japan, China, Korea, Paraguay and Brazil, with both Japan and China having peak consumptions reaching 2,000 tonnes of Steviol glycosides per year in 1995 – 2003. Some beneficial side effects of Steviol glycoside consumption have been demonstrated in a number of scientific studies and papers. These include reducing high blood pressure, reducing high blood

glucose levels, a reduction in dental caries bacteria and other bactericidal effects. These effects, combined with the non-calorie sweetness, the 'all natural' nature and flavor enhancing properties, add to the attractiveness of using Steviol glycosides in foods and beverages**.**

Interaction with other low calorie sweeteners

With regard to the practical application of low calorie sweeteners in synergistic mixtures, binary aqueous solutions of Stevioside with other individual low calorie sweeteners, Saccharin, Cycalmate, Aspartame, Acesulfame K and Neohesperidin dihydrochalcone, were investigated. Excellent stability were found in the course of thermal treatment at 80oC for up to 4 hrs as well as over 4 months of incubation at room temperature, indicating that there are no chemical interference to the simultaneous use of Stevioside with low calorie sweeteners.

Advantages of Stevia & Steviol Glycosides

What makes the stevia plant so special is that it can be used to replace sugar (sucrose). Indeed, the leaves contain diterpene glycosides with a sweet taste but which are not metabolized and contain no calories. The biggest part of the sweet glycosides consists of the Stevioside molecule.

The principal advantages of stevia and Steviol glycosides are the following

- It is a natural non-synthetic product.
- Stevioside (the Steviol glycosides) contains no calories as like of other sweeteners.
- Stevia leaves can be used in their natural state (fresh as well as dried form).
- The plant has been reported to be non-toxic.
- Thanks to its high sweetening intensity, only small quantities need to be used in its applications.
- The leaves as well as the pure Stevioside extract can be used as such or while cooking.
- Studies suggested it to be safe for diabetics, Phenylketonurian (PKU) patients as compared to other sweeteners.
- Stevia does not increase the blood sugar therefore can be used by diabetics without adverse glycemic responses.
- Due to its almost negligible calorie contribution, it is useful for overweight, obese and for health conscious individuals. Stevia in the form of pure extract has been reported to give 200 to 300 times sweetness than sugar.
- Stevia is non-fermentable.
- Stevia acts as plaque retardant anti-caries and prevents cavities.
- Stevia is non-toxic but, on the contrary, it is healthful, as shown by long experience
- The human body does not recognize the sweet glycosides and they pass right through the normal excretion channels and thus the body obtains no calories from stevia therefore stevia may be safe for diabetic and hypoglycemic patients in its pure, unadulterated form.
- Stevia can enhance the effect of other sweeteners such as honey and maple syrup so adding it to recipes might be helpful in reducing the amount of total sweetener needed.
- Stevia is comparatively more intense sweetener than other available artificial sweetener in market.
- Cheaper as compare to sugar as well as the rest of the available sweeteners.

Hypoglycemia: Sign of Hard Times

It is rather disturbing to learn that statisticians estimate that almost 20 million Americans suffer from some type of faulty glucose tolerance. Hypoglycemia and diabetes are the two major forms of blood sugar disorders and can deservedly be called modern day plagues. Hypoglycemia is an actual disorder that can cause of number of seemingly unrelated symptoms. More and more studies are pointing to physiological as well as psychological disorders linked to disturbed glucose utilization in brain cells. One study, in particular, showed that depressed people have overall lower glucose metabolism. Hypoglycemia occurs when too much insulin is secreted in order to compensate for high blood sugar levels resulting from eating sugary or high carbohydrate foods. To deal with the excess insulin, glucagon, cortisol and adrenalin pour into the system to help raise the blood sugar back to acceptable levels. This can inadvertently result in the secretion of more insulin and the vicious cycle repeats itself. A hypoglycemic reaction can

cause mood swings, fatigue, drowsiness, tremors, headaches, dizziness, panic attacks, indigestion, cold sweats, and fainting. When blood sugar drops too low, an overwhelming craving for carbohydrates results. To satisfy the craving and compensate for feelings of weakness and abnormal hunger, sugary foods are once again consumed in excess. Unfortunately, great numbers of people suffer from hypoglycemic symptoms. Ironically, a simple switch from a high sugar diet to one that emphasizes protein can help. In addition, because sugar cravings are so hard to control, a product like stevia can be of enormous value in preventing roller coaster blood sugar levels. One Colorado internist states: People who are chronically stressed and are on a roller coaster of blood sugar going up and down are especially prone to dips in energy at certain times of day. Their adrenals are not functioning optimally, and when they hit a real low point, they want sugar. It usually happens in mid-afternoon when the adrenal glands are at their lowest level of functioning. Our craving for sweets in not intrinsically a bad thing; however, what we reach for to satisfy that craving can dramatically determine how we feel. Stevia can help to satisfy the urge to eat something sweet without changing blood sugar levels in a perfectly natural way and without any of the risks associated with other non-nutritive sweeteners.

Diabetes: Pancreas Overload

Diabetes is a disease typical of western cultures and is evidence of the influence that diet has on the human body. Perhaps more than any other disease, diabetes shuts down the mechanisms which permit proper carbohydrate/sugar metabolism. When the pancreas no longer secretes adequate amounts of insulin to metabolize sugar, that sugar continues to circulate in the bloodstream causing all kinds of health problems. The type of diabetes that comes in later years is almost always related to obesity and involves the inability of sugar to enter cells, even when insulin is present. Diabetes can cause blindness, atherosclerosis, kidney disease, the loss of nerve function, recurring infections, and the inability to heal. Heredity plays a profound role in the incidence of diabetes, but a diet high in white sugar and empty carbohydrates unquestionably contributes to the onset of the disease. It is estimated that over five million Americans are currently undergoing medical treatment for diabetes and studies suggest that there are at least four million Americans with undetected forms of adult onset diabetes. Diabetes is the third cause of death in this country and reflects the devastating results of a diet low in fiber and high in simple carbohydrates. Most of us start our children on diets filled with candy, pop, chips, cookies, doughnuts, sugary juice, etc. Studies have found that diabetes is a disease which usually plagues societies that eat highly refined foods. Because we live in a culture that worships sweets, the availability of a safe sweetener like stevia, which does not cause stress on the pancreas is extremely valuable. If sugar consumption was cut in half by using stevia to stretch sweetening power, our risk for developing blood sugar disorders like diabetes and hypoglycemia could dramatically decrease.

Additional Therapeutic Benefits

Stevia is not only non-toxic but has several traditional medicinal uses. The Indian tribes of South America have used it as a digestive aid, and have also applied it topically for years to heal wounds. Recent clinical studies have shown it can increase glucose tolerance and decrease blood sugar levels. Of the two sweeteners (aspartame and stevia), stevia wins hands down for safety. Stevia has a long history of medicinal use in Paraguay and Brazil and while many of the therapeutic applications of stevia are anecdotal, they must be considered in that they have spanned generations. Experts who work with indigenous cultures frequently find that traditional applications of folk medicine can be verified with scientific data.

Stevia and Blood Sugar Levels

Clinical tests combined with consumer results indicate that stevia can actually help to normalize blood sugar. For this reason, the herb and its extracts are recommended in some countries as an actual medicine for people suffering from diabetes or hypoglycemia. Recent studies have indicated that stevia can increase glucose tolerance while decreasing blood sugar levels. Paraguayan natives have traditionally used stevia tea to regulate blood sugar. Stevia decoctions for diabetes are common and are usually prepared by boiling or steeping the leaves in water. While scientific studies are certainly warranted, it is thought that disturbed blood sugar levels respond to stevia therapy while normal levels remain unaffected.

Stevia and Weight Loss

Stevia is an ideal dietary supplement for anyone who wants to lose or maintain their weight. Because it contains no calories, it can satisfy cravings for sweets without adding extra pounds. It is also thought that using stevia may decrease the desire to eat fatty foods as well. Appetite control is another factor affected by stevia supplementation. Some people have found that their hunger decreases if they take stevia drops 15 to 20 minutes before a meal. While scientific studies are lacking in this area, it is presumed that the glycosides in stevia help to reset the appestat mechanism found in the brain, thereby promoting a feeling of satiety or satisfaction. Much of our nation's obesity epidemic is due to the over consumption of sugar-containing foods. Unfortunately, most sugary snacks are also loaded with fat, compounding the problem. When a sugar craving hits, anything will usually do. Doughnuts, candy bars, pies, pastries and cookies are considered high calorie, fattening foods. Using stevia to sweeten snacks and beverages can result making weight loss and management much easier.

High Blood Pressure

It is thought that taking stevia can result in lowering elevated blood pressure levels while not affecting normal levels. This particular application has not been researched, but its potential as a treatment for hypertension must be considered when assessing the value of herbal medicines for disease.

Microorganism Inhibitor

Stevia is thought to be able to inhibit the growth of certain bacteria and other infectious organisms. Some people even claim that using stevia helps to prevent the onset of colds and flu. Tests have supported the antimicrobial properties of stevia against streptococcus mutans . The fact that stevia has the ability to inhibit the growth of certain bacteria helps to explain its traditional use in treating wounds, sores and gum disease. It may also explain while the herb is advocated for anyone who is susceptible to yeast infections or reoccurring strep infections, two conditions that seem to be aggravated by white sugar consumption.

Oral Tonic

Stevia can be used as an oral tonic to prevent tooth decay and gingivitis. Stevia extracts are sometimes added to toothpaste or mouthwashes to initiate this effect. Stevia is used in some Brazilian dental products with the assumption that the herb can actually help to prevent tooth decay and retard plaque deposits. Stevia offers the perfect sweetener for oral products like toothpastes and mouthwash, enabling them to be more palatable without any of the drawbacks of other sweeteners.

Digestive Aid

Brazilians have used stevia to boost and facilitate better digestion. Again while this therapeutic application remains unresearched the fact that stevia has a long history of use as a gastrointestinal tonic must be acknowledged. Plant glycosides can exert numerous therapeutic actions in the human body.

Stevia and Skin Care

Whole leaf stevia or its by-products have been used to soften and tone the skin and to ease wrinkles and lines. Facial masks can be made by adding liquid to the powder, and liquid elixirs can be used as facial toners to help tighten the skin. Stevia concentrate in the form of drops has also been used directly on sores or blemishes to promote healing. For this reason, some advocates of stevia use it on other skin conditions such as eczema, dermatitis, or minor cuts or wounds. Stevia tea bags can be placed over the eyes to ease fatigue and to tone the skin. Stevia skin care products are available in clay bases, masks, and water-based creams. Liquid extracts can be directly applied to the skin.

REFERENCES

1. Anonymous (2000) Low calorie sweeteners and health; IFIC Review, Washington 1-12.
2. Pinheiro M.V.S, Oliveria M.V et al, The effect of different sweeteners in low-calorie yougurts-a review International Journal of Diary technology 2005, Vol. 58(4) 193-199.
3. Matsubara, Alimentos funcionais: Uma tendencia queabre perspectivesaos laticinios, Industria de Laticinios 2001: 10-18.
4. Tammie et al 1994 Siveri and Oliveirs 2002.
5. Zdemir & Sadikoglu Characterization of Rheological properties of systems containing sugar substitutes & carrageenam International Journal of

food Science and Technology 1998 Vol. 33,439-444.
6. inisterioda Saude, Journal of food Science and Technology 1997,Vol 32.
7. Kinghorn et al, Non-Cariogenic intense natural sweeteners Inc. Med. Res. Rev, 1998 Vol 18(5) 347- 360.
8. Antonie Al-Achi et al (Campbell University School of Pharmacy) Stevia: A plant for sweetness U.S.Pharmacist- a Johnson publication, 2000 Vol 25.
9. Mindore.D.J, Rank.A.M RIRDC (Rural Industries Research Development Corporation) publication Australia and New-Zealand, August 2002 report.
10. Elkins.R, Stevia-Nature's sweet, woodland publication 1999.
11. Midmore J.D., Rank A.H. An intense natural sweetener-laying the ground work for a new rural industry May 2006 RIRDC Publication No 06/020 RIRDC Project No UCQ-17A.
12. Dzyuba.O.O, Stevia rebaudiana (Bertoni) Hemsley-A New Source of Natural Sugar Substitute for Russia Rastitel Nye Resursy 1998 Vol 34(2) 86-95.
13. Gvasaliya.V.P, Kovalenko.M.C et al Studies on the Possibility of Growing Honey Grass in Abkhazia conditions Subtropiches kie Kul Tury 1990 Vol 5 149-156.
14. Shu.S, Stevia Rebaudiana Variety Trails, Zuocou Pinzhong Ziyuan 1989 Vol 1, 17-18.
15. Colombus.M, The Cultivation of Stevia 'Nature's Sweetener' Ontario Canada, 1997, 4. 98.
16. Shock.C.C, Rebaudi's Stevia: Natural Noncalorie Sweeteners, California Agriculture, 1982 Vol 36(9) 4- 5.
17. Lee.J.I et al, Studies on the New Sweetening Source Plant, Stevia Research Reports of the office of Rural Development Crop 1980 Vol 22-22.
18. Matejka.V, Climatic Requirements and Possibilities of Growing the Herb Stevia rebaudiana bertoni in Czech Republic, Agriculturra Tropica et Subtropica, 1992, Vol 25, 21-32.
19. Fors.A.L, A new character in the sweetener scenario Sugar Journal 1995 Vol 58(2) 30.
20. Shyu.Y.T et al Effects of harvesting dates on the characteristics, yield and sweetness Journal of Agricultural Research of China 1994 Vol 43(1) 29-39.
21. Megeji.N.W et al, Introducing Stevia Rebaudiana-A natural Zero calorie Sweetener Current Science; 2005 Vol 88(5).
22. Goenadi.D.H, Effect of slope position on the growth of Stevia in Indonesia communications in soil science & plant analysis 1987 Vol 18(11) 1317-1328.
23. Oddone.B, How to grow Stevia Gaurani botanicals Inc: Pawcatuck, Connecticut 1999: 130.
24. Tateo.F et al, Stevioside content and morphological variability in a population of Stevia Rebaudiana(bertoni) Bertoni form Paraguay, Italian Journal of Food Science, 1998 Vol 10(3) 261-267.
25. Huang.Y.S et al, Studies on the variation of Stevioside content and selection of type Rebaudioside A in Stevia Rebaudiana, Journal of Plant Resources and Environment, 1995, Vol 4(3) 28-32.
26. Korneienko.A.V et al, Stevia Cultivation; Sakharnaya svekla (Russain), 1995 Vol 10: 22-24.
27. Jia.G.N, An experiment on the cultivation of Stevia Rebaudiana Shaxi Agricultural science (Chinese) 1984(1) 20-21.
28. Suhendi.D Mass selection of Stevia rebaudiana bertoni Menara Perkebunan 1989 Vol 56(4) 93-95.
29. National Medicinal Plants Board-Department of AYUSH (Ministry of Health and Family Welfare, Govt.of India), Enquiry on present policies and prospects of cultivation of Stevia Rebaudiana, F.NO. A.11019/4/2005-NMPB Dated 19th May 2005.
30. Chalapathi.M.V, Shivraj.B et al, Nutrient uptake and yield of Stevia (Stevia rebaudiana bertoni) as 99 influenced by methods of planting and fertilizers levels, Crop Research, 1997, Vol 14(2), 205-208.
31. Chalapathi.M.V, Thimmegowda et al, Natural Noncalorie Sweetener (Stevia rebaudiana bertoni)-A future crop of India, Crop Research, 1997 Vol 14(2) 347-350.
32. Chalapathi.M.V et al, Vegetative Propagation of Stevia Crop Research 1999 Vol 18(2).

33. Ramesh.K, Singh V, Megeji.N.W Cultivation of Stevia (Stevia rebaudiana bertoni: A comprehensive Review Advances in Agronomy 2006 Vol 89, 137-177.
34. Kinghorn .A.D, Soejarto.D.D Current status of Stevioside as a sweetening agent for human uses Progress in Economic and Medical Plant Research 1985 Vol 1, 1-52.
35. Haa et al, 1976, Itagaki and Ito 1979.
36. Uneshi.H. Kobayashi.T et al, Purification of a stevia sweetening agent Jap. Patent, Vol 54-030199.
37. Brandle.J.E, Starratt.A.N, Gijzen.M, Stevia Rebaudiana: Agricultural biological and chemical properties, Canadian Journal of Plant Science 1998 Vol 78: 527-536.
38. Pasquel.A, Meireles.MA.A, Marques.M.O.M and Patenate.A.J, Extraction of Steviol glycosides with Co2+water, Co2+ethanol and Co2+water+ethanol, Brazilian Journal of Chemical Engineering 2000, Vol 17(3).
39. Combined Compendium of Food Additive Specifications, Tentative specification prepared at sixty third JECFA meeting; Published in FNP 52 Add 12: 2004.
40. Darise.M; Kohda.H, Mizutani et al, Chemical Constituents of Flowers of Stevia rebaudiana bertoni Agriculture Biological Chemical 1983 Vol 47: 133-135.
41. Kinghorn.A.D, Fullas.F, Hussain.R.A, Studies in natural products chemistry, structure and function(c) Elsevier Science Publishers, 1995 Vol 15-3.
42. Soejarto. A. D, Kinghorn. D et al Potential sweetening agents of plant origin-III- Organoleptic evaluation of stevia leaf Herbarium samples for sweetness; Journal of Natural Products 1982 Vol45(5), 590-599.
43. Rodriguez. E, Latinoamer. Q; 1977 Phytochemistry.