**Stevia:A Natural Sweetener.**

Sakshi Solanke

Department Of Clinical Nutrition And dietetics,Indian Institute of Food Science and Technology,

Cha.Sambhajinagar-431001

Sakshisolanke03@gmail.com

## ABSTRACT

Studies revealed that Stevia has been used throughout the world since ancient times for various

purposes; for example, as a sweetener and a medicines. 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. Its white crystalline compound (stateside) is the natural herbal sweetener with no calories

and is over 100 300 times sweeter than table sugar.

**Keywords**—Stevia leaves, radiosonde, stevioside, extract, powder, medicinal use

## INTRODUCTION

Stevia repudiation is a small perennial growing up to 65 80 cm tall, with senseless,

oppositely arranged leaves. Different species of Stevia contain several potential sweet

ening compounds, with S. rebaudiana being the sweetest of all. Stevia is a semi-humid

subtropical plant that can be grown easily like any other vegetable crop even in the

kitchen garden. The soil should be in the pH range 6.5 7.5; well-drained red soil and

sandy loam soil. Saline soils should be avoided to cultivate this plant. Stevia has been

successfully cultivated in recent years in many areas of Indian states: Rajasthan,

Maharashtra, Kerela and Orissa. The increasing demands for natural sweeteners

have driven the farmers in India toward large-scale Stevia cultivation. Diterpene

glycosides are the group of natural sweeteners that have been extracted from Stevia.

The leaves of wild Stevia plants contain 0.3% dulcoside, 0.6% rebaudioside C, 3.8%

rebaudioside A and 9.1% stevioside.

Stevia (Asteraceae) is a woody shrub that can reach 80 cm in height when it is fully

matured. The Stevia genus comprises at least 110 species (Rajbhandari and Roberts

1983) but there may be as many as 300. Its habitat extends from the southwestern

United States to the Brazilian highlands (Soejarto et al. 1982).

**Chemical constituents**

The complete chemical composition of Stevia species is not yet available. However, a

variety of Stevia species has been tested for their chemical compositions. The useful

part of this shrub is the leaves. Out of 110 species tested for sweetness, only 18 were

found to possess this characteristic (Soejarto et al. 1982). Eight ent-kaurene glyco

sides—namely dulcoside A, rebaudiosides A

E, steviolbioside, and stevioside—

produce the sweet taste sensation (Kinghorn et al. 1984). These glycosides are mainly

compounds of the diterpene derivative steviol (Shibata et al. 1995). S. rebaudiana

Bertoni, the sweetest species, contains in its leaves all of the eight ent-kaurene glycosides

(Kinghorn et al. 1984), with stevioside being the major constituent (3 8% by weight of

the dried leaves) (Melis 1992). In addition, S. rebaudiana Bertoni contains stigmasterol,

b-sitosterol, and campesterol (D’Agostino et al. 1984). The same species also contains

steviol, a product formed by enzymatic hydroxylation within the plant (Kim et al. 1996).

Other chemicals with no sweet taste are also found in Stevia species and some may even

be bitter in taste. Stevisalioside A (from the roots of Stevia salicifolia) (Mata et al. 1992),

longipinane derivatives in the roots of Stevia connata (Sanchez-Arreola et al. 2000),

epoxylabdane diterpenes and a clerodane derivative in the leaves of Stevia subpubescens

(Roman et al. 2000), flavonoid from the leaves of S. rebaudiana (Soejarto et al. 1982),

Stevia nepetifolia (Rajbhandari and Roberts 1983), Stevia microchaeta, Stevia monardifolia,

Stevia origanoides (Rajbhandari and Roberts 1985) and Stevia procumbens (aerial parts)

(Sosa et al. 1985), and sesquicentennial lactones from the aerial parts of S. procumbens and

the leaves of S. origanoides (Calderon et al. 1987) are in this group.

**Human studies**

Despite centuries of use, there is still a lack of comprehensive clinical studies on Stevia

as a supplement. In normal human volunteers, the effect of administering extracts of

S. rebaudiana on glucose tolerance tests was investigated. Subjects were given aqueous

extracts from 5 g leaves every 6 h for 3 days. A glucose tolerance test was performed

before and after administration of the extracts. The results showed that treatment with

Stevia resulted in an increase in glucose tolerance and a decrease in plasma glucose

concentrations (Curi et al. 1986). Moreover, it was shown recently that both steviol and

stevioside can produce a direct effect on beta cells in the pancreas to release insulin.

The authors concluded that this plant may have a potential use in the management of

type 2 diabetes (Jensen et al. 2000).

**Cariogenic and mutagenic effects**

Since Stevia products are used as sugar substitutes by many populations, a study was

conducted to test whether stevioside and rebaudioside A may have the potential of

causing dental caries from prolonged use. Rats were fed a diet containing 0.5%

stevioside or 0.5% rebaudioside A for 5 weeks. Neither compound showed a potential

of increasing the risk of developing dental caries (Das et al. 1992). Several researchers

investigated the risk of mutagenicity. In two studies (Matsui et al. 1986; Pezzuto et al.

1996), steviol produced a dose-related positive mutagenic effect in some tests. In the

same studies, stevioside was found to be devoid of this effect. Other reports indicated

lack of mutagenicity of both compounds (Suttajit et al. 1993; Klongpanichpak et al.

1997). Because of these contradictory reports, the Food and Drug Administration is

still cautious in introducing this herb as a sugar substitute until its safety is completely

established (FDA 1999).

**Stevia products**

Some examples of Stevia products available on the market in the USA are presented

in Table III. Products of Stevia can be purchased directly from various companies or

from local pharmacies. Many companies sell Stevia products via the Internet.

**Medicinal values**

Studies on food safety, including an extensive review of the literature, undertaken prior

to 1982 (Lee 1979; Kinghorn 1982) concluded that Stevia leaves and extracts are safe;

studies since then confifirm this. Possible medicinal uses have been investigated often by

using Stevia extracts as intravenous infusions in rats; possible effects on glucose

metabolism, diuresis, organ weights, endocrine function, and so on, have been studied

in this way (Kinghorn 1987; Nunes and Pereira 1988; Oliveira Filho 1988; Suanar

unsawat and Chaiyabut 1996, 1997). Stevia extract infusions have also shown some

anti-androgenic activity in rats (Sincholle and Marcorelles 1989). Likely beneficiary

effects of Stevia extracts, as antioxidants and to relieve blood pressure and hyperten

sion, have also been shown (Chan et al. 1998; Xi 1998; Xi et al. 1998). Steviol (a

precursor in the biosynthesis of steviosides) can be produced from steviosides expert

imentally using specific bacteria but not in situ in the human body. Steviol can exhibit

some toxic and mutagenic activity (Tateo 1990).

Investigations of the effect of aqueous extract of S. rebaudiana leaves on glucose

tolerance have been carried out by Curi et al. (1986) on volunteers. Aqueous extract

of 5 g leaves were administered to volunteers at regular 6-hourly intervals for 3 days,

with glucose tolerance tests performed before and after extract administration.

The extract increased glucose tolerance; it significantly decreased plasma glucose

levels during the test and after overnight fasting in all volunteers. In Japan, where

artificial chemical sweeteners are not approved, many toxicology safety studies

have been conducted (Elton Johnson 1990). Among studies carried out are some

to investigate carcinogenicity and mutagenicity (if any) in animal testing (Oliveira

Filho 1988; Toruan-Mathius et al. 1995; Toyoda 1997), to show dental benefits in

the form of plaque inhibition and cavity reduction (Elton-Johnson 1990), to confifirm

the safety of Stevia for diabetic use (Polanski et al. 1997; Methanol and

Narongsak 1997). The safety of feeding to animals, chickens and humans has also

been confirmed by a wide range of studies (Sincholle and Marcorelles 1989; Smolyar

1993; White et al. 1994; Melis 1995, 1997; Suanarunsawat and Chaiyabut 1996,

1997; Wood 1996; Polyanskii et al. 1997).

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. The use of dried leaves (pieces or powdered) is

unacceptable in domestic cooking and does leave a sediment in clear drinks, and so

forth, and can also leave a green colour. There may also be an unpleasant aroma

associated with the dried leaves. Appropriate processing of the dry herbage may

remove this aroma, which is due to specific leaf compounds (not steviosides)

(Tsanava et al. 1991). Although Stevia has been used without any problems for

many years in its native Paraguay and in other countries for lesser periods, health

and safety issues have been receiving considerable attention in the past 20 years.

There has been considerable media attention in the USA, including claims and

counterclaims before the US FDA. Many of these claims relate to its potential

competitive position in relation to aspartame. Stevia products have been approved

for use in the USA as nutrition supplements although many protagonists claim it

should be granted Generally Regarded As Safe status in the same manner as tea,

coffee, sugar and fruit and vegetables, and so on. The general safety of steviosides

could be largely due to the fact that they are not broken down nor are absorbed in the

digestive tract (Hutapea 1997). Bacteriological studies on hot water extract from

S. rebaudiana have been carried out by Tomita (1997). Lactobacilli were not killed on

exposure to the fermented extract; however, under acidic conditions, the extract was

found to be bactericidal.

In Japan, artificial sweeteners were banned some 40 years ago so Stevia has been

their chosen alternative to sweeten their food and beverages. The Japanese have

performed over 40,000 clinical studies and found Stevia to be safe. Stevia in its raw

form, although incredibly sweet, has a very subtle liquorice essence to it. A sign of an

excellent Stevia product is one that is free of this liquorice essence and still not bitter

(Tateo et al. 1998). Genus Jan (2002) concluded that Stevia and stevioside are safe

when used as a sweetener. Stevia is suited for both diabetics and Phenylketonuria

(PKU) patients, as well as for basepersons intending to lose weight by avoiding sugar

supplements in the diet. No allergic reactions to it seem to exist. Midmore and Rank

(2002) found that the aqueous extracts of the leaves—boiled in water, cooled, then

strained (filtered)—are preferred in many situations and are better suited for controlled

levels of sweetening. Crystalline powders and extracts are preferred in commercial

situations as they have a fixed known sweetening value. Fixed concentration liquids are

also acceptable. Kumar et al. (2007) reported that the Stevia is sweetest plant in the

world because leaves contain diterpene glycoside that has a sweet taste but it is not

metabolized and contains no calories. It is native to a relatively small area of eastern

Paraguay (on the Brazilian border) where its leaves have been used by the local Guarani

Indians as a sweetener for many hundreds of years. They specially used it in the local

green tea (Mate tea-Hex sp.), as well as with other unpalatable medicinal and other

drinks. The leaves are 30 times sweeter than cane sugar and can be safely used by

diabetic patients. Sharma and Mogre (2007) observed the effect of consumption of

Stevia extract on 20 selected hypercholestronic women: 20 ml extract was used to

intervene in one subject in a glass of water (200 ml). They found the consumption of

Stevia extract reduces the levels of cholesterol, triglyceride and low-density lipoprotein

cholesterol signifificantly while an increase in high-density lipoprotein-cholesterol was

noted, which is desirable. They concluded that Stevia extract had a hypolipidaemic

effect used to reduce the resistance of cardiovascular disease. The documented

properties of Stevia are anti-bacterial, anti-fungal, anti-inflflammatory, anti-microbial,

anti-viral, anti-yeast, cardio-tonic, diuretic, hypoglycemic, hypertensive and as a

vasodilation. Stevia has an advantage over artificial sweeteners because it is stable at

high temperatures and has a pH range 3 9. Stevia extract is used as a sweetener or

fl flavour enhancer in many countries such as China, Japan, Korea, Israel, Brazil and

Paraguay. It is also used in soft drinks, ice creams, cookies, pickles, chewing gum, tea

and skincare products (Lee 1979; Kinghorn 1982, 1987; Elton Johnson 1990; Tateo

1990). Stevia plant and its extract both are used in weight-loss programme because of

their ability to reduce the craving for sweet and fatty foods (Jain et al. 2007)

**Vitamins and Minerals**

Stevia contains many vitamins included vitamins A, C and vitamins of B-complex like thiamine and riboflavin [1]. A previous study was shown that stevia contains water-soluble vitamins such as vitamin C and vitamin B complex. In leaves, folic acid was a major compound and after that vitamin C is found in a major concentration [19]. Stevia is also a source of some major or minor minerals. Along with nutrition, it is also used in the health and cosmetic industries due to the effectiveness of its phytochemical content. A survey was performed in a study in which plant samples were collected from the province Aydin in Turkey and then their mineral content was determined (N, K, P, Mg, Ca, Cu, Na, Fe, Mn and Zn) [20]. Stevia in unprocessed form is highly nutritious having vitamins and minerals included vitamin C, niacin, magnesium, calcium, chromium, zinc, potassium and phosphorus are shown in table 2. The stevia leaves contain protein, fibre and at least 100 phytonutrients [21]. Stevia contain minerals included magnesium, calcium, iron and phosphorous. The minerals are beneficial for cardiovascular system, bone formation and porosity against bone and important for bone formation. The minerals present in stevia leaves are beneficial for immune system. Zinc and selenium are the trace minerals present in stevia products. While, many other trace minerals are also present in stevia leaves included silicon, chromium, cobalt and manganese which are used in enzymatic processes. These provide function of excretory system, utilization of oxygen, physiological assembly and disassembly of energy safely

Phenolic compounds and antioxidants The phenolic compounds present in stevia leaves are chlorogenic acids, polyphenol family of esters, hydroxycinnamic acids esters with quinic acid, possessing excellent hydrophilic antioxidant activity and therapeutic properties [26]. The glycosides present in stevia leaves are non-nutritive substitutes of sugar which don’t provide any energy on consumption. Besides their sweetening properties, stevia leaves also show antioxidant properties and its sweet diterpenes are reported in the literature [27]. Stevia rebaudiana which is a chrysanthemum herb is used as a vegetable-based sweetening additive in health drinks and many other food products. According to studies, it was investigated that the stevia leaves show antioxidant activity and the presence of bioactive compounds. The analysis shows that stevia leaves contain folic acid 52.18 mg/100g. The stevia contains phenolic and flavonoid contents of 130.76μg catechin and 15.64μg quercetin in leaves and 43.99μg catechin and 1.57μg quercetin in cells of mg of water extracts, respectively. Pyrogallol is the major phenolic compound present in both leaf and cellular extracts of stevia. Additionally, according to various studies the leaf extracts contain a large number of free radicals, hydroxyl radicals and superoxide anion radical scavenging activities than cellular extract

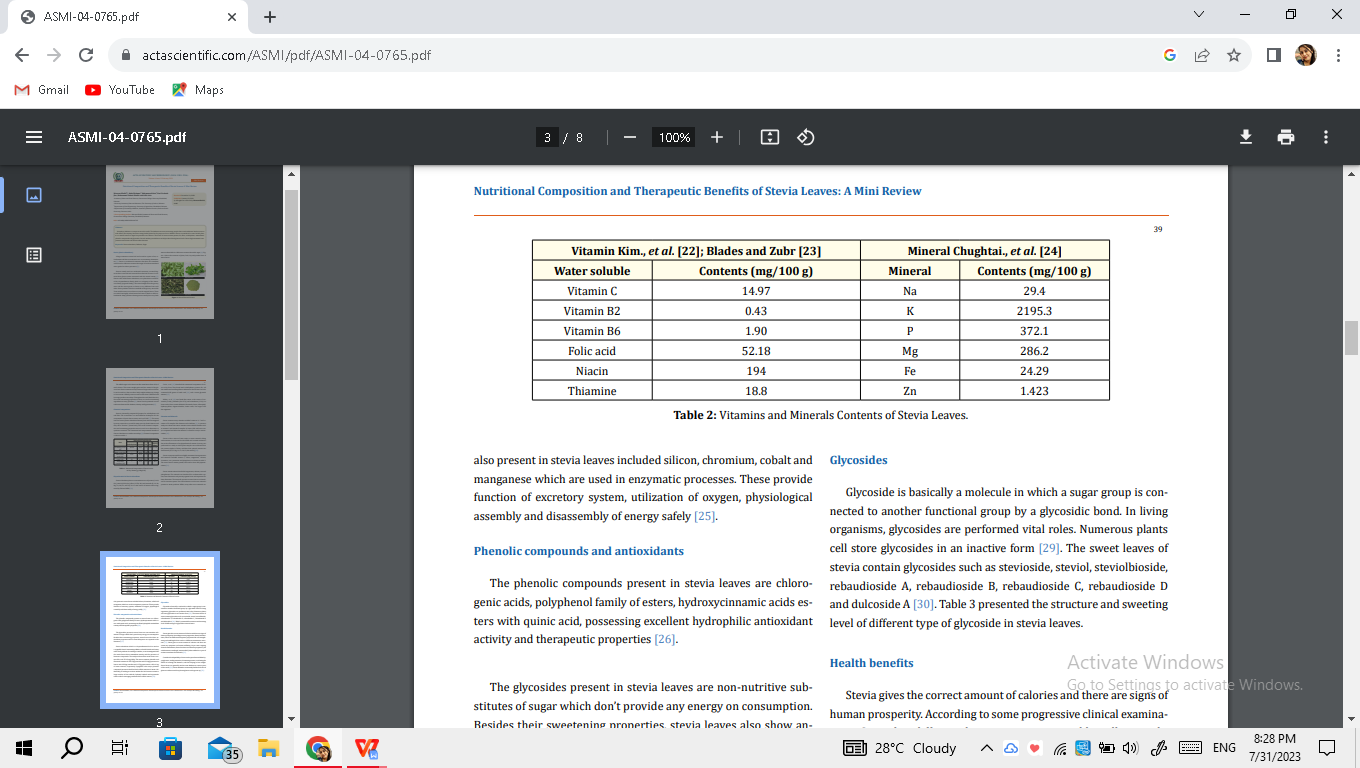


Figure 1 Vitamins and Minerals Contents of Stevia Leaves

**Uses of Stevia**

. Stevia is safe for diabetics, as it does not affect blood sugar levels.

. Stevia does not have the neurological or renal side effects as other artificial

sweeteners.

. Stevia possess anti-fungal and anti-bacterial properties in addition to its other

versatile uses. It can be safely used in herbal medicines, tonics for diabetic patients

and also in daily usage products such as mouthwashes and toothpastes.

. Mild Stevia leaf tea offers excellent relief for an upset stomach.

**Conclusion**

Stevia is a herb that is used extensively in various areas of the world (without

documentation of long-term use and effects) as a non-caloric sugar substitute. Various

reports in animals and humans indicate that the safety of this herb is not yet completely

determined. The current status of using this herb in the USA is as a ‘dietary

supplement’. Until further information is available, pharmacists should be advised

to conform to the FDA recommendation when counselling patients about this herb.

Specifically, mild to moderate use as a supplement should be safe, but increased use for

other pharmacological effects may not be warranted.

## REFERENCES

* Calderon JS, Quijano L, Gomez F. 1987. Heliangolides from Stevia origanoides. J Nat Prod 50(3):522–525.
* Cardello HM, DaSilva MA, Damasio MH. 1999. Measurement of the relative sweetness of stevia extract,
* aspartame and cyclamate/saccharin blend as compared to sucrose at different concentrations. Plant Foods
* Hum Nutr 54(2):119–130.
* Chan PX, Liu DY, Chen JC, Tomlinson B, Huang WP, Cheng JT. 1998. The effect of stevioside on blood
* pressure and plasma catecholamines in spontaneously hypertensive rats. J Life Sci 63(19):1679–1684.
* Cramer B, Ikan R. 1987. Progress in the chemistry and properties of rebaudiosides. In: Grenby T.H., editor.
* Developments in sweeteners New York: Elsevier. pp 45–48.
* 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.
* D’Agostino M, DeSimone F, Pizza C. 1984. Steroli della Stevia rebaudiana Bertoni. Boll Soc Ital Biol Sper
* 60(12):2237–2240.
* Das S, Das AK, Murphy RA. 1992. Evaluation of the cariogenic potential of the intense natural sweeteners
* stevioside and rebaudioside A. Caries Res 26(5):363–366.
* Elton Johnson DR. 1990. Stevioside—‘Naturally’ Tuscon, AZ: Calorie Control Council. 5pp.
* FDA Consumer, National Technical Information Services, 5285 Port Royal Road, Springfifield, VA 22161,
* pp. 152–157.
* Genus Jan MC. 2003. Stevioside. Phytochemistry 64(5): 913–921.
* Genus Jan MC. 2002. Safety evaluation of stevia and Stevioside. J. Nat Prod Chem 27(8):299–319.
* Hutapea AM. 1997. Digestion of stevioside (a natural sweetener) by various digestive enzymes. J Clin
* BiochemNutr 23(3):177–186.
* Jain JL, Jain S, Jain N. 2007. Fundamentals of biochemistry New Delhi: S. Chand & Co. Pub. Ltd.
* pp 104–107.
* Jakinovich W, Moon C. 1990. Evaluation of plant extracts for sweetness using the mongolian gerbil. J Nat
* Prod 53(1):190–195.
* Jeppesen PB, Gregersen S, Poulsen CR. 2000. Stevioside acts directly on pancreatic beta cells to secrete
* insulin: Actions independent of cyclic adenosine monophosphate and adenosine triphosphate-sensitive
* K+-channel activity. Metabolism 49(2):208–214.
* Kim KK, Sawa Y, Shibata H. 1996. Hydroxylation of ent-kaurenoic acid to steviol in Stevia rebaudiana
* Bertoni—Purifification and partial characterization of the enzyme. Arch Biochem Biophys 332(2):223–230.
* Kinghorn AD. 1982. Purifification of Stevia rebaudiana sweet constituents by droplet counter current
* chromatography. J Chromatogr 237(3):478–483.
* Kinghorn AD. 1987. Biologically active compounds from plants with reputed medicinal and sweetening
* properties. J Nat Prod 50(6):1009–1024.
* Kinghorn AD, Soejarto NPD, Nanayakkara CM. 1984. A phytochemical screening procedure for sweet ent
* kaurene glycosides in the genus Stevia. J Nat Prod 47(3):439–444.
* Klongpanichpak S, Temcharoen P, Toskulkao C. 1997. Lack of mutagenicity of stevioside and steviol in
* Salmonella typhimurium TA 98 and TA 100. J Med Assoc Thai 80(11):S121–S128.
* Kobayashi M, Horikawa S, Degrandi IH, Veno J, Nijisuhasi H. 1977. Fatcs of stevia Phytochemistry
* 16:1405–1407.
* Kohda H, Kasai R, Yamasaki K, Murakami K, Tanaka P. 1976. Steviodsides from Stevia rebaudiana Bertoni
* Phytochemistry 15:981–982.
* Kumar S, Jha YK, Singh P. 2007. Stevia: A natural potential source of sugar replacer. Bev Food World
* 34(7):70–71.
* Lee SJ. 1979. A study on the safety of stevioside from Stevia rebaudiana as a new sweetening source. Korean J
* Food Sci Technol 11(4):224–231.
* Mata R, Rodriguez V, Pereda-Miranda R. 1992. Stevisalioside A, a novel bitter-tasting ent-atisene glycoside
* from the roots of Stevia salicifolia. J Nat Prod 55(5):660–666.
* Matsui, M, Matsui, K, Kawasaki Y. 1996. Evaluation of the genotoxicity of stevioside and steviol using six
* . Ciriminna R., et al. “A bioeconomy perspective for natural sweetener Stevia”. Biofuels, Bioproducts and Biorefining 13.3 (2019): 445-452. 50. Samuel P., et al. “Stevia leaf to stevia sweetener: exploring its science, benefits, and future potential”.
* The Journal of Nutrition 148.7 (2018): 1186S-1205S. 51. Ahmad U and Rabia SA. “Anti diabetic property of aqueous extract of Stevia rebaudiana Bertoni leaves in Streptozotocininduced diabetes in albino rats”.
* BMC Complementary and Alternative Medicine 18.1 (2018): 179. 52.
* AbdElwahab AH., et al.
* “Comparative effects of Stevia rebaudiana and aspartame on hepato-renal function of diabetic rats: biochemical and histological approaches”.
* Journal of Applied Pharmaceutical Science 7.8 (2017): 34-42.
* in vitro and one in vivo mutagenicity assays. Mutagenesis 11(6):573–579.
* Melis MS. 1992. Renal excretion of stevioside in rats. J Nat Prod 55(5):688–690.
* Melis MS. 1995. Chronic administration of aqueous extract of Stevia rebaudiana in rats: Renal effects.
* J Ethnopharmacol 47(3):129–134.
* Melis MS. 1997. Effects of steviol on renal function and mean arterial pressure in rats. Phytomedicine
* 3(4):349–352