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PLANT BASED NATURAL SWEETENER *STEVIA* AND ITS APPLICATION IN FOOD INDUSTRY

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ABSTRACT

Stevia is a perennial shrub belonging to Asteraceae family. It has been in use for hundreds of years for medicinal purposes. *Stevia* contains natural compounds stevioside and rebaudioside A, extracted from its leaves, which can be approximately 150-300 hundred times sweeter than sucrose. It is an alternative choice to table sugar and HFCS utilized in beverages, bakery, confectionary, dairy food products. Besides being a zero-calorie meals ingredient, it has a protracted shelf life, high-temperature tolerance and is non-fermentative. This review article focuses on its health benefits, manufacturing of *Stevia* extract from *Stevia* leaves and their end-product utility in the food industry.

Keywords: *Stevioside*, sweetener, properties, therapeutic, food application

INTRODUCTION

Sucrose or commonly known as table sugar can prove to be detrimental for our health when consumed in high quantities on a regular basis. Sucrose consumption provides us with 4kcal/g of energy but this comes with no other nutrient that our body requires. Excessive consumption of sugar can downscale the other nutrients present in nutritionally dense foods. Sugar if consumed in large amounts can lead to a phenomenon known as 'internal starvation'. This makes us feel hungrier after its consumption. Sugar doesn't act as a source of energy in the normal intake quantities. It however has been found to prevent and hinder energy production from other sources (DiNicolantonio, Berger, 2016).

According to a 2016 study, consumption of a high sugar diet has effects more far reaching than a diet high in saturated fats. Sugar increases the risk of Coronary Heart disease. It could lead to increased blood glucose levels and an elevated risk for Fatty liver disease. The mortality rate due to Cardiovascular Diseases was found to be significantly higher when sugar consumption is immoderate (DiNicolantonio, Berger, 2016). CVDs are a cause of major concern in India, with the average death rate being higher than the global average. An unhealthy lifestyle and an improper diet are the leading factors for this disease (Prabhakaran, Jeemon, Roy, 2016). Therefore, there is need to reduce sugar consumption and to come up with low calorie alternate sweeteners.

Stevia is an ideal sweetener. One kg of *Stevia* is 200 times sweeter than the same amount of table sugar (Ranjan *et al.*, 2011). It has zero calories. It has been found to have a slight bitter aftertaste which has been attributed

to stevioside (Yadav *et al.*, 2011). In rat studies, the use of *Stevia* lowered blood glucose levels. Fatty rats with type- II diabetes showed improvement. It has also shown promise as a vasodilator in hypertensive animals (Ranjan *et al.*, 2011).

Plant characteristics

Stevia rebaudiana grows up to 65-80 cm (Goyal & Goyal, 2010). It has 3-4 cm long leaves which are elliptical in shape. The stem is brittle and woody. The branching root network extends from the rhizome. The flower has 5 petals and is white in colour with a light purple corolla tube (Lemus-Mondacaa *et al.*, 2012).

Stevia is an easily cultivable plant which grows in semi-humid and subtropical conditions. It requires well-drained red soil and sandy loam soil which favours the growth of plant while saline soil is considered to be unfavourable. The ideal pH for the soil is between 6.5-7.5 (Goyal & Goyal, 2010).

In the last decade, *Stevia* cultivation has started in the Indian states of Maharashtra, Rajasthan, Karnataka, Orissa, Andhra Pradesh, Karnataka, Chhattisgarh and West Bengal etc. With a high production potential of 2-3 t ha⁻¹ of dry leaves, India has a competitive edge. The climate in many states is conducive to the growth of *Stevia* (Kumari & Ghosh, 2019).

Structure and Composition

The *Stevia* leaves comprises 80-85% of water (Sharma *et al.*, 2006). It contains diterpene glucosides viz. Stevioside and rebaudioside impart a sweet taste (Brandle, Starratt, Gijzen, 1998). Many natural products



and more than hundreds of compounds have been isolated and identified from *S. rebaudiana* Bertonii. The foremost known are steviol (ent-13-hydroxykaur-16-en-19-oic acid and its glycosides) and its glycosides stevioside, rebaudioside A, steviolbioside, dihydroisosteviol, rubusoside and dulcoside A. (Savita *et al.*, 2004). *Stevia* is a nutrient

enriched plant containing of different nutrients such fibre, protein, lipids, amino acids, riboflavin, quercetin etc. (Deshmukh *et al.*, 2018)

attain a pure *Stevia* extract. Dried leaves are steeped in water once that separated and purified the sweet molecules are extracted which are present in plant. With a pure *Stevia* leaf extract, the extraction and purification process bring sweetness more like sugar taste to it. According to Codex Alimentarius commission and JECFA the ADI for Steviol glycosides is 4mg/kg body weight/day.

APPLICATIONS OF STEVIA IN FOOD INDUSTRY BEVERAGE INDUSTRY:

Stevia could also be a used by leading beverage brands in the form of ready-to-drink (RTD) teas, sugary occasional beverages, Carbonated soft drinks (CSDs), Flavoured waters, juices and alcoholic beverages. It provides a strategic selling approach like innovation, artificial sweetener replacement, sugar moderation for teenagers and adults (Clos, 2008). *Stevia* could also be a powerful ingredient to eliminate sugars from a number of drinks. It offers advantages like zero calories, natural origin, stability and a huge variety in application. Category-specific *Stevia* solutions will cut back sugar whereas protect its flavour and mouthfeel. (Mintel,2004 Ranji, 2014)

Therapeutic Values and Health benefits of *S. Rebaudiana*

Stevia extract has shown promise as a cure for diseases like CVD, Diabetes mellitus, cancer etc. (Megeji *et al.*, 2005). The secretion from INS- 1 and β cells of islets of Langerhans is believed to be the reason for the hyperglycemic action of *Stevia* leaf extract. According to a study conducted by Melis on rats, in higher doses than that used for sweetening, *Stevia* extract showed vasodilating action. In hypertensive rats it also lowered arterial pressure (Melis, 1992). Stevioside present in *Stevia* extract exhibits gastroprotective action in cases of Inflammatory Bowel Disease (IBD) (Shiozaki *et al.*, 2004). The mechanism that has been suggested for the anti-inflammatory effect of *Stevia* extract involves the blocking of Calcium channel which inhibits the contraction of smooth muscles. Stevioside is believed to be responsible for this action, it reduces histamine-induced gastric abnormalities and it impedes the action of pepsin (Shiozaki *et al.*, 2006). It has also been found to reduce free acidity which is the cause of formation of ulcers and gastric lesions (Pandiyan *et al.*, 2009). The methanolic and ethanolic extract of stevioside are cancer growth blockers (Deshmukh *et al.*, 2018).

1.1 Soft Drinks: *Stevia*'s rapid growth in beverage market has several advantages like being natural and calorie free, it's good for dental health as it doesn't ferment and has a stable pH. Another one its advantages is that its heat stable and to light exposure which makes it's a preferable choice even for drinks which require heat treatment like pasteurization (Kroyer, 2010). *Stevia* may be a very good sweetener alternative for CSDs that typically have low pH. The number of flavour options which utilize *Stevia* as a sweetener has also seen a rise in the last few years. New flavours like Cola and lime and lemon have been introduced. The possibilities are endless. What needs to be kept in mind while formulating a new beverage is to achieve a balance between the sweetness and acidity. The concentration of steviol glycosides that is used, plays a crucial role in doing so (Chang and Cook, 1983).

1.2 Tea and Coffee: Tea is one of the most

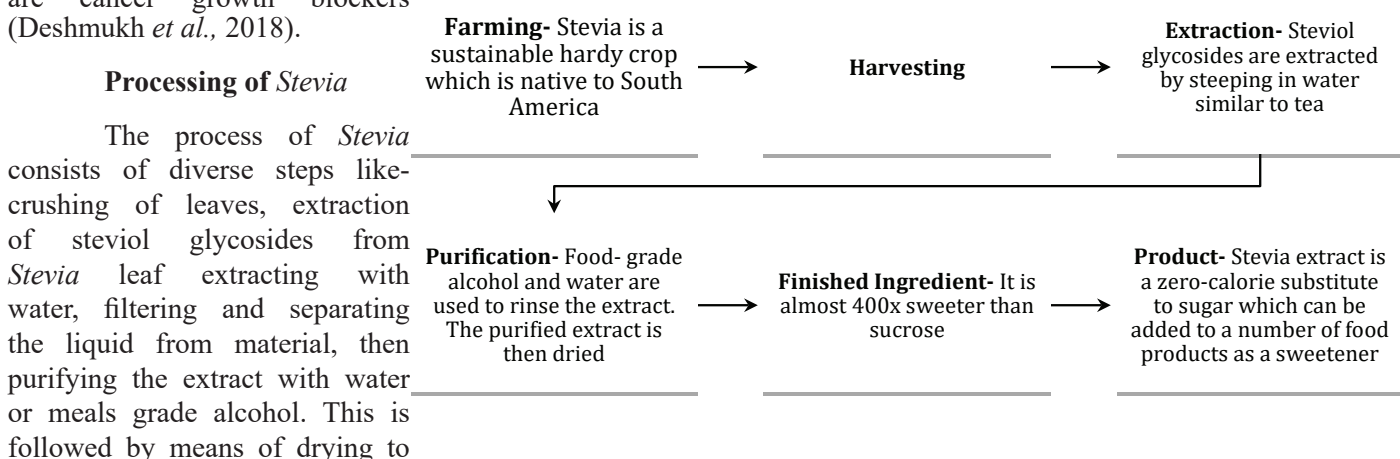


Table 1: Proximate Analysis of *Stevia* leaf powder

S.No.	Proximate Composition	Concentration % DW
1.	Moisture(g/100g)	7.2±1.0
2.	Protein(g/100g)	16.0 ±0.58
3.	Carbohydrates (g/100g)	31.2±1.10
4.	Crude Fat(g/100g)	4.2±0.3
5.	Ash (g/100g)	11.9±0.95
6.	Crude Fibre(g/100g)	14.83±0.89
Minerals		
7.	Iron (mg/100g)	9.0±1.15
8.	Calcium(mg/100g)	18.7±0.20

popular beverages consumed by man. Sweet tea is favoured by several consumers; hot or cold. There are numerous choices to sweeten home-baked or RTD tea from natural extract or artificial sweeteners. With the growing quality of *Stevia*, 392 new RTD teas sugared with *Stevia* are introduced inside the market within the recent past (TrevizamMoraes *et al.*, 2010) Formulators try to seek out choices for the consumers to possess the sweet drink without calories. *Stevia* based mostly sweeteners will cut sugar amount in coffee whereas enhancing the mouthfeel perception in ice coffee making it creamier. *Stevia* adds more value to sweetened type tea drinks. When in a study the antioxidant potential of black and green tea was analysed. It was found that all sweeteners other than *Stevia* lowered it antioxidant activity (Korir *et al.*, 2013). Analysis on coffee indicates that a formulation with zero.0998% *Stevia* leaf extract was similar in ideal sweetness profile to it of 12.5% (Azevedo, 2012).

Juice: Consumers are attempting to seek out less sugar in juice products. They have turned towards healthier option that contain lower calories and added sugars. Sugar is added to juices and fruit beverages in order to accentuate the natural sweetness of the fruit, this accounts for higher amounts for higher amounts for total calories. When researchers used a combination of Steviosides and Sacchrose for Peach juice. They found that it might end in 25% reduction in calories, remaining stable under traditional thermal additionally as high process conditions (Parpinello, 2001).

Dairy Industry: Dairy historically showed up several challenges for formulators making an attempt to reduce sugar whereas maintaining texture, indulgence and mouthfeel. *Stevia* is great choice as a result of its stability throughout the sterilisation method.

Yogurt: Flavoured yoghurt is very popular as a breakfast accompaniment, mostly in European countries but also all around the world. A study conducted to substitute sucrose in strawberry flavoured yoghurt. It showed that the amount of sucrose used can be cut by half by using it in combination with *Stevia (rebaudiana*

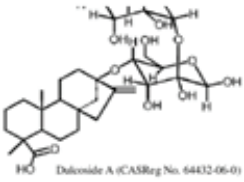
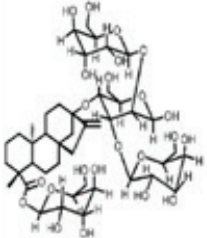
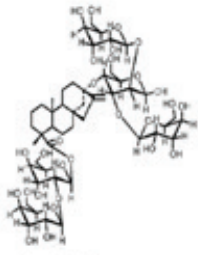
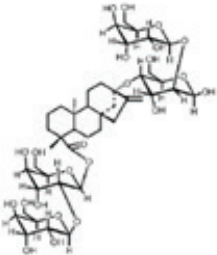
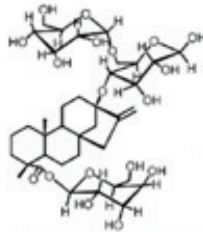
A). This can be done affecting the rest of the composition (Reis, 2011). *Stevia* works wonderfully well when used with another sweetener. Thus, it has very good synergistic qualities (Hergesell *et al.*, 2014).

Flavoured Milk: Flavoured milk, like milk which can be a preferred and consumed drink, with wide sensory acceptance among consumers of assorted ages and socio-economic levels (Paixão, 2014). Milk supplies of Calcium, vitamin D, heptoflavin and phosphorus, potassium, vitamin A, cobalamin and vitamin B complex (Krebs-Smith, 2014). Incorporating *Stevia* may be a great possibility for reducing the sugar levels in flavoured milk. It's necessary to take care of consumers' acceptance, particularly for kids, when reducing sugar in milk. Formulation of flavoured milk with *Stevia* tends to work best for larger sugar reductions, and *Stevia's* natural flavours enhances cocoa and farm products. *Stevia* is usually used as a thickening agent and complex carbohydrate by providing higher mouthfeel in low sugar formulations (Johnson, 2002).

ICE CREAM: the sweeteners utilised in dessert have a vital influence on consumer acceptance because of their impact on texture and freezing purpose, consistency and texture. For economic and practical reasons, saccharose (sugar) is usually used in dessert production. However, the use of non-nutritive sweeteners is increasing because of health considerations concerning ice cream's high-sugar content. In studies conducted using *Stevia*, the resultant product had a considerably lower consistency and brix with a higher overrun and melting rate. Whereas mixtures containing each saccharose and *Stevia* had higher sensory acceptance than the ones made entirely with *Stevia* (Alizadeh & Azizi-Lalabadi, 2014).

Baked Goods: In many elements of the world, which include Europe, sweet products inclusive of cakes, cookies, muffins (Karp, 2017) and biscuits are contributing exceptionally to overall sugar intake. Incorporating *Stevia* is a splendid preference for lowering the sugar observed in a lot of those products. Sugar

Table 2. Compounds imparting sweet taste to *S. rebudiana*

S. No	Component	Amount	Structure	Reference
1.	Dulcoside A	0.3%	 Dulcoside A (CASReg No. 64432-06-0)	Chalapathi, MV, Thimmegowda S,1997
2.	Rebaudioside A	2-4% w:w	 Rebaudioside-A (CAS Reg No. 10513-16-1)	Prakash <i>et al.</i> , 2008
3.	Rebaudioside D	0.6%	 Rebaudioside-D	
4.	Rebaudioside E	3.8%	 Rebaudioside-E	
5.	Stevioside	4-13% w:w	 Stevioside (CASReg No. 57817-89-7)	Prakash <i>et al.</i> , 2016

is one of the crucial elements in bakery products. It offers a sweet flavour and additionally contributes to crispness, cell structure, browning, tenderization and shelf stability. Research confirms the benefits of incorporating bulking agents like fibre into *Stevia* sweetened baked products. The addition of coffee silver-skin (fibrous husks) improved moisture and coloration in reduced-sugar biscuits made with *Stevia* (Gao, 2016). In addition to bulking agents, extra moisture can assist create

a higher texture. *Stevia* is heat labile so its sweetness isn't lost whilst baking.

Chocolate & Confectionery: Sugar, particularly sucrose, is one of the important elements in chocolate. Sucrose is responsible for improving both taste and texture of the final product. Replacement of sugar with *Stevia* may be used with a different technology to lessen the quantity of sugar level.

Table 3. Health and therapeutic benefits of *Stevia* extract

Disease	Therapeutic/health benefit	Reference
Diabetes	Stevioside modify blood glucose levels by enhancing insulin secretion and its usage in insulin deficient rats.	Chen <i>et al.</i> , 2005
Blood pressure regulation	Studies endorse that <i>Stevia</i> relaxes arteries and decrease blood pressure. Regular intake decreases the quantity of LDL cholesterol in the blood.	Atteh <i>et al.</i> , 2008
Cancer	Labdane sclareol in <i>Stevia</i> leaf extract has anti-tumorous and cytotoxic properties. Inhibits tumor promotion and initiation. Stevioside, steviol and isosteviol, and their metabolites inhibit tumor..	Kaushik <i>et al.</i> , 2010
Dental Caries	<i>Stevia's</i> own bacteriostatic and bactericidal properties prevents decay and gingivitis.	Wu <i>et al.</i> , 1998

Table 4. Amounts of *Stevia* extract (StebianA™) used in food applications

S. No.	Product	Proportion of <i>Stevia</i> to cane sugar	Additive amount
1.	Sodas	20-100%	0.06-0.75g/kg
2.	Fruit beverage	30-50%	0.078-0.278g/kg
3.	Milk beverage	20-50%	0.006-0.70g/kg
2.	Ice-creams	30-50 %	0.078-0.278 g/kg
3.	Confection	80-100%	2-12g/kg
4.	Breads and cakes	80-100%	0.2-1g/kg

In a study when *Stevia* along with isomalt was used as an alternative to *Sucrose*. The result showed that the added *Stevia* and isomalt has no effect on factors such as acidity, fat and colour. It did have an effect on its hardness, calories, water activity, moisture and ash. The final product with 40% *Stevia* and 60% isomalt was accepted the most on the basis of physicochemical and sensory scores. 79(Berenjy, Saboohi, Nateghi, 2020).

In another study a bulking agent such as inulin, polydextrose and maltitol were used in addition to *Stevia* to replace sucrose. The final results indicate that the use of maltitol with *Stevia*; maltitol, polydextrose, inulin and *Stevia* yielded the best results. The calories provided by these two variants were less by 9.1% and 18.2% from the control. The variant made using all three- maltitol, inulin and polydextrose also boasted a fibre content of 16%. The final products thus achieved very most similar to the control sample on the basis of sensory and quality properties (Aguilar-Villa *et al.*, 2020)

CONCLUSION

Stevia can be used as a calorie alternative especially in high carbohydrate diets. *Stevia* leaves impart sweetness and have many additional health benefits. Furthermore, *Stevia* has several antioxidants that lower blood pressure level, cholesterol, renal problems, obesity, dental caries etc and controls diabetes. Minerals are found in trace amounts like, potassium, phosphorus, magnesium, etc. In the food processing industries such as beverage, dairy, confectionary, chocolates, baked products. *Stevia* is a vital ingredient to eliminate sugars while preserving flavour and mouthfeel of the original product. *Stevia* has proven to perform well as a sucrose alternative and has been proven

for consumption safe by most studies conducted thereby leading to its increased demand in the market.

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