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Stevia rebaudiana – A Functional Component for Food Industry

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INTRODUCTION

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 has for long 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 (Sirohi, 1999). These sugars along with sweetening qualities also have been found to contribute calories, which can lead to obesity, a risk factor for some chronic diseases such as diabetes mellitus, hypertension, cardiovascular diseases, etc.

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 foods a taste that is similar to that of sucrose and however are generally several hundred to several thousand times sweeter than sucrose. Most do not contain any calories, and those that do contain calories, are used in very small amounts because of their concentrated sweetening property.

Stevia (*Stevia rebaudiana* bertoni) is a natural sweet herb native of northeastern 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. The crude stevia leaves and herbal green powder is 10-15 times sweeter than sucrose, a good quality leaf is estimated to be 30 times sweeter than sucrose. It has slight after taste bitterness.

The present work was conducted to study the sweetness equivalence, duration of sweet-ness stimulation, nutrient composition and functional properties of leaves of *stevia rebaudiana*. Organoleptic acceptability, shelf life and glycemic index of selected products were also studied.

MATERIALS AND METHODS

Sweetness equivalence of stevia to sugar was carried out for threshold test. 1gm of stevia in 100ml of water was asked to be matched with 10gm, 15gm, 20gm and 25gm sugar in 100ml of water. Perception of duration of Sweet Stimulus was measured in seconds in comparison to sweet stimulus of sugar.

Moisture, energy, protein, fat, total carbohydrate, ash, crude fiber, calcium, phosphorus, Iron, sodium, potassium, oxalic acid and tannins were determined by standard procedures (AOAC, 1980).

Functional properties of stevia leaf powder viz., bulk density (Narayana and Rao, 1982), Water and fat absorption (Rosario and Hores, 1981), Solubility and swelling power (Iyer and Singh, 1977), Emulsification value (Sathe and Salunkhe, 1981) and pH were determined.

Products developed using steiva (0.25 – 1.0 gm / 100 gm) in substitution to sugar were fruit custard, jam, chikki, basen ladu, wheat ladu, biscuit, grape juice, bun, tea and milk shake and were evaluated for appearance, flavour, texture, taste and overall acceptability by trained and semi-trained judges using 5-point hedonic scale. The shelf life study was carried out for selected products upto 3 months in air tight polythene pouch, and tested for its sensory attributes weekly.

The glycemic response of stevia product was estimated to know the effectiveness of the product in diet of diabetics. The GI of Stevia bun with 75g of carbohydrate were tested in comparison to the bun without stevia and for glucose.

RESULTS AND DISCUSSION

Sweetness equivalence of stevia in comparision to sucrose is shown in Table 1. Sweetness of 1 gm of stevia in 100 ml water was equivalent to a sucrose solution containing 20 gms of sucrose. Similar results were also obtained by Cardello et al. (1999a) in which they evidenced that stevia leaf extracts were 152 times sweeter than 3 per cent sucrose and 97 times sweeter than 10 per cent sucrose.

Table 2 shows the duration of perception of sweet stimulus of stevia in comparison to sucrose. The duration of the sweet stimulus was greater

Table 1: Sweetness equivalence of stevia in compa-rison to sucrose

Quantity of stevia (gm)	*Sucrose equivalent (gms)*	*Perception (%)*
1	10	14
1	15	14
1	20	58
1	25	14

for stevia than for sucrose as perceived by 50 per cent of the judges, where the sweet stimulus lasted for more than 40 seconds. The results are in conformity with the study of Cardello et al. (1999b).

Table 2: Perceived duration of sweet stimulus of stevia in comparison to sucrose.

Sweet stimulus (seconds)	*Perception*	
	Stevia (1gm) (%)	*Sucrose (20gm) (%)*
< 20	50	60
20-40	0	20
>40	50	20

$\chi^2 = 3.3766^{NS}$

NS: Non-significant

Nutrient composition (Table 3) of stevia which was analysed on dry weight basis indicated that energy value analysed being 2.7 kcal per gram which may be entailed as the status of low calorific sweetener due to its intense sweetness in compa-rison to other available low calorie sweeteners. (Anon, 2000). Intense sweeteners include acesulfame potassium (calorie free), aspartame (4kcal/g) saccharin (calorie free) and sucralose (calorie free). Calorie contribution to the diet by commonly used sucrose being considered high as it gets utilized by the body more completely and has a potential to escalate towards over weight status. In this context, the use of stevia as a low calorie sweetener could be of immense help in restricting the calorie intake in the diet of affluent and also wherein calorie restricted diet are prescribed.

Other major nutrients i.e., protein, fat, carbohydrate, ash and crude fiber were 9.8, 2.5, 52, 10.5 and 18.5g/100g of stevia respectively. In this back ground it appears that stevia is a good source of protein, ash and crude fiber which are the essential factors for maintenance of good health and are comparable to commonly used cereals in India.

Analyzed mineral composition of stevia indicated that calcium, phosphorus, iron, sodium and potassium found to be 464.6, 11.4, 55.3, 190 and 1800 mg/100g, respectively. This further establishes stevia as a mineral loaded ingredient required to protect the body, regulate and maintain the various metabolic processes.

Table 3: Nutrient composition of stevia per 100gm (dry wt. basis)

Nutrient composition	*per 100 gm.*
Proximate	
Moisture (g)	7
Energy (K cal)	270
Protein (g)	10
Fat (g)	3
Total carbohydrate (g)	52
Ash (g)	11
Crude fibre (g)	18
Minerals	
Calcium (mg)	464.4
Phosphorus (mg)	11.4
Iron (mg)	55.3
Sodium (mg)	190.0
Potassium (mg)	1800.0
Anti-Nutritional Factors	
Oxalic acid (mg)	2295.0
Tannins (mg)	0.010

In addition stevia was found to have higher percentage of anti-nutritional factor - oxalic acid, which may hinder the bio availability of calcium, iron and other nutrients as in case of green leafy vegetables.

The functional properties of stevia determined are presented in Table 4. The functional properties of any food apart from its nutritional value would aid in determining suitability in various methods of cooking and in different aspects of handling. The bulk density of stevia was found to be 0.443 gm/ml. other properties such as water absorption capacity, fat absorption capacity and emulsification value were found to be 4.7, 4.5 and 5ml/gm respectively, where as the swelling power and solubility were at 5.012 and 0.365 g/g of stevia with pH of 5.95.

Bulk density of stevia appeared to be low compared to other protein rich pulses. Higher bulk densities are desirable as this is known to reduce the paste thickness. This is an important factor in child feeding where bulk is of concern. However, stevia appears to lack this property. It is known that proteins increase their water holding capacity, when their swelling ability is enhanced. Water binding capacity is an important function of protein in viscous foods

Table 4: Functional properties of stevia leaf powder

Properties	*Values*
Bulk density	0.443 gm/ml
Water absorption capacity	4.7 ml/gm
Fat absorption capacity	4.5 ml /gm
Emulsification value	5ml / gm
Swelling	5.01 gm / gm
Solubility	0.365 g/gm
pH	5.95

such as soups, gravies, doughs, and baked products. Hence increased water absorption capacity of stevia observed in the study appears to be advantageous may be due to it's higher protein content.

Stevia appears to have adequate fat absorption capacity. Fat absorption capacity has been attributed to the physical entrapment of oil. This is important since fat acts on flavour retainers and increase the mouth feel of foods. The ability of protein to aid the formation and stabilization of emulsion is critical for many applications such as cake, batters, coffee whiteners, milks, frozen desserts etc depending on the composition and stresses during processing under which it is subjected. Crammer and Ikan (1986) expressed that since stevioside is stable at 95^0C it is a suitable sweet additive to cooked or baked foods.

The mean scores of sensory evaluation for appearance, texture, flavour, taste and over all acceptability showed no perceivable variation between the products. All the products developed were equally accepted. Surprisingly, the quantity of stevia required for each of these products was significantly small i.e. 0.25-1.0 gm.

Storage study was conducted to study the shelf life for a period of three months. Few products like wheat ladu, basen ladu and chikki were found to be acceptable upto 12 weeks of storage. The mixed fruit jam was completely spoiled at 5^{th} week due to development of fungus, where as biscuit spoiled at the 1^{st} week of storage itself, while bun could not be stored for more than 2 days. Other products such as grape juice, milk shake, tea and fruit custard were not considered for shelf life study because of the perishable nature of ingredients used.

Table 5 presents the glycemic response of bun with stevia on normal and diabetic subjects. The concept of Glycemic Index (GI) of various foods has emerged as a boon to diet therapy for diabetes mellitus indicating beneficial aspect of foods

Table 5: Glycemic index of stevia bun in diabetic and normal subjects

Test Products	*Normal subjects*	*Diabetics*
Glucose	100	100
Control bun	60.4	72
Stevia bun	55.5	62.12

consumed both individually, supplemented or in mixed diet. The glycemic index for many foods were reported by Jenkins et al. (1981) for 62 commonly eaten foods and sugars. Dilawari and co-workers (1987) obtained glycemic index for legumes and cereals. In the present study the results indicated that stevia has hypoglycemic response.

CONCLUSION

There is need for creating awareness among the people about the availability / nutritional and therapeutic values of natural low calorie Sweetener "*Stevia rebaudiana*". The consumers demand for herbal foods may encourage stevia cultivation and production and would help to enjoy the sweet taste with minimal calories for those who have to restrict carbohydrate / sugar in their diet.

KEYWORDS Herb. Food Product. Nutrient. Disease.

ABSTRACT Stevia (*Stevia rebaudiana* Bertoni) is a natural herb native of northeastern 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. The stevia leaves in its powder form is green in color, 10 – 15 times sweeter than sucrose with after taste bitterness. However, there are no studies reported on the use of stevia in food product formulation and development and other related aspects. Considering its sweetness potentia-lities and possible health implications, an investigation was focused and the results indicated that gram of stevia sweetness was perceived to be equivalent to 20g of sucrose and produced more than 40 seconds of sweetness stimulus. Per cent nutrient composition of stevia was found to be impressive with 269 Kcal, 9.8 g of protein, ash at 10.5 g and crude fiber at 18.4 g. Mineral composition indicated that presence of fairly good amount of calcium (464 mg), iron (55.3 mg), sodium (190 mg) and potassium (1800 mg) with higher amount of oxalic acid (2295 mg). Functional properties of stevia studied revealed the suitability of substituting in different products. Varieties of stevia substituted products formulated and developed had different levels of acceptability. Similarly, their storage study for shelf life also varied. Glycemic Index of selected products found to be lower in diabetics as well as in normal individuals. Thus it can be concluded that the plant based stevia herb is a low calorie nutritious component has an immense potential in the main stream of food processing industries as a health and dietetic benefactor.

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