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Glycaemic index of *stevia* product and its efficacy on blood glucose level in type 2 diabetes

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Abstract

Stevia, a fantastic zero calorie sweetener, an incredible internal medicine, also products made from whole leaf concentrate have extra ordinary health benefits. The GI of foods has potential implications for the prevention and treatment of major chronic diseases, including diabetes, CHD and obesity. The objectives of the study were to determine the glycaemic index of chappathi with *stevia* leaf powder and to find out the therapeutic efficacy of chappathi with stevia extract on blood glucose level of women with type 2 diabetes. Six women with diabetes were selected for determining glycaemic index of chappathi with stevia extract. The reference food (glucose), control food (chappathi) and test food (2 g% stevia incorporated chappathi) were given to each of the women on first ,second and third day respectively. Blood glucose levels were read by Glucometre for every 30 min. until a period of 2 hours. Glycaemic index was calculated by incremental area under curve method. Six type 2 diabetic women were selected randomly from thirty newly diagnosed diabetic women and the selected women consumed chappathi prepared with stevia leaf powder (2 g%) daily for breakfast. Supplementation period was 30 days (31-60 d). The effect of stevia was tested at pre test (1-30 d) and post test design (61-90 d). The glycaemic index of control and test food was 71 and 62 respectively. Mean significant reduction was found in fasting (104 to 87.5 mg/dl) and post prandial (250 to 183 mg/dl) blood glucose concentration of type 2 diabetic women after 30 d of supplementation of 2 g *stevia*, moreover significant ($P<0.05$) increment was observed in mean fasting (87.5 to 93.2 mg/dl) and post prandial (183.1 to 199.5 mg/dl) blood glucose concentration after withdrawing *stevia* (60-90 d) from their daily diet. Hence it may be concluded that *stevia* product had moderate glycaemic index and it reduces hyper glycaemia in type 2 diabetic women.

Keywords: Stevia, glycaemic index, diabetics, blood glucose, supplementation.

Introduction

Medicinal plants are the gift of nature to man. The traditional systems of medicines are plant based and have no side effects (Rajendran, 2003). *Stevia rebaudiana* the sweet herb is gaining significance in different parts of the world. It is totally innocuous, safest natural sweetener, and it can substitute sugar in various preparations. The leaves contain glycosides, which taste sweet, but do not provide calories. The major glycoside is stevioside, which accounts for its incredible sweetness. *Stevia* leaves have a greenish colour and can be used as flavour enhancers or sweeteners in a wide variety of foods and beverages (Bonvie *et al.,.,* 1998). Extracts from the leaves of *stevia* can have a variety of beneficial therapeutic effects, including beneficial effects on pancreatic beta cells and enhancing the secretion of insulin (Mohammad, 2004). Stevioside and rebaudioside A can boost insulin production of pancreatic cells and increase glucose tolerance as well (Camila, 2007). Glycaemic index is a numerical system of measuring how much raise in circulating blood sugar that the carbohydrate triggers. The higher the number the greater the blood sugar response (Miller, 2004). Glycaemic control has been shown to be improved with low glycaemic index diets in subjects with type 2 diabetes (Wolever & Mehling, 2002) and recommendations for a reduction in carbohydrate of high GI in the diabetic diet have been made (Willett, 2002). It is possible to formulate low- glycaemic food products containing high proportions of fibre and complex carbohydrates, moderate of protein and low sugar and fat content (Amuna *et al.,* 2006). Carbohydrates that are low or moderately glycaemic would also be suitable for diabetes management (Brand-Miller *et al*., 2003). Globally, diabetes affects 246 million people, which is about 6 percent of the total population. International diabetes federation estimates that the numbers of diabetic patients in India are more than doubled from 19 million in 1995 to 40.9 million in 2007. It is projected to increase to 69.9 million by 2025.Currently, upto 11 percent of India's urban population and 3 percent of rural population above the age of 15 have diabetes (IDF, 2007). Scientific research indicates that *stevia* effectively regulates the blood sugar in people with diabetes and hypoglycaemia bringing it towards more normal levels (Shine, 2004). Stevioside reduces postprandial blood glucose and tends to potentiate the insulin secretion in type 2 diabetic patients. Stevioside is a food additive for improving diabetes regulation (Kjeld, 2004).

Objectives

- To determine the glycaemic index of chappathi with *stevia* leaf powder and
- To find out the therapeutic efficacy of chappathi with stevia on blood glucose level of women with type 2 diabetes.

Materials and methods

Multi mix flour (MMF) was prepared using wheat (35 g), oats (35 g), soyabean (25 g) and fenugreek seeds (5 g) and these ingredients were purchased from the departmental store, Salem.

The ingredients were cleaned and pulverized using electric mixer. Multimix flour (100 g) was mixed with 0.5 g common salt and water needed to give correct hand feel. 2 g% of *stevia* leaf powder incorporated into multi mix flour. Dough was needed to bring it to chapathi making consistency and was allowed to rest for 30 min. at room temperature. Dough was divided into balls of 20 g each. Each dough ball was rolled and flattened into chapathi and roasted on a preheated griddle for 20 sec on one side, 10 sec on the other side, and held over flame until complete puffing occurred (Rao & Bharati, 1996). Six women with diabetes were selected for determining glycaemic index of chappathi with stevia extract. The reference food (glucose), control food (chappathi) and test food (2 g% stevia incorporated chappathi) were given to each of the women on first ,second and third day respectively. Blood glucose levels were read by Glucometre for every 30 min until a period of 2 h. Glycaemic index was calculated by incremental area under curve method. Of the 30 newly diagnosed diabetic women selected from MG diabetic research centre, Salem for collection of baseline data, a subsample of 6 type 2 diabetic women were included for the intervention study. The selected type 2 diabetic women were examined between 07.30 and 10.00 a. m after an 8 h fast. Initial (Zero day) fasting and postprandial (2 h after consumption of food) blood samples were analysed. They were observed for 30 d and no treatment was given during this period and treated as pre-supplementation period (0-30 d) subsequently the blood samples were taken and analysed on the 30th d for fasting and postprandial glucose one. The investigator prepared chappathi and supplemented to the selected women daily as breakfast for a period of 30 d and this period was treated as supplementation period (30-60 d). Fasting and post prandial blood samples were analysed after 30 d of supplementation (60th d) further they were observed for 30 d and no treatment was given during this period. It was treated as withdrawal period (60-90 d).

Fasting and post prandial blood samples (90th d) were taken and analysed to find the effect of supplementation in the selected type 2 diabetic women. One way ANOVA was applied to find out the significant difference among the glycaemic response of reference (glucose), control and *stevia* chappathi. Student't' test was used to establish the difference on glycaemic index between control and *stevia* chappathi. Paired't' test was used to ascertain the significant difference of two mean values of parameters during the pre supplementation, supplementation and withdrawal period.

Table 1. Mean glycaemic response of stevia chappathi (N=6).

Food product	Mean blood glucose concentration (mg/dl)				
	Fasting	30 min	60 min	90 min	120 min
Glucose	105.2±20.1	205.3±6.3	229.5±74.9	220.8±45.8	179.3 ± 43.8
Control chapathi	105.8 ± 8.4	184.3±59.8	180.3 ± 41.2	181.3 ± 75.6	147.7 ± 40.1
Stevia chapathi	95.3 ± 11.4	176.8 ± 6.1	174.2 ± 31.9	143.5 ± 30.9	132.0 ± 24.4
F-value	0.71 ^{NS}	0.34 ^{NS}	1.98 ^{NS}	3.07 ^{NS}	2.53 ^{NS}

NS - No significant

Results and discussion

Stevia substituted (2 g%) chappathi containing 50 g available carbohydrate was given to type 2 diabetic women to find out the glycaemic response and the mean values are presented in Table 1. The mean glycaemic response (Table 1) of reference food was found to be 105.2±20.1, 205.3±6.3, 229.5±74.9, 220.8±45.8 and 179.3 ± 43.8 mg/dl at fasting 30, 60, 90 and 120 min. respectively. The mean glycaemic response of chapathi prepared with multimix flour was 105.8±8.4, 184.3±59.8, 180.3 ± 41.2, 181.3 ± 75.6 and 147.7 ± 40.1 mg/dl at fasting, 30, 60, 90 and 120 minutes respectively and the mean glycaemic response of chapathi with *Stevia* was 95.3 ± 11.4, 176.8 ± 6.1, 174.2 ± 31.9, 143.5 ± 30.9 and 132 ±24.4 mg/dl at fasting, 30, 60, 90 and 120 minutes respectively. The peak value was 229.5 mg/dl for reference food observed at 60 minutes whereas the peak value was 184 and 176mg/dl for control chapathi and *Stevia* chappathi at 30 min. Thereafter the levels showed a reducing trend at 120 min. Glucose recorded the highest response (179.3mg/dl) followed by control chappathi (147.7mg/dl) and lowest response (132mg/dl) by the *Stevia* chapathi. Suzuki *et al.,* (1977) reported that powdered *Stevia* leaves (10 percent addition) to high carbohydrate diet decreased the blood glucose and hepatic glycogen levels in rats. Blood glucose concentration of diabetic women was less after the intake of *Stevia* chappathi when compared to control chapathi and reference food (glucose) intake. However the statistical 'F' value showed that the reduction of blood glucose concentration was insignificant.

Glycaemic index (GI) of control & stevia based designer foods

The GI of foods has potential implications for the prevention and treatment of major chronic diseases, including diabetes, CHD and obesity (Salmeron *et al.,* 1997; Ludwig, 2000).The lower GI values of diets high in whole grains and legumes is an important factor (Brand-Miller *et al.,* 2002).The GI concept was developed to predict post prandial increases in blood glucose concentration after the consumption of food. A low GI

food is defined as having a GI of ≤ 55 and a high GI food has a GI of ≥ 70. *Stevia* products possess potential hypoglycemic effects, as these influence blood sugar and insulin level of subjects. The glycaemic index of control chappathi and *stevia* chappathi was 71.2 and 61.9 respectively. The GI of *stevia* chappathi was lower than control chappathi but highly insignificant. This coincides with the study conducted on women with diabetes by Savitha *et al.* (2004) who reported that the glycaemic index of control bun and *stevia* bun was 72 and 62 respectively.

Effect of stevia chappathi in type 2 diabetic women

The effect of supplementation in women with Type 2 diabetes is presented in Table 2. The mean fasting blood glucose concentration of the selected diabetic women at zero day was 102±12 mg/dl and increased slightly to104±15 mg/dl on 30th day (without any supplement food).The consumption of *stevia* (2%) chapathi/pasta for 30 d reduced the glucose concentration to 87.5 mg/dl. Further, on withdrawal period the mean fasting blood glucose concentration increased to 93.2mg/dl. Statistical't' test showed that there was insignificant difference between zero day and 30 d. The mean reduction in the fasting blood glucose level after 30 d of supplementation of *Stevia* chappathi was significant, moreover the increase in the mean fasting blood glucose level after withdrawing *stevia* (60-90 d) from the daily diet differ significantly. There was no significant difference between 0 and 90, 30 and 90 days indicating that in absence of *stevia* food, their blood glucose concentration was slightly high during pre-supplementation and withdrawal period.

The mean post prandial blood glucose concentration of the selected diabetic women at zero day was 260.8± 25 mg/dl and it slightly decreased to 250.4±38 mg/dl on 30th day for 30 d supplementation of *stevia* chapathi/pasta it declined to 183.1±4 mg/dl. However after withdrawing *stevia* for a period of 30 d again the blood glucose concentration increased to 199.5±14 mg/dl. Statistical't' test showed that there was insignificant difference exist between zero day and 30 d. The mean reduction in the post prandial blood glucose concentration after 30 d of supplementation of 2 g% *Stevia* chappathi was significant (P<0.05) and also the increase in the mean postprandial blood glucose level after withdrawing *Stevia* from the daily diet differ significantly (P<0.05). Significant reduction was found in blood glucose concentration between 0 and 60 days. Owing to the effect of supplementation of *Stevia* for 30 d on blood glucose, similarly there was a significant (P<0.05) difference between 0 and 90, 30 and 90 d. It was observed that there were 16 and 27% decrease in the fasting and postprandial blood glucose level of the selected diabetic women respectively. This coincides with the study conducted by Sahiba *et al.* (2008) who reported that supplementation of one gram *Stevia* leaf powder per day for 90 d brought about 24.8 and 33.8% significant reduction in fasting and post prandial blood glucose level of diabetic subjects respectively. The results of the study showed that ingestion of *stevia* upto 2 g for 30 d significantly reduced fasting and post prandial blood glucose concentrations in women with diabetes.

Table 2. Mean fasting and post prandial glucose concentration in type 2 diabetic women.

Test days	Fasting		Post prandial	
	Mean ± SD mg/dl	't'value	Mean ± SD mg/dl	't'value
Day 0 vs Day 30	102± 12 104 ±15	0.5 NS	260.8 ±25 250.4 ±38	0.69 NS
Day 30 vs Day 60	104 ±15 87.5±5.8	2.85*	250.4 ±38 183.1± 4	5.21*
Day 60 vs Day 90	87.5±5.8 93.28± 6	3.47*	183.1± 4 199.5 ±14	3.65*
Day 0 vs Day 60	102± 12 87.5±5.8	4.06*	260.8 ±25 183.1± 4	8.45*
Day 0 vs Day 90	102± 12 93.28± 6	1.95 NS	260.8 ±25 199.5 ±14	6.36*
Day 30 vs Day 90	104 ±15 93.28± 6	1.69 NS	250.4 ±38 199.5 ±14	4.45*

Day 0 vs Day 30- Pre supplementation period;
Day 30 vs Day 60- Supplementation period
Day 60 vs Day 90- Withdrawal period
NS-No significant
**Significant at 5% level*

Conclusion

The study may be concluded that stevia effectively regulates blood glucose in women with type 2 diabetes. Therefore,it should be assumed that the *stevia* improves glucose tolerance,inhibits the monosacchharide transporter in the liver.The transporter carries glucose,fructose,and galactose in both directions and it halves the transport rate of glucose into the liver and hepatic release of glucose.

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