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Blood glucose lowering effect of the leaves of *Tinospora cordifolia* and *Sauropus androgynus* in diabetic subjects

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Abstract

Objective: To study the blood glucose lowering effect of the aqueous leaf digest prepared from *T. cordifolia* and *S. androgynus.* Materials and methods : The effect of the aqueous leaf digest (10g/200ml water) of the two experimental plants on post-prandial blood glucose levels was determined separately, in non-insulin dependent diabetic (NIDDM) subjects using the method of glucose tolerance test (GTT). The effect was compared with the glycemic response elicited by the control (glucose=50g) and the hypoglycaemic activity was evaluated in terms of glycemic index (GI) score. Results : The rise in the blood glucose levels of the subjects administered with the experimental samples were lower than the levels observed after feeding glucose control, with the glucose levels reverting back to fasting levels after 2 h. of administration in experimental groups. The GI scores of *T. cordifolia* (GI=39) and *S. androgynus* (GI=55) were significantly lower than that of glucose control (GI=100). Conclusion: *T. cordifolia* is found to exhibit a significant ability to reduce blood sugar levels in human subjects. This corroborates with the results of earlier animal studies and its use as an anti-diabetic agent in ayurvedic medical system. The hypoglycaemic activity of *S. androgynus* indicated in the present study warrants investigation into the compounds/extracts with anti-diabetic activity.

Keywords : *Tinospora cordifolia, Sauropus androgynus,* hypoglycaemic activity, glycemic index

1. Introduction

Tinospora cordifolia (Willd.) (Family : Menispermaceae) also referred to as ‘Amrta’ in Sanskrit is a valuable medicinal plant of the ancient pharmacopoeia. The dry stem and root of this plant is reported to be the main constituents of the formulated drugs. It is a large extensively spreading twiner, sometimes cultivated as an ornamental plant and the leaves afford as a good fodder for cattle [1]. Pharmacological and clinical studies carried out on this plant have shown it to possess hepatoprotective [2], anti-oxidant [3],

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immunogenic/adaptogenic [4,5,6], hypo-lipidaemic [7] and antimicrobial activity [8]. The aqueous and alcoholic extracts of the stem [9,10], aqueous root extract [11], and alcoholic and chloroform extracts of the leaves [12] have been reported to exert a significant hypoglycaemic effect in animal models (diabetic rats and rabbits).

The present study was carried out to substantiate and corroborate the results of animal studies in human subjects. Leaf sample was selected, as the use of the same is non-destructive to the plant than the stem or root. Also, the leaves have not been investigated extensively for its therapeutic potential or chemical composition.

Sauropus androgynus Merill (Syn. *Sauropus albicans Blume*) of the family Euphorbiaceae, commonly known as 'star' goose-berry and chekkurmenis is a perennial shrub found grown wild in South East Asia and mostly in the hilly regions of India. The dark green leaves are used for human consumption in Malaysia [13] and parts of India.

It has been promoted as being effective in controlling hypertension, gynecologic problems, hyperlipidemia, hyperuricemia, urolithiasis, gall stones and constipation [14]. Ethno-medical usage in India include the use of the leaves for ulcers, eye troubles and tonsillitis [15]. In parts of Tamil Nadu and Kerala, it is referred to as "diabetic greens" and believed to be useful for diabetic cure. In order to ascertain the efficacy of this belief, these leaves were included in the present study on antidiabetic effect.

2. Materials and methods

2.1 Preparation of leaf digest

Fresh leaf samples of *Tinospora cordifolia* were collected from the Institute campus, Anantapur and the leaves of *S. androgynus* were procured from a local garden, Tamil Nadu. Identification of the samples were verified using standard botanical monographs. They were further confirmed with the botanical gardens, Kotakkal, Kerala (for *S. androgynus*) and with Dept. of Botany, Sri Krishnadevaraya University, Anantapur (for *T. cordifolia*). The leaves were cleaned and wiped. Ten grams of the leaves were weighed and steamed in 100ml water. The steamed leaves were ground in a blender and the digest was made upto 200ml with distilled water.

2.2. Selection of subjects

A total of 18 NIDDM diabetic subjects within the age range between 50 to 65 years and the weight range between 70 to 85 kgs were selected from Anantapur town. They were divided into 3 groups having 6 subjects in each group.

2.3 Assessment of glycemic response

Oral glucose tolerance test (GTT) was conducted involving the measurement of increase in fasting blood glucose levels over a period of two hours after the administration of the leaf digest alongwith 50g of glucose. The feeding was started at 6.15 a.m. after an overnight fast. The entire feed sample was ingested within 10 min. and the blood samples were collected at periodic intervals of every 30, 60, 90 and 120 min. in heparinized capillary tubes. The glucose levels were determined in fresh plasma in an auto analyser using the glucose oxidase peroxidase method. The glycemic index was determined by the method given by Jenkins *et al.* [16].

$$\text{G I} = \frac{\text{Incremental area under the blood glucose response curve for test sample}}{\text{Incremental area under the blood glucose response curve for control (glucose)}} \times 100$$

The area under the blood glucose response curve was calculated using the following formula [16].

Area = (At/2)+ At + (A-B) t/2 + (C-D) t/2 …………….etc

Where, A, B, C, D represent the blood glucose concentration at fasting and at times t, 2t, 3t, 4t …… after the start of the test. 't' represents different time intervals between the blood samples.

2.4 Statistical analysis

Mean blood sugar levels are expressed in mg/100ml ±SD. The difference in the blood sugar levels at different time intervals, the area and GI calculated between the leaf digest treated group and the control group was analysed for statistical significance using Student's *t* - test [17].

3. Results and discussion

The rates of increments in the mean plasma glucose levels after the administration of experimental test samples and glucose control to the non-insulin dependent diabetic patients is depicted in Table 1. The mean plasma glucose levels increased progressively from 0 min and after reaching the peak at 60 min, the levels were found to reduce in all the groups and at 120 min, the blood glucose levels were found to revert back to the fasting levels with the exception of glucose control group, in which the magnitude of difference from the fasting level was still large.

From the values given in Table 1, it can be observed that, the glucose levels at 0 min were not significantly different but, the rise in the blood glucose levels was significantly lower in both the experimental samples tested, in comparison to the blood glucose levels of the control (glucose) group.

This difference in rise in glucose levels was significant at P<0.05 for *S.androgynus* from 30 min and from 60 min for *T.cordifolia*. At 120 min, the lowering of glucose levels were more pronounced (P<0.01) compared to control group. This indicates an improved glucose tolerance in the subjects fed the test samples.

The incremental areas under the blood glucose response curve for subjects consuming the experimental samples were significantly lower (P<0.01) than the glucose curve area of the subjects consuming glucose control (Table 1).

The glycemic index (GI) values were found to be 55.31 for *S. androgynus* and 38.86 for *T. cordifolia* leaves (Table 1). The GI values of the leaf samples were also found to be significantly different from that of glucose control (P<0.01). Glycemic index (GI) is an useful tool for measuring the rate at which foods/substances

Table - 1
Glycemic response of *Sauropus androgynus* and *Tinospora cordifolia* leaves

Treatment	Blood glucose levels (mg/dl)					Area under blood glucose response curve (mg.min/100ml)	Glycemic index
	0 min	30min	60min	90min	120min		
Glucose(Control)	158.8 ± 40.1	238.8± 46.8	306.6± 52.8	258.5± 43.6	238.0± 54.0	11012.5± 4107.9	100
Sauropus androgynus	126.4± 21.0	183.2±* 21.0	237.8±* 44.0	185.2±* 38.0	136.8±** 30.0	6966.0 ±** 2230.0	55.31 ±** 21.52
Tinospora cordifolia	150.0 ± 28.7	223.3± 38.6	240.0±* 32.4	221.7± 31.2	165.0±** 23.7	4788.88±** 1332.3	38.86±** 7.19

*P<0.05 *vs* glucose control; **P<0.01 *vs* glucose control; Values are mean ± SD of 6 subjects provide glucose to the blood and thus stimulate insulin release [18]. Products with low GI are therefore prescribed for diabetic subjects.

On comparison, the hypoglycemic action was found to be most pronounced in the leaves of *T. cordifolia* (GI=38.86), followed by *S. androgynus* (GI=55.31). The GI of *T. cordifolia* leaves as determined in the present study has been found to be comparable or lower than the GI values of different parts of a well-established hypoglycemic agent fenugreek. The GI values reported for fenugreek leaf, seeds, and root are 52.0, 40.7 and 37.7, respectively [19].

Higher amounts of many of the nutrient and non-nutrient components, such as protein, fat, fibre, phytates, lectins, tannins, polyphenols, saponins and enzyme inhibitors are associated with low GI of foods [18]. The leaves of *T. cordifolia* and *S. androgynus* have been found to be moderate to good sources of fibre, protein, phytates and polyphenols which could be responsible for their low GI value (unpublished data).

The hypoglycaemic potential of *T. cordifolia* leaves found in the present study is substantiated by a similar response observed by Wadood *et al.* [12], wherein the aqueous alcoholic and chloroform leaf extracts of *T. cordifolia* exerted a significant hypoglycaemic action both in normal and diabetic rabbits. The extracts of the leaf have been postulated to have an insulin-like action.

In *T. cordifolia* the presence of bitter components present may be more pronounced in increasing glucose tolerance. The bitter fraction of aqueous extract of *T. cordifolia* has been reported to inhibit hyperglycemia significantly [9]. The mode of action was attributed to a favourable influence on endogenous insulin secretion, glucose uptake and inhibition of peripheral glucose release .

The present study has thus, indicated that the leaves of the two experimental plants investigated have a good potential for lowering blood glucose levels in human subjects. The exact biological active constituent(s) in these leaves responsible for hypoglycaemic action has yet to be determined.

However, the observation is consistent with the use of these experimental plants in ancient and ethno-medical practice for diabetes management. This study warrants investigation into the composition of aqueous extracts for identification of hypoglycaemic principles.

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