

A Review on Antidiabetic Pharmacology of *Tinospora cordifolia*

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ABSTRACT

Diabetes mellitus is a metabolic disorder. Today, it is becoming a common disease among people due to change in life style, food habits etc. At present, different drugs are available for the treatment of Diabetes. But people still prefer indigenous medicines to treat these diseases. One of the mostly used traditional medicines for diabetes is made from *Tinospora cordifolia*. Many literature studies have also documented the use of its different parts in treating Diabetes mellitus. Different pharmacological studies give insight to its antidiabetic properties. Present study is an attempt to review the pharmacological aspects of *Tinospora cordifolia* as antidiabetic medicine.

Key words : Diabetes mellitus, *Tinospora cordifolia*, Pharmacology, Antidiabetic

Introduction

Diabetes is a disease in which the body is unable to produce or unable to properly use and store glucose (a form of sugar). Glucose backs up in the bloodstream - causing one's blood glucose or "sugar" to rise too high. As ethnic communities switch over from their native diets to more commercial foods, the rate of diabetes increases, eventually reaching the same proportions seen in western societies (Borah *et al.*, 2009). In modern medicine, no satisfactory effective therapy is available to cure the diabetes mellitus. Though insulin therapy is also used for the management of diabetes mellitus, but there are several drawbacks. Recently, there has been increasing interest in the use of medicinal plants. Throughout the world many traditional plant treatments for diabetes exist (Rajalakshmi *et al.*, 2009).

Tinospora cordifolia (Family: Menispermaceae) a renowned medicinal vine of Ayurveda is reported to possess multi-dimensional biological properties

(Sharma *et al.*, 2013). It is large, glabrous, deciduous climbing shrub belonging to the family menispermaceae. It is distributed throughout tropical Indian subcontinent and China. It is genetically large, diverse climbing shrub with flowers of greenish-yellow colour and the flowering season expands over summer and winter. It is indigenous to topical areas of India, Myanmar, and Sri Lanka. It is used in the treatment of various diseases and infections such as diabetes, high cholesterol, allergic rhinitis, Gout, upset stomach, lymphoma, and some cancers also (Kattupalli *et al.*, 2019).

Almost all the parts of the plant are documented to be useful in ethno-botanical surveys conducted by ethnobotanists (Lalramnghinghlova *et al.*, 2003; Sood *et al.*, 2005). In folk and tribal medicine, whole plant, powdered root and stem bark, decoction of root and stem, juice of the root, juice or paste of the leaves, and stem of the *T. cordifolia* are being used to treat various ailments. Assamese people use *Tinospora cordifolia* for curing different diseases. It is known as

Hogunilota in Assamese. They considered *Tinospora cordifolia* as a great remedy for Diabetes mellitus. Present study is an attempt to analyse the antidiabetic pharmacological activity of *Tinospora cordifolia*.

Antidiabetic Pharmacology of *Tinospora cordifolia*

Different pharmacological studies have reported the presence of many active compounds in this plant which act as potent agents against diabetes. Alkaloid, Glycoside, Diterpenes, Sterols, Flavonoids, Saponins etc are extracted from various extracts of *Tinospora cordifolia*. Scientists assume that the alkaloids are mainly responsible for the anti-diabetic activity (Chakravorty, 2016).

Antidiabetic pharmacology of *Tinospora cordifolia* leaf

The aqueous, alcoholic, and chloroform extracts of the leaves of *Tinospora cordifolia* were administered in doses of 50, 100, 150 and 200 mg/kg body weight to normal and alloxan-diabetic rabbits. The blood glucose and total lipid levels were estimated before and 2, 4, 6, and 8 hours after administration of the extract. The extract exerted a significant hypoglycaemic effect in normal as well as in alloxan-treated rabbits (Wadood *et al.*, 1992). In another study, 6-week-old male rats (Sprague-Dawley) were fed a laboratory diet and given water *ad libitum*. All rats were housed for 1 week at 21-22 °C under controlled light conditions. Food was withheld for 16 h before the experiment. Saponarin (isolated from *Tinospora cordifolia*) was orally administered to rats (n = 6, 220-225 g in weight) at a single dose of 20, 40, 80 mg/kg body weight. After 5 min, maltose was fed to rats through the same route at the dose of 2 g/kg body weight. Blood sample (20 µl) was collected from the tail vein at different time intervals till 2 h. Blood glucose was measured by a disposable glucose sensor. Blood glucose lowering activity of saponarin on maltose fed rat, was found to be encouraging compared to its *in vitro* activity on α -glucosidase (Sengupta *et al.*, 2009). Alcoholic leaf extracts injected in Rats at a dose of 0.5 mg/kg showed significant reduction in blood glucose level (Aglawe *et al.*, 2011). A study documented that the leaves of this plant are used in the treatment of diabetes. The soxhlet extract (5 mg/ kg) was subjected to evaluation of hypoglycemic activity. This extract was injected to rats and blood glucose level was determined after the treatment of 3 days, 7 days and 15 days. After the treatment in experimental rats hy-

poglycemic changes were observed in blood glucose level compared to the control group rats. The treated animals with the leaf extract clearly indicate the hypoglycemic effect like insulin (Sharma *et al.*, 2021).

Antidiabetic pharmacology of *Tinospora cordifolia* stem

The hypoglycaemic effect of *Tinospora cordifolia* stem extracts was assessed by injecting the extract into Streptozotocin induced rats (Selvaraj *et al.*, 2012). Diabetes mellitus was induced in male albino Wistar rats by intraperitoneal injection of streptozotocin (45 mg/kg b.w.) (Vetrivadivelan *et al.*, 2012). In a study an attempt was made to assess the bioactivity of daily oral administration of methanolic extract of *Tinospora cordifolia* stem (500 mg/kg body weight) for 6 weeks in normal and alloxan induced diabetic rats. A significant decrease in blood glucose, glycosylated haemoglobin were observed in diabetic rats on treatment with methanolic extract of stem compared to normal (Sivakumar *et al.*, 2011). The anti-diabetic efficiency of this medicinal plant was studied in experimentally induced type 2 diabetes in Sprague-Dawley rats. Diabetes was induced by a combination of high fat diet for a period of 10 weeks followed by intraperitoneal injection of streptozotocin (35 mg/kg of body weight). Oral treatment of *Tinospora Cordifolia* (100 and 200 mg/kg body weight) for 14 days regulated blood glucose, provoked insulin secretion. Treatment with TC (100 and 200 mg/kg) also inhibited glucose 6-phosphatase and fructose 1,6-diphosphatase ; and restored glycogen content in liver (Sangeetha *et al.*, 2011). Administration of stem extracts into Alloxan rabbit at a dose of 50 mg/kg significantly reduces the blood glucose level (Nasiruddin *et al.*, 2011). Aqueous extract administered to a High fructose fed Wistar Rat at a dose of 100 mg/kg results in improvement of glucose and lipid metabolism (Reddy *et al.*, 2009). In an experiment, Stem extracts both aqueous and alcoholic in different doses (200 and 400 mg/kg b.w.) were administered in streptozotocin-diabetic albino rats. The drug was given orally for 10 days and 30 days in different group of animals and the results were observed. The study clearly showed that *Tinospora cordifolia* has significant antidiabetic activity in diabetic animals and has an efficacy of 40–80% compared to insulin. *Tinospora Cordifolia* administration in diabetic animals did not cause any increase in serum insulin levels or regeneration of pancreatic β -cells but

caused increased hepatic glycogen synthase and decreased glycogen phosphorylase activity. This study strongly suggested that *Tinospora cordifolia* may act like oral antihyperglycemic drugs and indicated that treatment with *Tinospora cordifolia* may be an alternative to some of the present available drugs, which have some adverse effects (Kumar, 2015). The oral administration of various extracts (hexane, ethyl acetate and methanol) of *Tinospora cordifolia* stem were found to have potent antidiabetic activity that reduces blood sugar level in streptozotocin induced diabetic rats. In this study, the chronic (100 days) antihyperglycemic effect of the extracts at a dose of 250 mg/kg b.w.p.d of *Tinospora cordifolia* was investigated. Insulin was used as a ref-

erence drug at a dose of 3 I.U/kg.b.w.p.d. Supplementation of methanol extract significantly reduces the fasting blood glucose level when compared to other 2 extracts (Evans *et al.*, 2000).

Antidiabetic pharmacology of *Tinospora cordifolia* root

Oral administration of an aqueous *T. cordifolia* root extract to alloxan diabetic rats caused a significant reduction in blood glucose and brain lipids (Stanely *et al.*, 2000). Oral administration of the alcoholic root extract of *Tinospora cordifolia* for 6 weeks resulted in a significant reduction in blood and urine glucose in alloxan diabetic rats (Stanely *et al.*, 2003). The antidiabetic efficiency *Tinospora cordifolia* was studied in

Table 1. Antidiabetic pharmacological profile of *T. cordifolia* Leaf

Sl. No.	Animal model	Extract used	Drug induced	Effect	Reference
1.	Rabbit	Alcoholic, Aqueous, Chloroform	Alloxan	Reduced Blood Glucose Level	Wadood <i>et al.</i> , 1992
2.	Rats	Methanol	Maltose	Hypoglycemic activity	Sengupta <i>et al.</i> , 2009
3.	Rats	Alcoholic extract	-	Significant decrease blood glucose level	Aglawe <i>et al.</i> , 2011
4.	Rat	Soxhlet	-	Hypoglycemic effect like insulin	Sharma <i>et al.</i> , 2021

Table 2. Antidiabetic pharmacological profile of *T. cordifolia* Stem

Sl. No	Animal Model	Extract	Drug induced	Effect	Reference
1.	Rat	Alcoholic	Streptozotocin	Significant hypoglycemic effect	Selvaraj <i>et al.</i> , 2012
2.	Rat	Aqueous	Streptozotocin	Significantly reduced blood glucose level and also reduced body weight	Vetrivadivelan <i>et al.</i> , 2012
3.	Rat	Methanol	Alloxan	Significantly decrease in blood glucose, glycosylated Haemoglobin, cholesterol and increase in body weight and protein level.	Sivakumar <i>et al.</i> , 2011
4.	Rat	Aqueous & Alcoholic	Streptozotocin	Reduced blood glucose level in liver.	Sangeetha <i>et al.</i> , 2011
5.	Rabbit	-	Alloxanrabbit	Significant decrease blood glucose level	Nasiruddin <i>et al.</i> , 2011
6.	Wistar Rat	Aqueous	High fructosediet	Improvement of glucose and Lipid metabolism.	Reddy <i>et al.</i> , 2009
7.	Albino rat	Aqueous, Alcoholic	Streptozotocin	Antidiabetic activity in diabetic animals and has an efficacy of 40–80% compared to insulin	Kumar, 2015
9.	Rat	Hexane, Ethyl acetate and methanol	Streptozotocin	Reduces the fasting blood glucose level	Evans <i>et al.</i> , 2000
0.	Wistar Rat	Alcoholic	-	Antidiabetic and antihyperlipidemic	Rajalakshmi <i>et al.</i> , 2009

experimentally induced type 2 diabetes in Sprague-Dawley rats. Oral treatment of *T. cordifolia* root extract (100 and 200 mg/kg body weight) to these rats for 14 days regulated blood glucose, provoked insulin secretion. (Sangeetha *et al.*, 2011). A study was undertaken to evaluate antihyperglycemic, antihyperlipidemic and antioxidant activities of Dihar, a polyherbal formulation containing drugs from seven different herbs along with *Tinospora cordifolia* in streptozotocin (45 mg/kg IV single dose) induced type 1 diabetic rat. Treatment with Dihar (100 mg/kg) for 6 weeks produced decrease in serum glucose and lipids levels and increased insulin levels as compared to control (Patel *et al.*, 2009).

Antidiabetic pharmacology of *Tinospora cordifolia* whole plant

The antihyperglycemic effect of Makaradhwaja was assessed in normal rats by injecting streptozotocin at 45 mg/kg to induce hyperglycemia. Powdered form of Makaradhwaja (Red sulphide of mercury) and Guduchi Ghana (dried extract of *Tinospora cordifolia*) with Honey was administered orally at 22.5 mg/kg dose levels for 15 days (Khedekar *et al.*, 2012). A study was conducted to evaluate the effects of daily oral feeding of *Tinospora cordifolia* extracts with some other herbs on blood glucose concentrations and kidney functions in streptozotocin diabetic rats. Plasma glucose concentrations in diabetic induced mice were reduced

by the administration of extracts of *Tinospora cordifolia* by 7.45% (Grover *et al.*, 2001). Isoquinoline alkaloids of *Tinospora cordifolia* extract named magnoflorine showed alpha glucosidase inhibition leading to significant reduction in glucose absorption from small intestines (Patel *et al.*, 2012).

Discussion

Medicinally important plant *Tinospora cordifolia* is used to treat a variety of diseases in traditional medicine. The current study revealed the capacity of *Tinospora cordifolia* to lower blood glucose levels in various animal models. The antidiabetic property of this herb was examined using several plant parts including the leaf, stem, roots, and entire plant. Aqueous, alcoholic, Hexane, Ethyl acetate and methanolic extracts of different parts of this herb were used for this purpose. In some cases, diabetes was initially produced in laboratory animals using various drugs like streptozotocin, alloxan, etc. before the animals were administered these extracts. However, in several experiments, the extracts were given to the laboratory animals without prior drug administration. This study finding revealed that *Tinospora cordifolia* is significantly anti-diabetic. Various extracts from this plant help lower blood sugar levels. Additionally, it can cause weight loss. *Tinospora cordifolia* not only maintains glycaemic controls like those conventional drugs but possesses

Table 3. Antidiabetic pharmacological profile of *T. cordifolia* Root

Sl. No.	Animal model	Extract	Drug induced	Effect	Reference
1.	Rat	Aqueous	Alloxan	Significant reduction in blood glucose and brain lipids	Stanely <i>et al.</i> , 2000
2.	Rat	Alcoholic	Alloxan	Significant reduction in blood & urine glucose and lipid in serum, also decrease in bodyweight	Stanely <i>et al.</i> , 2003
3.	Rat	Aqueous, Alcoholic	Streptozotocin	Reduced blood glucose level in liver	Sangeetha <i>et al.</i> , 2011
4.	Rat	-	Streptozotocin	Anti-hyperglycaemic	Patel <i>et al.</i> , 2009

Table 4. Antidiabetic pharmacological profile of *T. cordifolia* whole plant

Sl. No	Animal Model	Extract	Drug induced	Effect	Reference
1.	Rat	-	Streptozotocin	Reduced blood glucose level.	Khedekar <i>et al.</i> , 2012
2.	Mice	-	Streptozotocin	Reduced plasma glucose concentration.	Grover <i>et al.</i> , 2001
3.	-	Magnoflorine	-	Reduced glucose absorption from small intestines.	Patel <i>et al.</i> , 2012

multiple target actions obliterating the complex diabetic pathology and remote apparent metabolic complications (Sharma *et al.*, 2015). *T. cordifolia* is significant and they have negligible side effect than the synthetic diabetic drugs (Sharma *et al.*, 2014).

Conclusion

Different scientific research on *Tinospora cordifolia* suggested the potential of this plant as a source of antidiabetic agent. The above review discussed in detail the antidiabetic medicinal properties of *Tinospora cordifolia*. It was found that the antidiabetic properties of *Tinospora cordifolia* leaves, stem and roots have been experimentally proven. Various drugs have been developed to control diabetes but these drugs cannot completely eradicate it. There is a possibility of obtaining some beneficial outcomes regarding the management of diabetes by undertaking in-depth study on the medicinal properties of *Tinospora cordifolia*.

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