

# Talapotaka Pushpa: A Promising Herbal Remedy for Diabetes Mellitus

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## Abstract

Talapotaka is the synonym of plant *Cassia auriculata* in Ayurvedic classics. It is commonly known as Avartaki in Sanskrit. It carries a beautiful bright yellow-colored flower having a potent antidiabetic activity. Diabetes mellitus (DM) is associated with several changes and impairment in the function of many vital organs. Herbal remedies for DM always recover the above-mentioned complications of DM. Talapotaka Pushpa (*C. auriculata* flower) is one such herbal remedy which could improve DM. In the present review article, data are compiled supporting the antidiabetic potential of Talapotaka Pushpa that may be helpful for the researchers to focus on the priority areas of research yet to be discovered.

**Key Words:** Talapotaka, *Cassia auriculata*, Diabetes, Herbal

## INTRODUCTION

In the 21<sup>st</sup> century, herbal medicines are preferred over modern medicine due to their safety, efficacy, cultural acceptability, and lesser side effects. Plant and plant products have utilized with varying success to cure and prevent diseases throughout history.<sup>[1]</sup> Diabetes is a type of metabolic disorder which is the fifth-leading cause of death worldwide, accounting for 5.2% of all deaths. Its chronic nature, the severity of complications and the means necessary to control them become diabetes a disease very costly for affected individuals and their families, as well as for the health system. Costs directly related to diabetes range from 2.5% to 15% of the annual health budget, depending on their prevalence and the sophistication of the treatment available.<sup>[2]</sup> Various factors responsible for diabetes burden in India include genetic predisposition along with lifestyle changes and associated with urbanization and globalization. All these factors contribute to making India as a diabetes hub. In India, diabetes causes among the highest economic burden in the world.<sup>[3]</sup> Micro- and macro-vascular complications of diabetes lead to increased morbidity and mortality.<sup>[4]</sup> Almost 50% of undetected diabetic people present with micro- and macro-vascular complications at the time of diagnosis.<sup>[5]</sup> Diabetes imposes

a large economic burden on the individual, national healthcare system, and economy. There are several plants routinely screened for antidiabetic activity. Talapotaka is the synonym of plant *Cassia auriculata* in Ayurvedic classics. It is commonly known as Avartaki in Sanskrit. A book published by the Central Council for Research in Ayurvedic Sciences (CCRAS) (Siddha-Vaidya-Saral Upchar pranali, CCRAS, 3<sup>rd</sup> edition, CCRAS, Delhi, 2005) has mentioned the synonym of Avartaki as Talapotaka in Sanskrit.<sup>[6]</sup> It carries beautiful bright yellow-colored flowers so that it is also known as Pitapuspa, Pitkalika, and Pitkala.<sup>[7]</sup>

## PLANT DESCRIPTION

### Habit and habitat

A tall, evergreen shrub is distributed in dry zones of southern, westerns, and central India, extending up to Rajasthan.<sup>[8]</sup>

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## Botanical classification

Kingdom: Plantae, Division: Magnoliophyta, Class: Magnoliopsida, Order: Fabales, Family: Leguminosae, Genus: *Cassia*, Species: *Auriculata*.<sup>[9]</sup>

## Flower description

It has irregular, bisexual, bright yellow, and large (nearly 5 cm across) flowers, and the pedicels are glabrous and 2.5 cm long. The racemes are short, erect, few-flowered, crowded in axils of upper leaves which form a large terminal inflorescence. There are five sepals which are distinct, imbricate, glabrous, concave, membranous, and unequal, of which two outer ones are much larger than the inner ones. The petals are also five in numbers which are free, imbricate, and crisped along the margin, bright yellow veined with orange. The anthers are ten in number and are separate. The ovary is superior and unilocular, with marginal ovules.<sup>[10]</sup>

## Chemical constituents of flower

A proanthocyanidin dimer designated as auricassin was isolated from the methanolic extract of flowers. It yielded (+)-catechin and cyanidin chloride on mild acid hydrolysis.<sup>[11]</sup> In another study, the ethanolic extract of flowers yielded  $\beta$ -sitosterol and kaempferol.<sup>[12]</sup>

Formulations and preparations of *Talapotaka Pushpa* constitute the following as main ingredient:

1. *Talapotaka Churna*.<sup>[13]</sup>
2. *Aavarai kudineer*.<sup>[14]</sup>
3. *SUGNIL*.<sup>[15]</sup>
4. *Avarai Panchaga Choornam*.<sup>[16]</sup>
5. *Kalpa herbal tea*.<sup>[16]</sup>
6. *Diasulin*.<sup>[17]</sup>

## Phytochemistry of *C. auriculata* flower

Phytochemical screening of *C. auriculata* flower has revealed by many researchers, where different phyto-constituents are found to be constituted by different extracts of *C. auriculata* flower, which are mentioned in Tables 2 and 3.

## Classical description

Prameha/Madhumeha can be considered as DM by different perspectives based on clinical symptoms, and attempts have been made by Ayurvedic physicians and researchers to treat these two entities using classical formulations mentioned in *Prameha Chikitsa*.<sup>[22]</sup> The first and most elaborate description of *Avartaki* in a classical text is available in *Kaiyadeva Nighantu*, where its *Pramehaghna/Madhumehaghna* action through different botanical parts of the plant has been

mentioned. *Kaiyadeva Nighantu* was written by *Kaiyadeva* in the 15<sup>th</sup> century. According to *Kaiyadeva Nighantu*, the flower has *Pramehashamana* property.<sup>[23]</sup>

## Modern/contemporary description

*Talapotaka Pushpa* (*C. auriculata* flower) has been investigated by a number of researchers to elucidate the exact mechanism by which effective therapeutic outcomes occur for DM. Many experimental studies have been published using *Talapotaka Pushpa* (*C. auriculata* flower) and with different extracts. In case of diabetes, there are complex metabolic disturbances due to which complications run parallel to the disease. The herbal plant contains a number of phytoconstituents which show different modes of action and prevent, suppress, or cure the disturbances at the same time. Similarly, *Talapotaka Pushpa* (*C. auriculata* flower) has been established to have different modes of action scientifically in diabetes-induced experimental models, which are mentioned in Table 4.

## Hypoglycemic activity

The oral administration of aqueous extract of flowers in a dose of 0.45g/kg bw for 30 d resulted in a significant reduction in blood glucose and an increase in plasma insulin in STZ-induced diabetic rats. The flower extract decreased the lipid peroxides and caused an increase in reduced glutathione, superoxide dismutase, catalase, glutathione peroxidase, and glutathione S-transferase levels in diabetic rats. The extract at 0.45g/kg bw was more effective than the standard drug glibenclamide.<sup>[33,34]</sup> Further, the extract significantly decreased the blood glucose, glycosylated hemoglobin, and gluconeogenic enzymes and increased plasma insulin, hemoglobin, and hexokinase activity.<sup>[35]</sup>

## Protein-tyrosine phosphatase (PTP) 1B inhibitory activity

The PTP superfamily comprises more than 100 enzymes. The aberrant of PTP activity contributes to several human pathologies, such as diabetes, obesity, cancer, and immune disorders. PTP 1B is a key member in the downregulation of the insulin and leptin signaling pathway by dephosphorylating the insulin receptor and insulin receptor substrates. Development of PTP 1B inhibitors from natural products or synthetic counterparts is one of the biggest issues. An active compound from *C. auriculata* flowers has PTP 1B inhibitory activity. The gas chromatography–mass spectrometry analysis revealed that the spectra obtained from n-butanol fraction were propanoic acid 2-(3-acetoxy-4, 4, 14-trimethylandro-8-en-17-yl). This isolated compound was found to possess significant PTP 1B inhibitory activity. Recent studies have shown that PTP 1B inhibitors have emerged as potential therapeutics for the treatment of Type-2

**Table 1: Pharmacotherapeutics of Talapotaka (*C. auriculata*) as per Ayurveda<sup>[18,19]</sup>**

Name of Drug	Guna	Rasa	Vipaka	Virya	Doshagnata	Rogagnata
Talapotaka	Laghu, Ruksha	Kashay, Tikta	Katu	Sheeta	Kapha-Pitta	Stambhan, Krimighna, Mutrasangrahaney, Shukrastambhan, Kusthaghna, Atisar, Pramehaghna

*C. auriculata*: *Cassia auriculata*

**Table 2: Phytochemical analysis of ethanolic extracts of *C. auriculata* flower<sup>[20]</sup>**

Phytochemical	Flower
Alkaloids	+
Phenols	+
Glycosides	+
Flavonoids	+
Tannins	+
Saponins	+
Proteins	+
Carbohydrates	+

*C. auriculata*: *Cassia auriculata*

**Table 3: Phytochemical analysis of *C. auriculata* flower extract<sup>[21]</sup>**

Tests	Methanol	Ethyl acetate	Hexane
Tannins	+	+	+
Phenols	+	+	-
Flavonoids	+	+	-
Glycosides	-	-	-
Steroids	+	+	-
Terpenoids	-	-	-
Antraquinone	-	-	-
Quinones	+	+	-
Saponins	-	-	-
Coumarins	+	+	-

*C. auriculata*: *Cassia auriculata*

diabetes and obesity. PTP 1B inhibitors also exert beneficial systemic effects such as circulating hemoglobin A1c and the reduction of fructosamine levels, insulin sensitivity, and plasma metabolic profile reinstallation and reduction of serum insulin and leptin levels. The antidiabetic activity of the isolated compound showed effects comparable to that of glibenclamide in alloxan-treated diabetic rats. PTP 1B is known to have several binding sites such as electrostatic, hydrophobic, and hydrogen-bonding sites and also several N-terminals favorable for binding to the acidic site. The molecular features of the isolated compound propanoic acid 2-(3-acetoxy-4,4,14-trimethylandro-8-en-17-yl) might facilitate the hydrophobic interaction and the hydroxyl group in propanoic acid may be presumed to form hydrogen bonds.

### Antioxidant activity

The noticeable management of diabetes and associated complications by phytoconstituents with their antioxidant properties has been reported.<sup>[36]</sup> The aqueous extract of the *C. auriculata* flowers showed curative effects on the lowered constituents in the brain and elevated lipid peroxidation of streptozotocin in diabetic rats. It is known that free radicals formation is elevated in diabetes and its complications.<sup>[37]</sup> *In vitro* studies revealed that the water-soluble fraction of ethanol extract has more antioxidant potential than the aqueous extract of *C. auriculata* flowers, i.e., the potential of scavenging the free radicals by the water-soluble fraction of ethanol extract has more efficient than the aqueous extract.<sup>[38]</sup> The presence of flavonoids in *C. auriculata* flowers may be responsible for antioxidant activities.<sup>[16]</sup>

### Antihyperlipidemic activity

The diabetic control rats showed a marked increase in the frequency of cholesterol, free fatty acids, triglycerides, and phospholipids. The lipid level was significantly reduced by the treatment of aqueous extract of *C. auriculata* flowers. The streptozotocin-induced diabetes leads to an excess of fatty acids in serum which promotes its conversion into phospholipids and cholesterol in the liver. This phospholipid and cholesterol along with excess triglycerides formed at the same time in the liver may be discharged into the blood in the form of lipoproteins. Hypercholesterolemia and hypertriglyceridemia were observed to be common in streptozotocin-diabetic rats and significant increase reported in the experiment. The marked hyperlipidemia that characterizes the diabetic state may, therefore, be regarded as a consequence of the uninhibited actions of lipolytic hormones on the fat depots. Downregulation of NADPH and NADH, which is a cofactor in the fat metabolism, by aqueous extract of *C. auriculata* flowers resulted in its antihyperlipidemic effect. Synthesis of fats from carbohydrates resulted from the binding of H<sup>+</sup> with NADP<sup>+</sup> in the form of NADPH by higher activity of glucose-6-phosphatase. Aqueous extract of *C. auriculata* flowers may be capable of oxidizing NADPH. Enhanced hexokinase activity in an aqueous extract of *C. auriculata* flowers-treated rats suggests greater uptake of glucose from the blood by the liver cells. Lipid metabolism shifted toward carbohydrate metabolism through enzymatic activities during diabetes which enhances the utilization of glucose at the peripheral sites. Inhibition of endogenous synthesis of lipids

**Table 4:** Different modes of action of *C. auriculata* flower<sup>[24-33]</sup>

<i>C. auriculata</i> flower	Intervention	Experimental model	Study outcome
Flower	Aqueous extract	STZ-induced diabetic rats	Suppresses enhanced gluconeogenesis Enhances utilization of glucose through increased glycolysis <sup>[24]</sup>
Flower	Aqueous extract	STZ-induced diabetic rats	Inhibits the alpha-glucosidase enzyme <sup>[25]</sup>
Flower	Aqueous extract	STZ-induced diabetic rats	Antihyperlipidemic effect <sup>[26]</sup>
Flower	Aqueous extract	STZ-induced diabetic rats	Antiperoxidative effect
Flower	Aqueous extract	STZ-induced diabetic rats	Antioxidant effect
Flower	Aqueous extract	Alloxan-induced diabetic rats	PTP-1B inhibitory activity. <sup>[27]</sup>
Flower	Alcoholic extract	Alloxan-induced diabetic rats	A gradual fall in blood glucose Significant changes were observed in lipid profile and metabolic enzyme <sup>[28]</sup>
Flower	Powder	STZ-induced diabetic rats	A significant (P<0.05) decrease in the level of TBARS, conjugated dienes and hydroperoxides in plasma, liver and kidney as compared to that of diabetic rats <sup>[29]</sup>
Flower	Methanol extract	Sprague–Dawley rats	A significant and potent lowering of blood glycemic response toward maltose ingestion The antihyperglycemic effect was as potent as that of therapeutic drug and acarbose <sup>[25]</sup>
Flower	Hydromethanolic extract	Alloxan-induced diabetic rats	The n-butanol fraction exhibited significant reduction (P<0.001) in blood glucose levels Also found effective in restoring the blood lipids <sup>[30]</sup>
Flower	Ethanol extract	Triton WR1339-induced hyperlipidemic rats	Significantly reduced the TC, TG, and LDL levels and significantly increased HDL level <sup>[31]</sup>

*C. auriculata*: *Cassia auriculata*, PTP: Protein-tyrosine phosphatase

may be due to the action of aqueous extract of *C. auriculata* flowers. Metabolic aberrations in streptozotocin-diabetic rats suggest a high turnover of triglycerides and phospholipids. Aqueous extract of *C. auriculata* flowers may antagonize the metabolic aberration and thereby restore the normal metabolism by tilting the balance from high lipids to high carbohydrate turnover. Modification of fatty acid composition by increased lipid levels contributes to lowering the resistance of tissues and a higher rate of oxidative stress. Aqueous extract of *C. auriculata* flowers may result in the production of high NADP<sup>+</sup> which leads to downregulation of lipogenesis and lower risk of the tissues toward oxidative stress and high resistance to diabetes. The antihyperlipidemic effect could represent a protective mechanism against the development of atherosclerosis.<sup>[34]</sup>

## DISCUSSION

Several medicinal preparations in varied forms are used in the Ayurvedic system of medicines for diabetes. The treatment of diabetes with synthetic drugs is costly and chances of side effects are high. Phytochemicals obtained from different medicinal plants present an opportunity for the development

of novel types of therapeutics for DM. Near about 800 plants possessing antidiabetic potential were reported by different ethnobotanical information reports. Several plants have been used as a dietary adjuvant and in treating the number of diseases even without any knowledge of their proper functions and constituents. This practice may be attributed to the uncompromised cost and side effects of the synthetic hypoglycemic agent. Although various synthetic drugs were developed, their safety and efficacy regarding the treatment model are yet to be achieved.<sup>[39]</sup> It is quite evident from this review that Talapotaka Pushpa (*C. auriculata* flower) contains a number of phytoconstituents which reveals its use as a potent antidiabetic remedy. Diabetes is worsened by the different physiological changes such as hyperglycemia, hyperlipidemia, and free radical generation. These consequences can be possibly arrested and also reversed by Talapotaka Pushpa (*C. auriculata* flower). More research is needed to isolate the constituents responsible for the biological actions. It was also observed that no clinical trials have been done so far. The traditional and ethnomedicinal literature showed that the Talapotaka Pushpa is very effective as an antidiabetic remedy. Using the reverse pharmacological approaches in natural drug discovery, a potent and safe drug can be investigated from the plant for various chronic diseases.

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