



Review Paper

Traditional Medicinal Uses, Phytochemical Profile and Pharmacological Activities of *Cassia fistula* Linn.

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Abstract

Cassia fistula Linn. (Family Leguminosae, Sub – family Caesalpineae), a very common Indian plant is known for its medicinal properties. This plant is also known as Indian Laburnum, Yellow shower because of its characteristic yellow flowers in pendulous raceme and with typical branches. It is a native of Tropical Asia. It is widely cultivated in South Africa, Mexico, East Africa and Brazil. This plant is used in folk medicine for tumors of the abdomen, glands, liver and throat cancer. It is also used to cure burns, constipation, convulsions, diarrhea, dysuria and epilepsy. Ayurvedic medicines recognizes as carminative and laxative. It is also used to cure leprosy, skin diseases and syphilis. Phytochemical investigations prove its importance as an important valuable medicinal plant. *C. fistula* is known to be an important source of secondary metabolites notably phenolic compounds. It is known as rich source of tannins, flavonoids and glycosides. Pharmacological activities include antibacterial, antidiabetic, antifertility, anti-inflammatory antioxidant, hepatoprotective, antitumor, antifungal activities. This article aims to provide a comprehensive review on morphology, traditional uses, phytochemical constituents and pharmacological activities.

Keywords: *Cassia fistula* Linn., ayurvedic medicines, secondary metabolites, phenolic compounds, pharmacological activities, phytochemical profile.

Introduction

Cassia fistula L., (Fabaceae, Caesalpinioideae), a very common plant known for its medicinal properties is a semi-wild in nature. It is distributed in various regions including Asia, South Africa, China, West Indies and Brazil¹. It is commonly known as Amultas and in English popularly called “Indian Laburnum” has been extensively used in Ayurvedic system of medicine for various ailments. It is deciduous and mixed-monsoon forests throughout greater parts of India, ascending to 1300 m in outer Himalaya, is widely used in traditional medicinal system of India².

Geographical distribution: In deciduous and mixed monsoon forests throughout greater parts of India, ascending to 1300 m in outer Himalaya. In Maharashtra, it occurs as a scattered tree throughout the Deccan and Konkan³. The plant is cultivated as an ornamental throughout India⁴.

Taxonomic Position⁵

Kingdom:	Plantae
Subkingdom:	Tracheobinota
Super Division:	Spermatophyta
Division :	Mangoliophyta
Class:	Magnoliopsida
Sub Class:	Rosidae
Order:	Fabales
Family:	Fabaceae
Genus:	<i>Cassia</i>
Species:	<i>fistula</i>

Vernacular Names

Bengali:	amultash, sondal, sonali
English:	golden shower, Indian laburnum
Gujarati:	Girmala
Hindi:	Bandarlathi, bharva, suvarnaka
Malayalam:	Tengguli, rajah
Sanskrit:	saraphala, survanaka, argwadha, rajtaru
Tamil:	kavani, konnai, tirukontai, sarakkonne, Raelachettu
Telugu:	Kakkemara
Marathi:	Bahava
Punjabi:	Amaltaas, Kaniyaar, Girdnalee
Oriya:	Sunaari
Urdu:	Amaltaas
Arab:	Khayarsambhar chalyaphruek, khuun
Thai:	Canâfstula mansa, chácara, Guayaba cimarrona
Spanish:	Bâton casse, casse doux, casse espagnol
Trade name:	Indian laburnum

Morphology

It is a deciduous tree with greenish grey bark, compound leaves, leaflets are each 5-12 cm long pairs. A semi-wild tree known for its beautiful bunches of yellow flowers and also used in traditional medicine for several indications. A fruit is cylindrical pod and seeds many in black, sweet pulp separated by transverse partitions. The long pods which are green, when

unripe, turn black on ripening after flowers shed⁶. Pulp is dark brown in colour, sticky, sweet and mucilaginous, odour characteristic, and somewhat disagreeable⁷. Drug occurs in flat or curved thick pieces; outer surface smooth to rough with warty patches; greenish grey to red; inner surface rough, reddish with parallel striations; fracture, laminate; odour, sweet and characteristic; taste, astringent⁸.

A tree 6-9 m high; trunk straight; bark smooth and pale grey when young, rough and dark brown when old; branches spreading, slender. Leaves 23-40 cm long; main rachis pubescent; stipules minute, linear-oblong, obtuse, pubescent. Leaflets 4-8 pairs, ovate or ovate-oblong, acute, 5-12.5 by 3.8-9.5cm, bright green and glabrous above, paler and silvery-pubescent beneath when young, the midrib densely pubescent on the underside, base cuneate; main nerves numerous, close, conspicuous beneath; petiolules 6-10 mm long, pubescent or glabrous. Flowers in lax racemes 30-50 cm. long; pedicels 3.8-5.7 cm. long, slender, pubescent and glabrous. Calyx 1 cm long divided to the base, pubescent; segments oblong, obtuse. Corolla 3.8 cm across, yellow; stamens all antheriferous. The pods are pendulous, cylindric, nearly straight, smooth, shining, brown-black, indehiscent, with numerous (40-100) horizontal seeds immersed in a dark coloured sweetish pulp. Seeds broadly ovate, 8mm. long, slightly less in breadth, and 5mm thick⁹.

The fruit pods are 40-70 cm long and 20-27mm in diameter, straight or slightly curved, smooth but finely striated transversely, the striations appearing as fine fissures. The rounded distal ends bear a small point marking the position of the style. The dorsal suture appears as a single vascular strand and the ventral suture as two closely applied strands. Internally the pod is divided by thin, buff coloured, transverse dissepiments at intervals of about 0.5cm. Each compartment contains one seed which is flat, oval, reddish brown with a well marked raphe. The seed contains a whitish endosperm in which the yellowish embryo is embedded¹⁰.

Traditional Medicinal Uses

The root is prescribed as a tonic, astringent, febrifuge and strong purgative¹¹⁻¹⁵. Extract of the root bark with alcohol can be used for backward fever. The roots are used in chest pain, joint pain, migraine and blood dysentery. The extract of the root lowered the blood sugar level up to 30 per cent¹⁶. Root is useful in fever, heart diseases, retained excretions and biliousness¹⁷. The aqueous extract of the root bark exhibits anti-inflammatory activity. The root is used in cardiac disorders biliousness, rheumatic condition, haemorrhages, wounds, ulcers and boils and various skin diseases¹⁸. *Cassia fistula* leaves are crushed to prepare a thick paste and mixed with coconut oil. This paste is applied over the burnt skin twice a day^{19,20}.

The stem bark is used against amenorrhoea, chest pain and swellings. The bark possess tonic and antidyseric properties, it is also used for skin complaints, the powder or decoction of the

bark is administered in leprosy, jaundice, syphilis and heart diseases²¹.

The leaves extract reduced mutagenicity in *E. coli*²². The leaves are laxative and used externally as emollient, a poultice is used for chilblains, in insect bites, swelling, rheumatism and facial paralysis²³⁻²⁵. Leaves possess anti periodic and laxative properties, the leaves are used in jaundice, piles, rheumatism ulcers and also externally skin eruptions, ring worms, eczema. The leaves and bark mixed with oil are applied to pustules, insect bites²⁶. Juice of leaves is used in skin diseases^{27,28}. Juice of leaves is useful as dressing for ringworm, relieving irritation and relief of dropsical swelling. The pulp of the fruit around the seeds is a mild purgative²⁹. Leaves and flowers are both purgative like the pulp³⁰. Ashes from burnt pods mixed with little salt are used with honey taking 3-4 times to relieve cough. Fruits are used as cathartic and in snake bite³¹.

Flowers and pods are used as purgative, febrifugal, biliousness and astringent. The ethanolic 50% extract of pods show antifertility activity in female albino rats. The heated pods are applied to swellings on the neck due to cold. The fruits are reported to be used for asthma³². Pulp is given in disorders of liver. The drug is used as analgesic as an antipyretic, it is a remedy for malaria and fever. It is also applied in blood poisoning, anthrax and antidyseric, leprosy and antidiabetic, for the removal of abdominal obstruction³³. The extract of the flower inhibits the ovarian function and stimulate the uterine function in albino rats. Fruits are used in the treatment of diabetes, antipyretic, abortifacient, demulcent, lessens inflammation and heat of the body; useful in chest complaints, throat troubles, liver complaints, diseases of eye and gripping³⁴. The fruit pulp is used for constipation, colic, chlorosis and urinary disorders³⁵.

The seeds are emetic, used in constipation and have cathartic properties. The seeds are slightly sweet and possess laxative, carminative, cooling, improves the appetite and antipyretic activity³⁶. They are useful in jaundice, biliousness, skin disease and in swollen throat³⁷. A seed dried produce marked hypoglycaemic activity. Seed powder is used in amoebiasis.

Phytochemical Profile

A majority of the ascribed biological effects of *C. fistula* extracts have been attributed to their primary and secondary metabolite composition. Primary metabolite analysis has essentially been focussed on the seed, pollen, fruit, leaf and pod. The seeds are rich in glycerides with linoleic, oleic, stearic and palmitic acids as major fatty acids together with traces of caprylic and myristic acids. It has been reported that the stem bark of *C. fistula* is also a potential source of lupeol, β -sitosterol and hexacosanol. In an earlier study it was reported that one of the major carbohydrates in the seeds was galactomannan consisting of 8 different types of sugar moieties. A detailed biochemical analysis of the flower's pollen, suspected to play a

significant allergenic role, showed a protein composition of 12% with appreciable amounts of free amino acids such as phenylalanine, methionine, glutamic acid and proline. Carbohydrate, lipid and free amino acid contents were of the order of 11.75, 12 and 1.42%, respectively³⁸.

The edible fruit tissue of the Indian laburnum fruit was reported to be a rich source of potassium, calcium, iron and manganese than fruits like apple, apricot, peach, pear and orange. The protein (19.94%) and carbohydrate (26.30%) contents are indicative of the potential of the fruit to be an important source of nutrients and energy. Apolar compounds including 5-nonatetracontanone, 2-hentriacontanone, triacontane, 16-hentriacontanol and sitosterol along with an oil (probably an isoprenoid compound) showing antibacterial activity have also been isolated in *C. fistula* pods³⁹. *C. fistula* plant organs are known to be an important source of secondary metabolites, notably phenolic compounds. Fistucacidin, an optically inactive leucoanthocyanidin (3,4,7,8,4' pentahydroxyflavan) was first extracted from the heartwood. The presence of kaempferol and a proanthocyanidin whose structure has been established as a leucopelargonidin tetramer having a free glycol in the acetone extract of the flower has been documented. Proanthocyanidins containing flavan-3-ol (epiafzelechin and epicatechin) units with an abnormal 2S-configuration have also been observed in pods together with the common flavan-3-ols and proanthocyanidins like catechin, epicatechin, procyanidin B-2 and epiafzelechin⁴⁰.

Pharmacological Activities

Antioxidant activity: The investigation suggest that the antioxidant properties of 90% ethanol extracts of leaves, and 90% methanol extracts of stem bark, pulp and flowers from *Cassia fistula*. The antioxidant activity power was in the decreasing order of stem bark, leaves, flowers and pulp and was well correlated with the total polyphenolic content of the extracts. The reason for low antioxidant activity in the flower and pulp fractions could be the presence of some prooxidants, such as chrysophanol and reducing sugars which dominate the antioxidant compounds present in the extracts. Thus, the stem bark had more antioxidant activity in terms of reducing power, inhibition of peroxidation, O₂ and DPPH radical scavenging ability⁴¹.

It has been reported that aqueous extract of *Cassia fistula* (Linn.) flowers (ACF) was screened for its antioxidant effect in alloxan induced diabetic rats. An appreciable decrease in peroxidation products viz thiobarbituric acid reactive substances, conjugated dienes, hydroperoxides was observed in heart tissues of ACF treated diabetic rats. The decreased activities of key antioxidant enzymes such as superoxide dismutase, catalase, glutathione peroxidase, glutathione reductase and glutathione in diabetic rats were brought back to near normal range upon ACF treatment. These results suggest that ACF has got promising antioxidative activity in alloxan diabetic rats.

Central Nervous System activities: The methanol extract of seeds of *C. fistula* was tested for different pharmacological actions in mice. The extract significantly potentiated the sedative actions of sodium pentobarbitone, diazepam, meprobamate and chlorpromazine. It also potentiated analgesia induced by morphine and pethidine in a dose-dependent manner. The extract also influenced behaviour in mice⁴².

Wound healing activity: The potential of *Cassia fistula* to treat the infected wound on albino rat model was investigated⁴³. The alcohol extract of *C. fistula* leaves was analyzed for antibacterial effect against *Staphylococcus aureus* ATCC 29213 and *Pseudomonas aeruginosa* ATCC 27853. Formulated ointment was topically applied on the infected wound. Wound reduction rate, histological analysis, biochemical analysis, and gelatin zymography were obtained to assess the healing pattern. *C. fistula* treated rats showed, better wound closure, improved tissue regeneration at the wound site, and supporting histopathological parameters pertaining to wound healing. Biochemical analysis and matrix metalloproteinases expression correlated well with the results thus confirming efficacy of *C. fistula* in the treatment of the infected wound. Along with the other activities such as antitumor, antioxidant, hypoglycemic, hepatoprotective, antibacterial, hypocholesterolaemic, and antidiabetic activity, the healing potential of *C. fistula* provides a scientific rationale for the traditional use of this plant in the management of infected dermal wound and can be further investigated as a substitute to treat infected wounds without using synthetic antibiotics.

Antifungal and Antibacterial activity: The hexane, chloroform, ethyl acetate, methanol and water extracts from the flower of *Cassia fistula* were tested against bacteria and fungi. All the extracts exhibited antibacterial activity against Gram-positive organisms with minimum inhibitory concentrations (MIC) between 0.078 and 2.5 mg/ml. Among the Gram-negative bacteria, only *Pseudomonas aeruginosa* was susceptible to the extracts. Ethyl acetate crude extract was fractionated using chromatographic techniques. A crystal was isolated, which was confirmed as 4-hydroxy benzoic acid hydrate using X-ray crystallography. It exhibited antifungal activity against *Trichophyton mentagrophytes* (MIC 0.5 mg/ml) and *Epidermophyton floccosum* (MIC 0.5 mg/ml). Three lectins, i.e. CSL-1, CSL-2 and CSL-3, purified from the *Cassia fistula* seeds, were tested for their antibacterial activities against different pathogenic bacteria, i.e. *Bacillus subtilis*, *B. megaterium*, *Streptococcus haemolyticus*, *Streptococcus aureus*, *Sarcina lutea*, *Shigella sonnei*, *Escherichia coli*, *Klebsiella sp.*, *Shigella shiga*, *Shigella boydii*, *Shigella flexneri*, *Shigella dysenteriae*, *Salmonella typhi* and *Pseudomonas aeruginosa*, using 30 micro g/disc. CSL-3 was active against all bacterial strains and showed strong activity against *B. megaterium*, *Streptococcus haemolyticus* and *Shigella boydii*. CSL-2 showed poor activity against most of the bacterial strains and has strong activity against only *Streptococcus haemolyticus*. CSL-1 was inactive against all the bacterial strains except *Streptococcus*

haemolyticus and *Sarcina lutea*. All the lectins significantly affected the mortality rate of brine shrimp. Among them, CSL-2 was highly toxic (6.68 micro g/ml) followed by CSL-1 (10.47 micro g/ml) and CSL-3 (13.33 micro g/ml). Aqueous extract of *C. fistula* in disc diffusion method showed significant activity against *S. aureus* but not against other bacteria tested. Alcoholic extract showed greater inhibition against *S. aureus* compared to aqueous extract. One of the field isolates of *S. aureus* resistant to chloramphenicol was also susceptible to the alcoholic extract of *C. fistula*. Zones of inhibition of alcoholic and aqueous extracts were in the range of 7.0-12.0 mm and 7.0-11.6 mm, respectively. MIC values of the alcoholic extracts against *S. aureus* were in the range of 0.78-6.25 mg/ml^{44,45}.

Antitumor activity: The effects of methanolic extract (ME) of *Cassia fistula* seed on the growth of Ehrlich ascites carcinoma (EAC) and on the life span of tumour bearing mice were studied. ME treatment showed an increase of life span, and a decrease in the tumour volume and viable tumour cell count in the EAC tumour hosts. Cytological studies have revealed a reduction in the mitotic activity, and the appearance of membrane blebbing and intracytoplasmic vacuoles in the treated tumour cells. Improvement in the haematological parameters following ME treatment, like haemoglobin content, red blood cell count and bone marrow cell count of the tumour bearing mice have also been observed. The results of the present study suggest that ME of *C. fistula* seed has an antitumor activity. Haematological studies have revealed that out of the three doses of ME, ME at the dose of 100 mg/kg has shown better results than at the doses of 200 and 300 mg/kg. The exact mechanism by which ME mediates its antitumor effect is still to be elucidated. Cytological changes indicate that ME might be having a direct tumorocidal effect on the tumour cells^{46,47}.

Antifertility activity: The petroleum ether extract of seeds of *Cassia fistula* was screened for the antifertility activity in proven fertile female albino rats at the doses 100, 200 and 500 mg/kg b.wt./day. Oral administration of the extract to mated female rats on days 1-5 of pregnancy resulted in a decline in the fertility index, numbers of uterine implants and live foetuses in a dose dependent manner as was confirmed by laparotomy on day 15 of pregnancy. The extract (100 mg/kg b.wt.) exhibited weak estrogenic activity when given alone and tested in immature bilaterally ovariectomized female albino rats, but exhibited slight antiestrogenic activity when administration along with estradiol valerate (0.1 mg/kg b.wt.). Blood sugar and haematological parameters were within normal range. Thus, the results of the present study indicate that the petroleum ether extract of *Cassia fistula* seeds possesses pregnancy terminating effect by virtue of anti-implantation activity⁴⁸.

Anti-leishmaniatic activity: The effectiveness of *Cassia fistula* in the treatment of leishmaniasis, the efficacy of concentrated boiled extract and hydroalcoholic extract of *C. fistula* on leishmaniasis was compared with intralesional injection of Glucantime [meglumine antimonate] in this study. 63.6% of patients treated with the concentrated boiled extract, 52.7% of

patients treated with the hydroalcoholic extract, and 45.5% of patients treated with Glucantime. In total, 22 patients (40%) given the concentrated boiled extract of *C. fistula*, 20 patients (36.4%) given the hydroalcoholic extract of *C. fistula*, and 36 patients (65.5%) of the Glucantime group showed complete cure. The efficacy in the third group was significantly higher than the first ($P < 0.02$) and second groups ($P < 0.005$), but there was no difference between the efficacy of concentrated boiled extract and hydroalcoholic extract of *C. fistula*. These results show that this plant could be used topically along with Glucantime for decreasing the time and dose of treatment with Glucantime. The potential of *Cassia fistula* boiled extract in the treatment of cutaneous leishmaniasis, to evaluate the efficacy of intralesional meglumine antimonate-*C. fistula* fruit gel combination for the treatment of cutaneous leishmaniasis. A total of 140 patients with cutaneous, one group received intralesional meglumine antimonate injection and *C. fistula* fruit gel, and the second group (control) was treated with intralesional meglumine antimonate plus placebo gel. Improvement was defined as complete cure, partial cure and treatment failure. At week 12, forty-seven (67.1%) patients in the experimental group achieved complete cure, compared to 29 (41.4%) patients in the control group ($P < 0.001$). Results indicate that the *C. fistula* fruit gel increases the efficacy of intralesional meglumine antimonate for the treatment of cutaneous leishmaniasis. Combination therapy with intralesional meglumine antimonate and *C. fistula* fruit gel should be considered for the treatment of acute cutaneous leishmaniasis⁴⁹.

Conclusion

It is quite obvious that the plant is widely used in traditional medicinal system of India and has been reported to possess hepatoprotective, anti-inflammatory, antitussive, antifungal and also used to check wounds healing and antibacterial properties. It is known as a rich source of tannins, flavanoids and glycosides present in *Cassia fistula* might be medicinally important and/or nutritionally valuable. The plant is rich in carbohydrates, Linoleic, Oleic, and Stearic. Leaf of *Cassia fistula* mainly contains Oxalic Acids, Tannins, Oxyanthraquinones, Anthraquinones Derivatives. Fruit of *Cassia fistula* contains Rhein Glycosides Fistulic Acids, Sennosides A B, Anthraquinones, Flavanoid-3-ol-derivatives. Ceryl Alcohol, Kaempferol, Bianthraquinone Glycosides, Fistulin, Essential Oils, Volatile Components, Phytol (16.1%), 2-Hexadecanone (12%), Crystals, 4-Hydroxy Benzoic Acids Hydrate have been reported from the plant. The present review summarizes some important pharmacological studies on *Cassia fistula* and phytochemical investigations and isolated principles from them, which can be investigated further to achieve lead molecules in the search of novel herbal drugs.

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