

CASSIA FISTULA: FROM TRADITIONAL MEDICINE TO MODERN THERAPEUTICS- A REVIEW

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ABSTRACT

Cassia fistula Linn, a member of the Fabaceae family, widely recognized by common names such as Golden Shower tree and Amaltas. The plant has a long history of use in traditional medicine for managing several ailments, including burns, convulsions, constipation, diarrhea, dysurea, epilepsy, leprosy and various skin disorders and syphilis. Phytochemical investigations have revealed that C. fistula contains various bioactive constituents, particularly Tannins, flavanoids and Glycosides. Various pharmacological studies have demonstrated several biological activities with the plant, including antidiabetic, antibacterial, antifertility, antiinflammatory, antioxidant, Hepatoprotective, antifungal and antitumor effects. The review provides overview of the taxonomy and botanical characteristics of C. fistula along with it's major Phytochemical constituents and reported pharmacological activities.

KEYWORDS: Cassia fistula, Phytochemical constituents, Anti tumor, Nanotechnology.

1. INTRODUCTION

Natural plants are valuable gifts of nature and have played an important role in human healthcare since ancient times. Plants that are widely distributed and readily available serve

as important sources of remedies for the prevention and management of various diseases. Several traditional systems of medicine, including Ayurveda, Siddha, Unani, and Homeopathy, rely on medicinal plants for their therapeutic benefits.^[1] *Cassia fistula* is a flowering medicinal plant belonging to the legume family Fabaceae and is classified under the subfamily Caesalpinioideae. It is widely recognized by the common name Amaltas. *Cassia fistula* is found throughout tropical regions, including India, China, Sri Lanka, Egypt, Mauritius, South Africa, Mexico, Brazil, East Africa, and Thailand. Although it has long been used in traditional medicine to manage various ailments, modern scientific investigations are now identifying its secondary metabolites and examining their biological effects.^[2]

Cassia fistula is a semi-wild, deciduous tree widely recognized for its golden-yellow blossoms and commonly called the golden shower tree or golden rain tree. *Cassia fistula* exhibits diverse pharmacological activities, including antipyretic, antimicrobial, antifungal, larvicidal, analgesic, anti-inflammatory, antioxidant, antitumor, antidiabetic, hepatoprotective, hypoglycemic, and laxative effects.^[3] Because of its medicinal properties, *Cassia fistula* is known as 'Aragvadha', a name that signifies its ability to eliminate diseases.^[4] The leaf juice of *Cassia fistula* exhibits bioactive properties that may help treat various skin diseases.^[5] The medicinal properties of *Cassia fistula* may support public health and potentially contribute to increased longevity.^[6] Additionally, nanotechnology has created new opportunities for applying *C. fistula*-derived compounds in precision medicine, as silver and gold nanoparticles synthesized from its extracts exhibit enhanced antimicrobial and cytotoxic effects, highlighting the plant's potential in biosynthetic nanomedicine.^[7] Global reports underscore the pressing need to develop plant-based therapeutic agents to combat antimicrobial resistance and the growing burden of chronic diseases.^[8] This review examines *Cassia fistula* with emphasis on its botanical characteristics, taxonomy, phytochemical constituents, and pharmacological activities. A study investigated the wound-healing potential of *Cassia fistula* in infected wounds and found that treatment with its extract enhanced wound closure and promoted tissue regeneration at the affected site.^[9]

The present review of the *Cassia fistula* is based on botanical characters, Taxonomy, Phytochemical constituents and pharmacological activity.

Synonym: *Cassia exceisa* kunth.

Taxonomical Classification

- Kingdom: Plantae
- Subkingdom: Tracheobionta
- Superdivision: Spermatophyta
- Division: Magnoliophyta
- Class: Magnoliopsida
- Subclass: Rosidae
- Order: Fabales
- Family: Fabaceae
- Genus: Cassia
- Species: Cassia fistula

Vernacular names

Language: Names

English: Golden shower tree, Indian Laburnum

Sanskrit: Saraphala; Sarvanaka; Argwadha; Rajtaru

Urdu: Amaltas

Bengali: Amaltas; Sondal; Sonali

2. Botanical description

Cassia fistula is a deciduous, semi-wild tree characterized by greenish-grey bark and compound leaves. The leaves are generally 23–40 cm long, with a pubescent main rachis and small, linear-oblong stipules. Each leaf consists of approximately 4–8 opposite pairs of leaflets, which are ovate to ovate-oblong in shape and measure about 5–12.5 cm in length and 3.8–9.5 cm in width. The leaflets are acute at the apex and cuneate at the base, with a bright green, smooth and glossy upper surface. The lower surface is comparatively pale and may exhibit a silvery pubescence, particularly in young leaves. The midrib is densely pubescent on the underside, while numerous closely spaced and prominent lateral veins are visible beneath. The individual petiolules are approximately 6–10 mm long and may be either pubescent or glabrous. The tree is also valued for its attractive clusters of flowers and has a long history of use in traditional medicine for various therapeutic purposes.^[10] The flowers are characterized by a vibrant yellow colour and are borne in long, elegant, drooping clusters.^[11] The flowers are arranged in loose, elongated racemes measuring approximately

30–50 cm in length. The pedicels are slender, about 3.8–5.7 cm long, and may be pubescent or glabrous. The calyx is nearly 1 cm long and divided almost to its base into oblong, obtuse segments. The corolla is yellow and measures around 3.8 cm in diameter, with all stamens bearing functional anthers. The fruit develops as a long, cylindrical pod containing numerous seeds embedded in a sweet, dark-coloured pulp. The seeds are separated from one another by transverse partitions. Initially green, the pods gradually turn black as they mature following the shedding of the flowers.^[12] The fruits are elongated, cylindrical pods measuring approximately 40–70 cm in length and 20–27 mm in diameter. They are generally straight or slightly curved, with a smooth surface marked by fine transverse striations that may develop into delicate fissures as the fruit matures. The distal end is rounded and bears a small projection corresponding to the former style. The dorsal suture is represented by a single vascular strand, whereas the ventral suture consists of two closely positioned strands. Internally, the pod is separated into numerous compartments by thin, buff-coloured transverse partitions occurring at intervals of approximately 0.5 cm. Each compartment contains a single flat, oval-shaped, reddish-brown seed with a distinct raphe. The pulp is dark brown, with a sticky and mucilaginous consistency. It has a characteristic odour that may be described as slightly unpleasant, along with a distinctly sweet taste.^[13] The drug is found as thick, flat or slightly curved pieces. Its outer surface ranges from smooth to rough and may show warty projections, with a colour varying from greenish-grey to reddish. The inner surface is rough and reddish, displaying parallel striations. The fracture is laminated, while the drug has a distinctive sweet odour and an astringent taste.^[14] The seeds are reddish-brown in colour and have a lenticular (lens-shaped) appearance, while the stem bark is brown in colour.^[15]



Figure 1: Plant of Cassia fistula.

3. Traditional Uses

Traditionally, *Cassia fistula* L. has been employed in the management of various health conditions, including cardiac disorders, itching, leukoderma, abdominal masses, metabolic disturbances, and tuberculosis. The plant is also reported to possess broad-spectrum antimicrobial and free-radical scavenging activities. It has been traditionally used for conditions such as hematemesis, uterine and menstrual disorders, thoracic obstruction, skeletal ailments, burns, depression, and dysuria. Its extracts have additionally been utilized for pest-control purposes. The roots are particularly valued for their laxative and purgative properties.^[16] *Cassia fistula* L. has traditionally been used to manage fever, impaired elimination, bilious disorders, joint and chest pain, dysentery, migraine, and elevated blood glucose levels. Leaf extracts have been reported for their traditional use in conditions such as blackwater fever, rheumatism, ringworm, eczema, and erysipelas. The leaves are also associated with antitussive and wound-healing properties and have demonstrated hypoglycemic activity.^[17] The seeds of *Cassia fistula* L. are traditionally used in the management of jaundice, throat swelling, and oral ulcers. They possess mildly sweet and cooling properties and are also reported to exhibit carminative and laxative effects. The seeds have further been used for treating certain skin disorders and bilious conditions. The bark is traditionally recognized for its anti-inflammatory, antioxidant, and antidiabetic properties.

The fruit pulp has been reported to possess antipyretic, antifungal, antiviral, anticandidal, and hepatoprotective activities and is traditionally used in the management of leprosy, diabetes, and abdominal and urinary disorders. The pods are employed as laxatives and have been used to manage fever and diabetes mellitus. Fruit extracts have also been investigated for estrogenic and antiestrogenic effects and are traditionally used as purgatives and antifungal agents. *Cassia fistula* L. has additionally been reported for its traditional use in the management of tuberculosis.^[18,19]

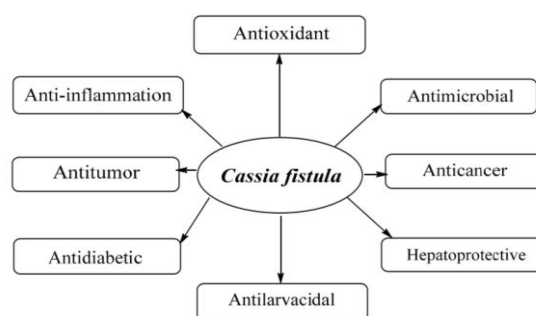


Figure 2: Biological properties of Cassia fistula.**4. Ethnomedicinal Applications**

Historically, *Cassia fistula* has been an important medicinal plant in traditional healthcare practices, particularly in Ayurveda, Siddha, and Unani systems. Ayurvedic literature has documented its use for managing various ailments, including constipation, skin diseases, fever, and arthritic conditions. It is traditionally regarded as “Raktaprasadana,” meaning an agent that helps purify the blood, and has also been employed for its purgative, fever-reducing, and antiperiodic properties.^[20]

The fruit pulp of *Cassia fistula* is traditionally recognized as a mild and gentle laxative and is considered suitable for use in both children and older adults. The leaves are commonly applied externally as poultices for conditions such as inflammation, facial paralysis, and insect bites. In addition, the bark and seeds have been traditionally employed in the management of skin disorders, ulcers, and diabetes.^[21]

5. Phytochemical constituents

The medicinal properties of *Cassia fistula* are primarily associated with its rich profile of bioactive secondary metabolites, including anthraquinones, flavonoids, tannins, alkaloids, sterols, saponins, glycosides, terpenoids, and phenolic compounds.^[7]

Table 1: Phytochemical constituents of Cassia fistula.

Sr. No.	Phytochemical Name	Categories	Degree
01	Rhein	Anthraquinone	32
02	Ellagic Acid	Polyphenol	32
03	Quercetin	Flavonoid	30
04	Kaempferol	Flavonoid	29
05	Gibberellin A3	Hormone	28
06	Licoisoflavone	Flavonoid	26
07	β-Sitosterol	Phytosterols	21
08	Stigmasterol	Phytosterols	19

5.1 Anthraquinones

Among the major bioactive compounds identified in *Cassia fistula*, anthraquinones such as rhein, emodin, chrysophanol, and physcion are notably present in the fruit pulp and pods. These constituents have been associated with various pharmacological activities, including laxative, anti-inflammatory, and anticancer effects. In particular, rhein and chrysophanol have shown potential anti-arthritis activity through their ability to influence inflammatory cytokine pathways.^[17]

5.2 Flavanoids

Flavonoids including kaempferol, luteolin, quercetin, and apigenin are commonly found in the leaves and flowers of *Cassia fistula*. These phytoconstituents contribute significantly to the plant's antioxidant potential and have also been associated with hepatoprotective effects. These bioactive compounds help neutralize free radicals by donating hydrogen atoms and preventing lipid peroxidation, thereby reducing oxidative damage and supporting the antioxidant potential of the plant.^[22]

5.3 Tannins and polyphenols

Tannins, particularly condensed tannins or proanthocyanidins, have been identified and measured in the bark and fruit pods of *Cassia fistula* through analytical methods such as the Folin–Ciocalteu and vanillin assays. Their astringent nature contributes to their traditional use in managing diarrhoea and supporting wound healing. Furthermore, their antioxidant activity has been linked to potential cardioprotective and anti-aging effects.^[7]

5.4 Glycosides and sennosides

The fruit pulp of *Cassia fistula* contains sennosides A and B, glycosides anthraquinone compounds that exert a gentle laxative action and are therefore valuable in pediatric and geriatric preparations for the safe and effective treatment of constipation.

Glycoside content: The fruit pulp and leaves contain anthraquinone glycosides in an inactive form, which are not absorbed in the small intestine.

Sennoside content: *Cassia fistula* contains sennosides, including sennoside B, but generally in lower amounts than commercial senna species such as *Cassia angustifolia*, resulting in a milder effect.^[10]

5.5 Alkaloids, Sterols and terpenoids

Phytosterols such as β -sitosterol and stigmasterol, along with the triterpenoid lupeol, are mainly present in the bark and roots of *Cassia fistula*. These compounds have been associated with anti-inflammatory, anticancer, and cholesterol-regulating effects. In addition, seed-derived alkaloids exhibit antimicrobial activity and may possess central nervous system depressant properties.^[7]

6. Pharmacological activities of *Cassia fistula*

The broad therapeutic potential of *Cassia fistula* L. is largely attributed to its diverse phytochemical constituents, particularly anthraquinones, flavonoids, and polyphenolic compounds, which contribute to numerous biological activities. Recent preclinical investigations have highlighted its promising effects against oxidative damage, inflammatory conditions, metabolic abnormalities, microbial infections, and cancer.^[23]

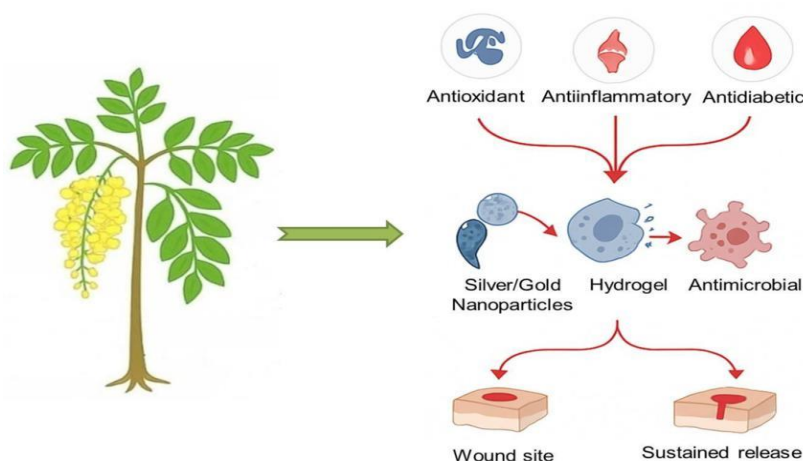


Figure 3: Pharmacological activities of *Cassia fistula*.

6.1 Anti oxidant activity

The therapeutic significance of *Cassia fistula* L. has long been associated with its high antioxidant potential. A recent investigation assessed the antioxidant and protective effects of *C. fistula* against hydrogen peroxide-induced oxidative stress in erythrocytes. The ethanolic extract demonstrated strong antioxidant activity and provided more than 90% protection to erythrocytes, while the aqueous extract exhibited approximately 75% antioxidant and protective activity.^[24]

Another study evaluated the antioxidant potential of *Cassia fistula* using 90% ethanolic leaf extracts and 90% methanolic extracts prepared from the stem bark, pulp, and flowers. Among the different plant parts examined, the stem bark exhibited the strongest antioxidant activity, as demonstrated by its reducing capacity, inhibition of lipid peroxidation, superoxide (O_2^-) scavenging, and DPPH radical-scavenging effects.^[25]

6.2 Anti-inflammatory activity

Studies have demonstrated that bark extracts of *Cassia fistula* L. exhibit notable anti-inflammatory activity, showing effectiveness in both acute and chronic experimental models.^[26] An investigation was conducted to assess the anti-inflammatory potential of different doses of the ethanolic leaf extract (ELE) of *Cassia fistula*. The findings revealed that ELE produced a dose-dependent reduction in both carrageenan-induced hind-paw edema and cotton-pellet-induced granuloma.^[27]

Another study investigated the anti-inflammatory potential of aqueous and alcoholic extracts prepared from the bark of *Cassia fistula* using sub-acute inflammation models. Both extracts demonstrated significant anti-inflammatory activity in the air-pouch granuloma and cotton-pellet granuloma assays.^[28]

6.3 Anti-tumor activity

Anthraquinones, including rhein and emodin derived from *C. fistula*, have demonstrated notable cytotoxicity in human cancer cell lines such as MCF-7, A549, and HeLa, with rhein promoting apoptosis through mitochondrial membrane depolarization and caspase activation while inhibiting cell proliferation by suppressing cyclin D1 and CDK4 expression.^[23]

Furthermore, silver nanoparticles produced with *C. fistula* extracts have exhibited enhanced cytotoxic effects against MDA-MB-231 breast cancer cells, reducing cell viability in a dose-dependent manner and increasing ROS production, which indicates potential synergistic effects between plant-derived phytochemicals and nanocarriers for cancer treatment.^[29] Furthermore, molecular docking studies suggest that rhein and kaempferol may contribute to anticancer activity in ovarian cancer.^[30]

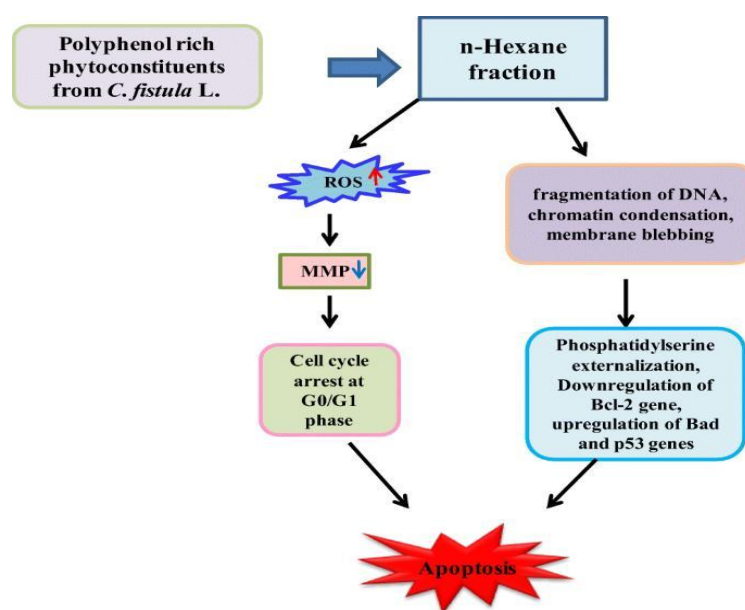


Figure 4: Mechanism of action of Cassia fistula.

6.4 Anti-diabetic activity

Diabetes mellitus is a widespread metabolic disorder and a significant global health concern. Although conventional antidiabetic medications are commonly used to manage the disease and its complications, they may cause adverse effects. Numerous plants contain bioactive compounds, including glycosides, alkaloids, terpenoids, flavonoids, and carotenoids, which are frequently associated with antidiabetic properties.^[31] The exact mechanisms underlying the antidiabetic effects of medicinal plants have not yet been fully elucidated, although they may promote insulin-dependent glucose uptake. A separate study prepared an aqueous extract of *C. fistula* and synthesized gold nanoparticles to assess their hypoglycemic activity, demonstrating that these nanoparticles possess promising antidiabetic potential.^[32]

6.5 Hepatoprotective activity

Liver injury can be induced by several chemical and environmental factors, including excessive doses of paracetamol and other analgesic or antipyretic drugs, alcohol exposure, infections, and toxic substances, which may damage hepatic cells through mechanisms such as lipid peroxidation. In this context, medicinal plants and other natural products have gained considerable attention for their potential hepatoprotective effects, particularly by supporting the detoxification and elimination of harmful substances. An investigation using an aqueous extract of *Cassia fistula* demonstrated a dose-dependent improvement in liver biochemical parameters, with reductions in total bilirubin, alkaline phosphatase, SGOT, SGPT, aspartate transaminase, and alanine aminotransferase, along with an increase in total protein levels. Histopathological examination further indicated comparatively mild hepatocellular damage in

the extract-treated groups when compared with the carbon tetrachloride (CCl₄)-treated group.^[33]

6.6 Anti-microbial activity

Extracts obtained from different parts of *Cassia fistula* have demonstrated significant broad-spectrum antimicrobial potential, showing inhibitory effects against several pathogenic microorganisms, including *Staphylococcus aureus*, *Escherichia coli*, *Candida albicans*, and *Aspergillus Niger*.^[34] Studies have also reported that *Cassia fistula* exhibits antifungal activity against *Candida* strains that are resistant to fluconazole, while its protease inhibitors have demonstrated notable antibacterial effects.^[35]

7. Safety, Toxicity and clinical relevance

Although *Cassia fistula* L. exhibits considerable pharmacological potential, a thorough evaluation of its safety is essential to ensure appropriate therapeutic use. The plant has traditionally been incorporated into formulations intended for children and elderly individuals and is generally regarded as safe when administered at low to moderate doses. Nevertheless, recent experimental findings indicate that its safety may depend on the dose, formulation, and duration of administration, with particular attention required when using highly concentrated extracts or advanced nano-based delivery systems.^[36]

Several investigations using animal models have assessed the safety and toxicity limits of medicinal plants. In a notable study, *Cassia fistula* pod infusion was compared with Senokot tablets and demonstrated a relatively low toxicity profile. The infusion showed an LD₅₀ value of 6600 mg/kg and produced no observable pathological alterations in the organs examined through microscopic evaluation.^[37]

7.1 Acute and sub chronic toxicity

Preclinical investigations have evaluated the acute and subacute toxicity of different *Cassia fistula* extracts using rodent models. Oral administration of ethanolic and aqueous extracts prepared from the fruit pulp at doses as high as 2000 mg/kg resulted in no mortality or noticeable behavioral abnormalities. Furthermore, no significant changes were observed in the hematological or biochemical parameters, suggesting that these extracts possess a relatively wide safety margin. A 28-day sub-chronic toxicity study found that daily oral

treatment with a hydroalcoholic fruit extract at 500 mg/kg caused no histopathological changes in major organs; however, mild increases in liver enzyme levels occurred at doses of 1000 mg/kg or higher, indicating the need for careful dose optimization in therapeutic use.^[38]

7.2 Reproductive and developmental toxicity

Evidence regarding the reproductive toxicity of *C. fistula* remains limited. Certain studies have reported that high doses of methanolic bark extracts may decrease sperm count and motility in male rats, possibly through oxidative stress or hormonal alterations. Nevertheless, these results are inconsistent and should be confirmed using standardized reproductive toxicity evaluations.^[39]

7.3 Nano toxicology considerations

Nanoparticles have been detected in organs including the liver, kidneys, and spleen across independent studies, highlighting the need for comprehensive long-term safety evaluations before *C. fistula*-derived nanoformulations can be considered for clinical use.^[40]

8. Medicinal uses of *Cassia fistula*

This plant exhibits a wide range of pharmacological activities, including antibacterial, antimicrobial, antifungal, anti-inflammatory, antitumor, anticancer, antioxidant, anti-yeast, and various dermatological effects.^[41] *Cassia fistula* contains a diverse range of phytochemical constituents, including carbohydrates, proteins, amino acids, flavonoids, tannins, anthraquinones and their derivatives, glycosides, trapezoids, sugars, alkaloids, saponins, rhein, mucilage, and several other bioactive compounds.^[42]

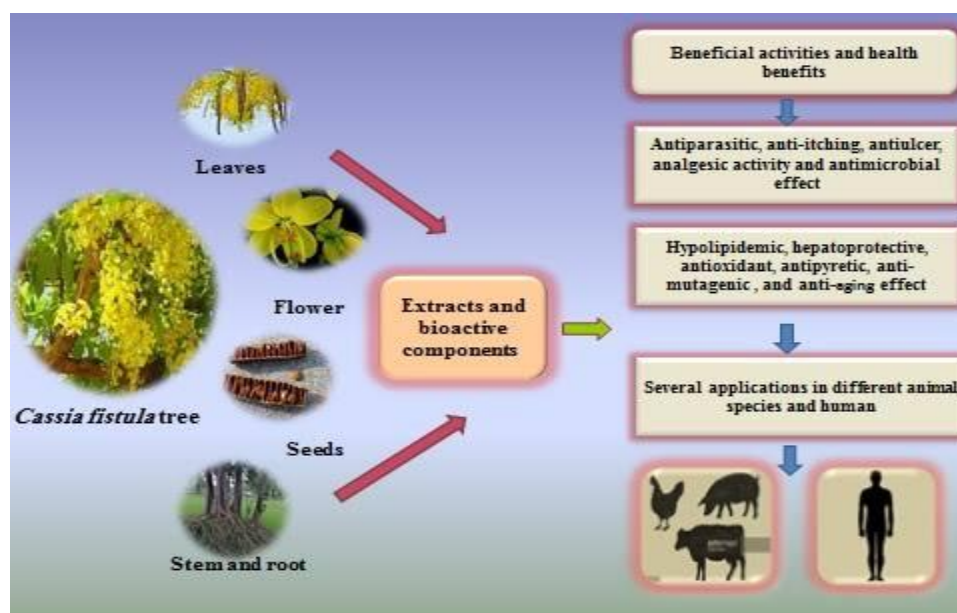


Figure 5: Medicinal uses of Cassia fistula.

8.1 Leaves: The leaves are known for their laxative, antiperiodic, soothing, and ulcer-healing effects.^[43]

8.2 Stem and bark: The bark contains approximately 10–12% tannins and is used as a tanning material, often together with *Senna auriculata*, in India, Pakistan, and other regions.^[44]

8.3 Roots: The roots are traditionally used to manage migraines, chest and joint pain, and bloody diarrhea, and are also regarded as potent purgative, fever-reducing, tonic, and astringent agents; studies have reported reductions in blood glucose levels of up to 30%.^[45]

8.4 Flowers, Fruits and seeds: In India and Bangladesh, the golden-yellow blossoms play a role in religious ceremonies, and both the flowers and unopened buds can be eaten.^[46]

The fruit is a rich source of iron and manganese, containing considerably greater amounts of these minerals than oranges, apples, peaches, pears, and apricots; its pulp is also composed of amino acids such as aspartic acid, glutamic acid, and lysine, which account for 15.3%, 13.0%, and 7.8% of the total amino acids, respectively.^[47]

The seeds were reported to contain approximately 16.6%, 19.5%, and 6.6% of the respective amino acids. In addition, the fruit provides a relatively high energy value of about 18 kJ/g, which may contribute to meeting the daily energy requirements of individuals.^[48]

9. Health benefits of Cassia Fistula

9.1 Digestive health and constipation relief

The fruit pulp, leaves, and seeds of Cassia fistula are traditionally recognized for their laxative effects. Its fruit pulp contains anthraquinone compounds, including rhein and sennosides, which may enhance intestinal motility and promote adequate water content in feces, thereby facilitating bowel evacuation and relieving constipation. Traditionally, the fruit pulp has been regarded as a relatively gentle laxative when used appropriately.^[49]

9.2 Blood sugar regulation

Experimental studies suggest that Cassia fistula extracts possess promising antidiabetic activity. Its phytoconstituents may contribute to glycemic control by reducing oxidative stress in pancreatic tissue and supporting insulin production and regulation, which can subsequently help decrease elevated blood glucose levels.^[50]

9.3 Skin disease management and wound healing

Extracts obtained from the leaves, bark, and fruit pulp of Cassia fistula have demonstrated notable antimicrobial, antifungal, and anti-inflammatory activities. Traditionally, these plant parts have been applied in the management of various dermatological disorders, including ringworm, eczema, and other skin eruptions, as well as erosive lesions associated with conditions such as pemphigus vulgaris. Furthermore, topical formulations containing C. fistula extracts have shown potential in accelerating wound closure, supporting tissue repair, and reducing inflammatory responses.^[51]

9.4 Respiratory support (cough suppressant)

C. fistula has traditionally been used to manage respiratory complaints, particularly cough. Preparations obtained from its pods and leaves are believed to help relieve coughing and support clearance of respiratory secretions, with traditional applications also extending to bronchitis and asthma-related symptoms.^[52]

CONCLUSION

Traditional medical systems such as Ayurveda, Siddha, Unani, and Homeopathy have contributed significantly to the investigation and therapeutic evaluation of medicinal plants. Cassia fistula L., commonly referred to as Amaltas, is an important medicinal flowering tree belonging to the family Leguminosae. It is widely cultivated and distributed across several

regions, including India, China, Sri Lanka, Egypt, Mauritius, South Africa, Mexico, Brazil, Thailand, and parts of East America. Pharmacognostical studies describe *C. fistula* as an ornamental tree characterized by bright golden-yellow flowers, green pods, oval to brown seeds, reddish-brown roots, and dark-brown mature stems. Numerous pharmacological activities have been reported for the plant, including antioxidant, antibacterial, antifungal, anti-inflammatory, antiparasitic, antifertility, and anticonvulsant effects, highlighting its considerable potential as a medicinal plant. The primary and secondary metabolites of *Cassia fistula* were classified according to the extracts in which they occurred, which were subsequently evaluated for antimicrobial activity and potential efficacy against chronic diseases, yielding promising outcomes for human health.

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