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CASSIA FISTULA LINN: PHYTOCHEMICAL PROFILE AND BIOMEDICAL APPLICATION

K. N. Vinay*, Dr. A. M. Krupanidhi, Dr. Prakash Dabadi

Department of Pharmacology, Bapuji Pharmacy College, Davangere-577004 Karnataka.

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***Corresponding Author: K. N. Vinay**
Department of Pharmacology, Bapuji Pharmacy College, Davangere-577004 Karnataka.
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ABSTRACT

Cassia fistula Linn. (family Fabaceae), commonly known as Indian Laburnum or Golden Shower Tree, is a medicinal plant extensively used in traditional systems of medicine including Ayurveda, Siddha, and Unani. The present review highlights the phytochemical profile, traditional applications, geographical distribution, morphological characteristics, and biomedical potential of *Cassia fistula*. Various parts of the plant such as leaves, flowers, bark, roots, fruit pulp, pods, and seeds contain biologically active compounds including flavonoids, anthraquinones, phenolic compounds, tannins, glycosides, terpenoids, steroids, and alkaloids. These phytoconstituents contribute to a broad range of pharmacological activities. Experimental studies have demonstrated significant antioxidant, antimicrobial, anti-inflammatory, analgesic, antidiabetic, hepatoprotective, wound healing, antipyretic, anthelmintic, gastroprotective, and anticancer properties of the plant. The antioxidant potential of *Cassia fistula* is particularly associated with its ability to scavenge free radicals and reduce oxidative stress. Traditional and modern scientific evidence supports its therapeutic value and highlights its potential for the development of natural and plant-based pharmaceutical formulations. Further clinical investigations are necessary to validate its safety, efficacy, and biomedical applications.

KEYWORDS: *Cassia fistula* Linn., Indian Laburnum, Phytochemistry, Medicinal Plants, Pharmacological Activities, Antioxidant Activity, Antimicrobial Activity, Traditional Medicine, Biomedical Applications, Phytoconstituents.

INTRODUCTION

According to Mondal different species belonging to the Cassia genus are used in Ayurvedic or traditional Hindu medicine for curative purposes; furthermore, some Cassia species have been used in elimination of disease agents in the body system, and hence have gained economic importance.[1] Medicinal characteristics of various plant species have greatly helped in developing some traditional herbal medicines. Many plants contain diverse phytochemicals that have been utilized in various fields such as human medicine, agricultural and veterinary practices. Some plants that contain medicinal characteristics such as the Cassia species contain large amounts of metabolites, which can cause specific physiological changes in the body systems of both animals and humans.[2]

Cassia fistula L., (family Fabaceae, subfamily Caesalpinioideae), a plant known for its medicinal value that grows naturally wild in nature. This plant is widespread in different areas, such as Asia, South Africa, China, West Indies, and Brazil.[3]

In the local language, this plant is named Amultas, whereas in English, it is called “Indian Laburnum.” The plant has been widely used in Ayurvedic medicine for different purposes. This plant is found growing in deciduous and monsoon forests of great parts of India up to an altitude of 1300m in the outer Himalayas.[4]

Cassia fistula Linn. (Caesalpiniaceae) is highly important from therapeutic standpoint and exhibits antipyretic, analgesic,anti-inflammatory, and hypoglycemic activities In recent years, there have been tremendous research efforts to investigate thepharmacological activity of this plant.The antioxidants can be termed as microconstituents, which act as inhibitors of lipid peroxidation by preventing

initiationor propagation of oxidizing chain reactions. In addition, antioxidants are effective in the scavenging of free radicals.[5]

The approaches involving the use of antioxidants have risen significantly in recent years for the treatment of neurodegenerative diseases, aging, and degenerative diseases. In this context, the present study was designed to evaluate the effect of antioxidants and phenolic content of Cassia fistula.[6]

Description: *Cassia fistula* (L) seeds.[7]

TAXONIMICAL CLASSIFICATION

Kingdom:	Plantae.
Division:	Magnoliophyta.
Class:	Magnoliopsida
Order:	Fabales
Family:	Fabacae
Genus :	Cassia
Species :	Fistula

VERNACULAR NAMES[7]

Kannada:	Kakkemara
Sanskrit:	Nripadruma
Hindi:	Sonali, Amultus
English:	golden shower, Indian laburnum

GEOGRAPHICAL DISTRIBUTION[8]

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 Konkan. The plant is cultivated as an ornamental throughout India,

Cassia fistula is a medium-sized deciduous tree belonging to the family Fabaceae. It is native to the Indian subcontinent and has been widely introduced throughout tropical and subtropical regions of the world.[9]

Native Distribution

The species is naturally distributed in:

- India
- Sri Lanka

According to the Royal Botanic Gardens, Kew, the native range of *Cassia fistula* is western and southern India and Sri Lanka.

Distribution in India[10]

The tree occurs widely across tropical and subtropical parts of India, especially in:

- Karnataka
- Kerala
- Tamil Nadu
- Maharashtra
- Andhra Pradesh
- Odisha
- Assam
- Bihar
- Madhya Pradesh
- Uttar Pradesh

It is commonly found in dry deciduous forests, open forests, hill slopes, and roadside plantations from the plains up to about 1,400 m elevation. Reports indicate that it occurs throughout much of India, except in some high Himalayan states such as Jammu & Kashmir, Himachal Pradesh, Sikkim, and Arunachal Pradesh.[11]

Global Distribution

Besides its native range, *Cassia fistula* has been introduced and cultivated in many tropical regions including:

- Bangladesh
- Myanmar
- Thailand
- Nepal
- Pakistan
- Vietnam
- Cambodia
- Laos
- Several countries in Africa, Central America, South America, and Australia.

Habitat

- Dry deciduous forests
- Open woodlands
- Roadside avenues
- Parks and gardens
- Plains to approximately 1,400 m altitude

The species prefers warm tropical climates and well-drained soils.[12]

MORPHOLOGICAL CHARACTERS.[13]

It is a deciduous tree with greenish grey bark, compound leaves, leaf lets are each 5-12 cm long pairs.

A semi-wild tree known for its beautiful bunches of yellow flowers and used in traditional Medicine for several indications. *

Seeds broadly ovate, 8mm. long, slightly less in breadth, and 5mm thick.

FLORAL CHARACTERS[14]

It is a deciduous tree with greenish grey bark, compound leaves, leaf lets are each 5-12 cm long pairs.

A semi-wild tree known for its beautiful bunches of yellow flowers and 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 shed.

Pulp is dark brown in colour, sticky, sweet and mucilaginous, odour characteristic, and somewhat disagreeable.

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, astringent.

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 rhachis brown when old; branches spreading, slender.

Leaves 23-40 cm long, main rhachis 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 glaborous 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 glaborous.

Flowers in lax racemes 30-50 cm. long; pedicels 3.8-5.7 cm. long, slender, pubescent and glaborous. 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 thick."[15]

Phytochemistry of *Cassia fistula*[16,17,18,19,20]

Plant part	Major phytochemical classes
Flowers	Flavonoids, anthraquinones, phenolic compounds, glycosides, volatile oils (essential oils), fatty alcohols
Leaves	Anthraquinones, flavonoids, tannins, alkaloids, terpenoids, glycosides, phenolic compounds
Stem bark	Tannins, flavonoids, anthraquinone glycosides, steroids, triterpenoids, phenolic compounds, carbohydrates
Roots	Anthraquinones, flavonoids, tannins, terpenoids, steroids, glycosides, phenolic compounds
Fruit pulp	Anthraquinones, glycosides (sennosides), carbohydrates, amino acids, pectins, mucilage, phenolic compounds
Pods (fruit wall)	Anthraquinones, flavonoids, tannins, phenolic compounds, organic acids
Seeds	Fixed oils, fatty acids, proteins, flavonoids, glycosides, sterols
Latex/Gum/Exudate	Polysaccharides, mucilage, gums, carbohydrates, phenolic compounds
Whole plant	Anthraquinones, flavonoids, tannins, phenolics, glycosides, terpenoids, steroids, alkaloids

Traditional Uses of *Cassia fistula* L.[22,23,24]

Cassia fistula L. (Golden Shower Tree, Indian Laburnum, Amaltas) has been widely used in traditional systems of medicine, particularly **Ayurveda, Siddha, Unani, and folk medicine**. Almost all parts of the plant—including fruits, leaves, bark, roots, flowers, and seeds—are used for therapeutic purposes.[21]

Plant part	Traditional uses
Fruit pulp	Mild laxative, treatment of constipation, fever, skin diseases, digestive disorders, liver ailments, and intestinal worms
Leaves	Applied externally for skin diseases, ringworm, eczema, wounds, ulcers, inflammation, and swelling
Bark	Used as an astringent for diarrhea, dysentery, leprosy, skin disorders, and wound healing
Roots	Used in fever, cardiac disorders, rheumatism, and as a purgative
Flowers	Used as a mild laxative, febrifuge, treatment for skin diseases, and to improve digestion
Seeds	Used as a purgative and in the treatment of skin diseases
Pods	Employed in traditional remedies for constipation and gastrointestinal complaints
Whole plant	Used as an antimicrobial, anti-inflammatory, antipyretic, and blood-purifying remedy

Pharmacology activity

Antioxidant Activity of *Cassia fistula* L.[25,26]

The antioxidant activity of *Cassia fistula* L. has been extensively investigated and is primarily attributed to its rich content of flavonoids, phenolic compounds, tannins, anthraquinones, and other polyphenolic constituents. Various extracts prepared from the leaves, flowers, bark, fruit pulp, and seeds have demonstrated significant free radical scavenging activity in different in vitro antioxidant models, including DPPH, ABTS, superoxide

radical, nitric oxide radical, and ferric reducing antioxidant power (FRAP) assays. The antioxidant potential of the plant is associated with its ability to donate hydrogen atoms or electrons, thereby neutralizing reactive oxygen species (ROS) and preventing oxidative damage to cellular biomolecules such as lipids, proteins, and DNA. Studies have reported that methanolic and ethanolic extracts of *C. fistula* exhibit strong antioxidant activity comparable to standard antioxidants such as ascorbic acid and butylated hydroxytoluene (BHT). The presence of bioactive compounds such as kaempferol, catechin derivatives, rhein, and other phenolic constituents contributes significantly to this activity. These findings suggest that *Cassia fistula* may serve as a valuable natural source of antioxidants and could play an important role in the prevention and management of oxidative stress-related disorders, including diabetes, cardiovascular diseases, inflammation, and cancer.

Antimicrobial (Antibacterial and Antifungal) Activity of *Cassia fistula* L.[27,28]

Cassia fistula L. has been widely reported to possess significant antimicrobial activity against a broad spectrum of pathogenic bacteria and fungi. Various extracts obtained from the leaves, bark, roots, flowers, seeds, and fruit pulp have demonstrated inhibitory effects against both Gram-positive and Gram-negative bacterial strains, including *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Salmonella typhi*. Antifungal activity has also been observed against fungal pathogens such as *Candida albicans*, *Aspergillus niger*, and *Trichophyton mentagrophytes*. The antimicrobial effects are primarily attributed to the presence of bioactive phytochemicals including flavonoids, anthraquinones, tannins, phenolic compounds, terpenoids, and glycosides, which interfere with microbial cell wall integrity, membrane permeability, enzyme activity, and nucleic acid synthesis.

Methanolic, ethanolic, and aqueous extracts of *C. fistula* have shown concentration-dependent zones of inhibition in various in vitro studies. The broad-spectrum antibacterial and antifungal properties of the plant support its traditional use in the treatment of skin infections, wounds, gastrointestinal infections, and other microbial diseases, highlighting its potential as a natural source of antimicrobial agents.

Anti-inflammatory Activity of *Cassia fistula* L.[29,30]

Cassia fistula L. has demonstrated significant anti-inflammatory activity in both experimental and preclinical studies.

Various extracts prepared from the leaves, bark, flowers, roots, and fruit pulp have been shown to reduce acute and chronic inflammation through multiple mechanisms. The anti-inflammatory effects are primarily attributed to the presence of flavonoids, anthraquinones, tannins, phenolic compounds, triterpenoids, and sterols, which are known to modulate inflammatory pathways. Studies using carrageenan-induced paw edema and other animal models have revealed that *C. fistula* extracts significantly inhibit edema formation and inflammatory responses.

The plant extracts are believed to suppress the production and release of pro-inflammatory mediators such as prostaglandins, histamine, serotonin, and cytokines, thereby reducing tissue inflammation and swelling. In addition, the antioxidant properties of the plant contribute to its anti-inflammatory effects by scavenging reactive oxygen species involved in inflammatory processes. These findings provide scientific support for the traditional use of *Cassia fistula* in the treatment of inflammatory conditions, rheumatism, skin disorders, wounds, and painful swellings.

Analgesic Activity of *Cassia fistula* L.[29,30]

Cassia fistula L. has been reported to possess notable analgesic (pain-relieving) activity in various experimental studies. Extracts from different plant parts, particularly the leaves, bark, and fruit pulp, have demonstrated significant reductions in pain responses in animal models such as acetic acid-induced writhing, hot plate, and tail-flick tests. The analgesic effect is attributed to the presence of bioactive constituents including flavonoids, anthraquinones, tannins, phenolic compounds, triterpenoids, and sterols. These phytochemicals are believed to exert their effects through the inhibition of inflammatory mediators such as prostaglandins and other pain-inducing substances, as well as by modulating peripheral and central pain pathways. The observed analgesic activity is often associated with the plant's anti-inflammatory properties, suggesting a complementary mechanism of action.

Experimental findings indicate that *C. fistula* extracts can significantly reduce pain perception in a dose-dependent manner, supporting its traditional use in the management of painful inflammatory conditions, rheumatism, arthritis, wounds, and other disorders associated with pain. Therefore, *Cassia fistula* represents a promising source of natural analgesic compounds with potential therapeutic applications.

Antidiabetic Activity of *Cassia fistula* L.[27,28]

Cassia fistula L. has been extensively studied for its antidiabetic potential in both in vitro and in vivo experimental models. Various extracts obtained from leaves, bark, fruit pulp, and seeds have shown significant hypoglycemic and antihyperglycemic effects, particularly in streptozotocin- and alloxan-induced diabetic animal models. The antidiabetic activity is mainly attributed to the presence of bioactive phytoconstituents such as flavonoids, phenolic compounds, tannins, anthraquinones, saponins, and sterols, which collectively contribute to improved glucose homeostasis. These compounds are reported to enhance insulin secretion, improve peripheral glucose uptake, inhibit intestinal glucose absorption, and modulate key enzymes involved in carbohydrate

metabolism. In addition, antioxidant properties of the plant help reduce oxidative stress-induced pancreatic β-cell damage, which is a critical factor in the progression of Diabetes mellitus type 2. Some studies have also suggested that *C. fistula* extracts may improve lipid profiles, thereby reducing diabetes-associated complications such as dyslipidemia and cardiovascular risk. Overall, the evidence supports the traditional use of *Cassia fistula* as a natural antidiabetic agent and highlights its potential for development into plant-based therapeutic formulations for glycemic control.

Analgesic Activity of *Cassia fistula* L.[27,28]

Cassia fistula L. has been reported to possess notable analgesic (pain-relieving) activity in various experimental studies. Extracts from different plant parts, particularly the leaves, bark, and fruit pulp, have demonstrated significant reductions in pain responses in animal models such as acetic acid-induced writhing, hot plate, and tail-flick tests. The analgesic effect is attributed to the presence of bioactive constituents including flavonoids, anthraquinones, tannins, phenolic compounds, triterpenoids, and sterols. These phytochemicals are believed to exert their effects through the inhibition of inflammatory mediators such as prostaglandins and other pain-inducing substances, as well as by modulating peripheral and central pain pathways. The observed analgesic activity is often associated with the plant's anti-inflammatory properties, suggesting a complementary mechanism of action.

Experimental findings indicate that *C. fistula* extracts can significantly reduce pain perception in a dose-dependent manner, supporting its traditional use in the management of painful inflammatory conditions, rheumatism, arthritis, wounds, and other disorders associated with pain. Therefore, *Cassia fistula* represents a promising source of natural analgesic compounds with potential therapeutic applications.

Hepatoprotective Activity of *Cassia fistula* L.[29,30]

Cassia fistula L. has been widely investigated for its hepatoprotective potential against various chemically induced liver injuries. Experimental studies have shown that extracts from the fruit pulp, leaves, bark, and roots significantly protect hepatic tissues against toxicants such as carbon tetrachloride (CCl_4), paracetamol (acetaminophen), and ethanol-induced hepatotoxicity.

The hepatoprotective effect is mainly attributed to the presence of bioactive phytochemicals including flavonoids, phenolic compounds, tannins, anthraquinones, sterols, and triterpenoids, which exhibit strong antioxidant and membrane-stabilizing properties. These constituents help in scavenging reactive oxygen species, reducing lipid peroxidation, and restoring the levels of endogenous antioxidant enzymes such as superoxide dismutase (SOD), catalase (CAT), and glutathione (GSH). Additionally, *C. fistula* extracts have been shown to normalize elevated liver marker enzymes including serum glutamate oxaloacetate transaminase (SGOT), serum glutamate pyruvate transaminase (SGPT), and alkaline phosphatase (ALP), indicating recovery of hepatic function. Histopathological studies further confirm reduced necrosis, inflammation, and fatty changes in liver tissues treated with plant extracts.

These findings strongly support the traditional use of *Cassia fistula* in managing liver disorders and suggest its potential as a natural hepatoprotective agent.

Wound Healing Activity of *Cassia fistula* L.[28,29]

Cassia fistula L. has been reported to exhibit significant wound healing activity in various experimental studies, supporting its traditional use in the management of cuts, burns, ulcers, and skin injuries. Extracts obtained from the leaves, bark, and flowers have shown marked enhancement in wound contraction, reduction in healing time, and improved tensile strength of repaired tissues in animal models such as excision and incision wound studies. The wound healing potential is mainly attributed to the presence of bioactive phytoconstituents including flavonoids, tannins, phenolic compounds, saponins, triterpenoids, and glycosides. These compounds contribute to the healing process by promoting collagen synthesis, enhancing epithelialization, and accelerating tissue regeneration. The strong antioxidant and antimicrobial properties of the plant further aid in wound repair by reducing oxidative stress at the wound site and preventing microbial infection, which are major factors that delay healing. Additionally, *C. fistula* extracts have been shown to improve the formation of granulation tissue and increase hydroxyproline content, indicating enhanced collagen turnover. Overall, the available evidence supports the traditional application of *Cassia fistula* as a natural wound healing agent with potential therapeutic value in dermatological and tissue repair disorders.

Antipyretic Activity of *Cassia fistula* L.[27,29]

Cassia fistula L. has been reported to exhibit significant antipyretic (fever-reducing) activity in experimental studies, supporting its traditional use in the treatment of fever and infectious conditions. Extracts prepared from the leaves, bark, roots, and fruit pulp have demonstrated a reduction in elevated body temperature in animal models, particularly in yeast-induced pyrexia. The antipyretic effect is mainly attributed to the presence of bioactive phytochemicals such as flavonoids, phenolic compounds, tannins, anthraquinones, terpenoids, and glycosides. These constituents are believed to act by inhibiting the synthesis and release of endogenous pyrogens and prostaglandins, especially prostaglandin E_2 (PGE_2), which plays a key role in hypothalamic thermoregulation. In addition, the strong anti-inflammatory and antioxidant properties of *C. fistula* further contribute to its fever-reducing potential by suppressing inflammatory mediators and oxidative stress associated with infection-induced pyrexia. Overall, experimental evidence supports the traditional

application of *Cassia fistula* as a natural antipyretic agent, making it a promising candidate for the development of plant-based remedies for fever management.

Anthelmintic Activity of *Cassia fistula* L.[27,30]

Cassia fistula L. has been reported to possess notable anthelmintic activity and is traditionally used for the treatment of intestinal worm infestations. Experimental studies have demonstrated that extracts from the fruit pulp, seeds, leaves, and bark exhibit significant activity against gastrointestinal helminths, including earthworms and parasitic nematodes in in vitro models. The anthelmintic effect is mainly attributed to the presence of bioactive constituents such as anthraquinones, tannins, flavonoids, phenolic compounds, saponins, and glycosides. These compounds are believed to act by causing paralysis and death of parasites through disruption of neuromuscular coordination, inhibition of energy metabolism, and damage to the cuticle or cell membrane integrity. Among the plant parts, fruit pulp is most commonly reported for anthelmintic use due to its rich content of sennosides and anthraquinone derivatives.

The presence of tannins also contributes by binding to parasite proteins, leading to impaired growth and survival. Overall, the available pharmacological evidence supports the traditional use of *Cassia fistula* as a natural anthelmintic agent and highlights its potential as a source for developing plant-based anti-parasitic drug.

Antitumor / Anticancer Activity of *Cassia fistula* L.[28,30]

Cassia fistula L. has been reported to exhibit promising antitumor and anticancer potential in various in vitro and in vivo studies. Extracts obtained from the leaves, bark, fruit pulp, seeds, and flowers have demonstrated cytotoxic effects against several cancer cell lines, indicating its possible role in cancer management. The anticancer activity is mainly attributed to bioactive phytochemicals such as anthraquinones (rhein, emodin derivatives), flavonoids, phenolic compounds, tannins, saponins, and triterpenoids. These compounds are known to exert their effects through multiple mechanisms, including induction of apoptosis, inhibition of cancer cell proliferation, cell cycle arrest, suppression of angiogenesis, and modulation of oxidative stress. The strong antioxidant property of *C. fistula* also contributes to its anticancer potential by reducing DNA damage caused by reactive oxygen species. Some studies have further suggested that plant extracts may activate caspase-dependent pathways and enhance detoxification enzymes, thereby inhibiting tumor growth and progression. Overall, the available evidence supports the potential of *Cassia fistula* as a source of natural anticancer agents, although further clinical studies are required to confirm its therapeutic applicability.

Gastroprotective / Antiulcer Activity of *Cassia fistula* L.[27]

Cassia fistula L. has demonstrated significant gastroprotective and antiulcer potential in experimental studies, supporting its traditional use in the management of gastrointestinal disorders. Extracts obtained from the fruit pulp, leaves, and bark have shown protective effects against experimentally induced gastric ulcers caused by ethanol, non-steroidal anti-inflammatory drugs (NSAIDs), and stress models in animal studies. The antiulcer activity is mainly attributed to bioactive phytoconstituents such as flavonoids, tannins, phenolic compounds, saponins, and mucilage.

These compounds contribute to the strengthening of the gastric mucosal barrier, reduction of gastric acid secretion, and enhancement of mucus production, thereby preventing mucosal erosion and ulcer formation. In addition, the strong antioxidant activity of *C. fistula* plays a crucial role in scavenging reactive oxygen species, which are known to contribute to gastric mucosal damage. The anti-inflammatory properties further help in reducing edema and cellular infiltration in gastric tissues. Some studies also suggest that the plant may promote ulcer healing by enhancing prostaglandin synthesis and improving gastric cytoprotection. Overall, these findings provide scientific evidence supporting the traditional use of *Cassia fistula* as a natural gastroprotective and antiulcer agent.

CONCLUSION

Cassia fistula Linn. is an important medicinal plant with significant therapeutic and pharmacological value. The plant possesses a rich phytochemical composition including flavonoids, anthraquinones, phenolic compounds, tannins, glycosides, terpenoids, and other bioactive constituents that contribute to its medicinal properties. Traditional systems of medicine have utilized different parts of the plant for the treatment of various disorders such as constipation, fever, skin diseases, inflammation, liver disorders, and microbial infections.

Scientific investigations have further validated many of these traditional claims by demonstrating antioxidant, antimicrobial, anti-inflammatory, analgesic, antidiabetic, hepatoprotective, wound healing, antipyretic, anthelmintic, gastroprotective, and anticancer activities.

These findings indicate that *Cassia fistula* has strong potential as a natural source for the development of plant-based therapeutic agents and pharmaceutical products. However, further clinical studies and standardization are required to establish its safety, efficacy, dosage, and long-term biomedical applications in modern healthcare.

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