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A REVIEW ON PHYTOPHARMACOLOGICAL SCREENING OF CASSIA FISTULA LINN. IN EXPERIMENTAL ANIMAL MODELS

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1. INTRODUCTION

Medicinal plants have been used for thousands of years as an important source of therapeutic agents for the prevention and treatment of various diseases. Even with the rapid advancement of synthetic pharmaceuticals, plant-derived medicines continue to play a significant role in modern healthcare because of their wide therapeutic range, relatively low cost, and better patient acceptance. According to the World Health Organization (WHO), nearly 80% of the population in developing countries relies partly or entirely on traditional herbal medicine for primary healthcare needs. Many modern drugs, such as aspirin, quinine, and digoxin, originated from medicinal plants, highlighting the importance of ethnomedicinal knowledge in drug discovery.

Among the numerous medicinal plants used in the Indian traditional system of medicine, Cassia fistula Linn. has attracted considerable scientific attention due to its diverse pharmacological activities. The plant belongs to the family Fabaceae (Leguminosae) and is commonly known as Golden Shower Tree or Indian Laburnum in English and Amaltas in Hindi. In Ayurveda, it is referred to as Aragvadha, meaning "disease killer," which reflects its extensive medicinal value. The plant is widely distributed throughout India and other tropical countries and is frequently cultivated as an ornamental tree because of its attractive yellow flowers.

Traditionally, different parts of Cassia fistula, including the leaves, bark, flowers, fruits, pulp, and seeds, have been used for the treatment of constipation, fever, skin diseases, diabetes,

rheumatism, liver disorders, and inflammatory conditions. The fruit pulp is especially valued for its mild laxative property, while the leaves and bark are used in various herbal formulations for wound healing and anti-inflammatory purposes. The broad range of traditional uses suggests the presence of multiple bioactive constituents with significant therapeutic potential.

Phytochemical investigations have confirmed that Cassia fistula contains a variety of secondary metabolites such as anthraquinones, flavonoids, tannins, saponins, glycosides, terpenoids, and phenolic compounds. Among these, anthraquinones such as rhein, emodin, chrysophanol, and physcion are considered important marker compounds. Flavonoids and phenolic compounds are known for their antioxidant properties, while tannins contribute to antimicrobial and wound-healing activities. The presence of these phytochemicals provides a scientific basis for many of the traditional medicinal claims associated with the plant.

In recent years, experimental pharmacology has become an essential tool for validating the therapeutic potential of medicinal plants. Various animal models have been employed to evaluate the pharmacological activities of Cassia fistula extracts and fractions. Streptozotocin-induced diabetic rats are commonly used for assessing antidiabetic activity; carrageenan-induced paw edema models are used for anti-inflammatory studies; carbon tetrachloride-induced hepatotoxicity models are used for hepatoprotective evaluation; and excision or incision wound models are used to study wound-healing effects. These models provide valuable information regarding efficacy, dose-response relationships, and possible mechanisms of action.

Several experimental studies have reported that Cassia fistula exhibits significant antidiabetic, anti-inflammatory, antioxidant, hepatoprotective, analgesic, antimicrobial, antipyretic, and wound-healing activities. The antidiabetic effect is believed to be mediated through the enhancement of insulin secretion, improvement of glucose utilization, and reduction of oxidative stress in pancreatic tissues. Anti-inflammatory activity has been attributed to the inhibition of inflammatory mediators such as prostaglandins, histamine, and cytokines. Antioxidant activity is associated with the ability of flavonoids and phenolic compounds to scavenge free radicals and enhance endogenous antioxidant defense systems.

Despite the growing number of experimental reports, the available information is scattered across different journals and databases. Variations in extraction methods, plant parts used,

animal species, doses, and study duration make it difficult to draw generalized conclusions regarding the therapeutic potential of the plant. Moreover, standardized extracts and detailed mechanistic studies are still limited, and only a few investigations have addressed long-term safety and toxicity.

Therefore, a comprehensive review of the phytopharmacological studies of Cassia fistula in experimental animal models is necessary. The present review aims to compile and critically analyze the published literature on the phytochemistry and pharmacological activities of Cassia fistula, with special emphasis on animal studies. The review also highlights the possible mechanisms responsible for the observed biological activities, identifies existing research gaps, and discusses future directions for the development of standardized herbal formulations and novel plant-based therapeutic agents.

The information presented in this review may be useful for researchers, pharmacologists, and herbal drug developers interested in the scientific validation of traditional medicinal plants and the exploration of Cassia fistula as a potential source of bioactive compounds for future pharmaceutical applications.

2. Botanical Profile of Cassia fistula Linn.

2.1 Taxonomical Classification

The taxonomical position of Cassia fistula Linn. is presented in Table 1.

Table 1: Taxonomical classification of Cassia fistula Linn.

Taxonomic rank	Classification
Kingdom	Plantae
Subkingdom	Tracheobionta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Rosidae
Order	Fabales
Family	Fabaceae (Leguminosae)
Subfamily	Caesalpinioideae
Genus	Cassia
Species	Cassia fistula Linn.

The species was first described by Carl Linnaeus and is one of the most important medicinal plants of the genus Cassia.

2.2 Vernacular Names

Cassia fistula is known by different names in various regions of India and other countries.

Table 2: Vernacular names of Cassia fistula Linn.

Language	Name
Sanskrit	Aragvadha, Rajataru
Hindi	Amaltas
Marathi	Bahava
Gujarati	Garmalo
Tamil	Konrai
Telugu	Rela
Kannada	Kakke
Malayalam	Kanikonna
English	Golden Shower Tree, Indian Laburnum

The Sanskrit name Aragvadha means “the disease killer,” indicating its high therapeutic value in Ayurveda.

2.3 Geographical Distribution

Cassia fistula is widely distributed throughout the tropical and subtropical regions of the world. It is native to the Indian subcontinent and is commonly found in India, Sri Lanka, Pakistan, Myanmar, Thailand, and other Southeast Asian countries.

In India, the plant grows abundantly in the states of Maharashtra, Madhya Pradesh, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Telangana, and Uttar Pradesh. It is commonly cultivated along roadsides, in gardens, and around temples as an ornamental tree because of its attractive yellow flowers.

The plant grows well in

- Tropical and subtropical climates
- Areas receiving moderate rainfall
- Well-drained loamy or sandy soils
- Temperatures ranging from 20°C to 38°C

2.4 Habit and Habitat

Cassia fistula is a medium-sized deciduous tree that usually attains a height of 8–15 m, although under favorable conditions it may grow up to 20 m. The tree sheds its leaves during the dry season and produces abundant flowers during the summer months.

The plant is commonly found in

- Dry deciduous forests
- Open grasslands
- Riverbanks
- Agricultural boundaries
- Urban landscapes and parks

Because of its adaptability, the species can tolerate periods of drought and is suitable for cultivation in many parts of India.

2.5 Morphological Characteristics

2.5.1 Root

The plant possesses a strong taproot system with several lateral branches. The roots are brown in color and help the plant withstand dry conditions.

2.5.2 Stem and Bark

The stem is erect, cylindrical, and covered with a grayish-brown bark. The bark is smooth in young trees but becomes rough and fissured with age. The bark contains tannins and other bioactive compounds that are used in traditional medicine for treating skin diseases and wounds.

2.5.3 Leaves

The leaves are paripinnate, alternate, and deciduous, measuring about 20–40 cm in length. Each leaf consists of 4–8 pairs of opposite leaflets.

Leaf characteristics

- Shape: Ovate to elliptic
- Length: 7–15 cm
- Width: 3–6 cm
- Apex: Acute
- Surface: Smooth and glabrous
- Color: Bright green when young, dark green when mature

The leaves are commonly used in herbal preparations for anti-inflammatory and wound-healing purposes.

2.5.4 Flowers

The flowers are the most distinctive feature of the plant. They are bright golden yellow and arranged in long drooping racemes measuring 20–50 cm in length.

Flower characteristics

- Diameter: 4–6 cm
- Petals: Five, unequal
- Stamens: Ten, with three long fertile stamens
- Flowering season: April to June

The profuse flowering gives the tree a spectacular appearance and is responsible for the name Golden Shower Tree.

2.5.5 Fruit

The fruit is a long cylindrical pod measuring 30–60 cm in length and 1.5–2.5 cm in diameter. Initially green, it turns dark brown or black on maturity.

Fruit characteristics

- Shape: Cylindrical and pendulous
- Surface: Smooth and woody
- Internal structure: Divided into many transverse compartments
- Pulp: Black, sticky, sweetish, and medicinally important

The fruit pulp is widely used as a mild laxative in Ayurvedic medicine.

2.5.6 Seeds

The seeds are hard, flattened, oval, and reddish-brown. Each pod contains 25–100 seeds embedded in the dark pulp.

Seed characteristics

- Shape: Elliptical
- Color: Reddish-brown
- Seed coat: Hard and glossy
- Taste: Slightly bitter

Seeds have been reported to contain proteins, fixed oils, and several phytochemicals with potential pharmacological activities.

2.6 Macroscopic Identification

The important diagnostic characters used for identification of Cassia fistula are:

- Medium-sized deciduous tree
- Long drooping racemes of bright yellow flowers
- Paripinnate leaves with 4–8 pairs of leaflets
- Long cylindrical woody pods containing black pulp
- Characteristic sweet odor of the fruit pulp

These features help in distinguishing Cassia fistula from other species of the genus Cassia.

2.7 Traditional Importance

In Ayurveda, Cassia fistula is classified as a Rasayana plant and is included in formulations used for:

- Constipation
- Fever
- Skin disorders
- Cardiac ailments
- Liver disorders
- Diabetes
- Inflammatory diseases

The fruit pulp is considered safe and gentle, making it suitable for children and elderly patients when used in recommended doses.

3. Phytochemical Constituents of Cassia fistula Linn.

The medicinal value of Cassia fistula Linn. is mainly due to the presence of various bioactive phytochemicals in its leaves, bark, flowers, fruit pulp, and seeds. These compounds include anthraquinones, flavonoids, tannins, phenolic compounds, saponins, glycosides, terpenoids, and steroids, which are responsible for many of the pharmacological activities reported in experimental animal studies.

3.1 Major Phytochemical Constituents

Anthraquinones

Anthraquinones are the characteristic constituents of Cassia fistula, especially in the fruit pulp and bark. The important compounds are rhein, emodin, chrysophanol, and physcion. These compounds possess laxative, anti-inflammatory, antimicrobial, and antioxidant activities.

Flavonoids

The leaves and flowers contain flavonoids such as quercetin and kaempferol. Flavonoids act as powerful antioxidants and help protect tissues from oxidative stress. They also contribute to the hepatoprotective and antidiabetic activities of the plant.

Tannins

Tannins are present mainly in the bark and leaves. They have astringent, antimicrobial, and wound-healing properties and help in reducing infection and promoting tissue repair.

Phenolic Compounds

Phenolic compounds such as gallic acid and ferulic acid exhibit strong free radical scavenging activity and protect cells from oxidative damage.

Saponins and Glycosides

Saponins and glycosides contribute to the anti-inflammatory and immunomodulatory effects of the plant and may enhance the absorption of other active constituents.

3.2 Distribution of Phytochemicals

Table 3: Distribution of major phytochemicals in different parts of *Cassia fistula*.

Plant part	Major constituents
Leaves	Flavonoids, tannins, phenolics
Bark	Tannins, anthraquinones, sterols
Flowers	Flavonoids and phenolic compounds
Fruit pulp	Rhein, emodin, chrysophanol
Seeds	Fixed oils, saponins, sterols

3.3 Pharmacological Importance

The pharmacological activities of Cassia fistula are closely related to its phytochemical composition:

- Anthraquinones: laxative and antimicrobial activity
- Flavonoids: antioxidant and hepatoprotective activity
- Tannins: wound-healing and antimicrobial activity
- Phenolics: protection against oxidative stress
- Saponins: anti-inflammatory and immunomodulatory activity

4. METHODOLOGY OF LITERATURE REVIEW

4.1 Literature Search

A systematic literature search was conducted to collect published information related to the phytopharmacological screening of Cassia fistula Linn. in experimental animal models. Scientific databases such as PubMed, Google Scholar, ScienceDirect, Scopus, and ResearchGate were searched for relevant articles published up to 2026. The search focused on studies evaluating the pharmacological activities of different parts of the plant, including the leaves, bark, flowers, fruit pulp, and seeds.

4.2 Search Terms and Keywords

The search was performed using various keywords and their combinations, including Cassia

fistula, Cassia fistula Linn., phytopharmacological screening, experimental animal models, antidiabetic activity, anti-inflammatory activity, antioxidant activity, hepatoprotective activity, analgesic activity, and wound-healing activity. Boolean operators such as AND and OR were used to improve the accuracy and relevance of the search results.

4.3 Selection of Studies

Only studies published in the English language and conducted on experimental animals were included in the review. Research articles reporting the pharmacological evaluation of Cassia fistula extracts or fractions with clear information regarding the animal model, dose, duration of treatment, and outcome measures were selected. Review articles, conference abstracts, in vitro studies without animal data, and studies lacking sufficient methodological details were excluded from the final analysis.

4.4 Data Collection and Analysis

Relevant data were extracted from each selected study, including the plant part used, type of extract, animal species, experimental model, dose administered, treatment duration, and major pharmacological findings. The collected information was carefully analyzed and grouped according to the reported pharmacological activities, such as antidiabetic, anti-inflammatory, antioxidant, hepatoprotective, analgesic, antimicrobial, and wound-healing effects.

5. Pharmacological Activities of Cassia fistula Linn. in Experimental Animal Models

5.1 Antidiabetic Activity

The antidiabetic activity of Cassia fistula has been extensively evaluated in streptozotocin (STZ)-induced diabetic rats. Various extracts of the fruit pulp, leaves, and bark have shown significant reduction in fasting blood glucose levels when administered orally. The treatment also improved body weight and reduced symptoms associated with diabetes. The possible mechanism of action involves stimulation of insulin secretion, improvement of peripheral glucose utilization, and antioxidant protection of pancreatic β-cells. The presence of flavonoids and phenolic compounds is considered responsible for the hypoglycemic effect.

5.2 Anti-inflammatory Activity

Anti-inflammatory activity has been studied using carrageenan-induced paw edema in rats, which is a widely accepted model for acute inflammation. Administration of methanolic and aqueous extracts significantly reduced paw swelling compared with the control group. The

inhibition of edema suggests that Cassia fistula may suppress the synthesis or release of inflammatory mediators such as prostaglandins, histamine, serotonin, and cytokines. The anti-inflammatory effect is mainly attributed to flavonoids, tannins, and triterpenoids present in the plant.

5.3 Antioxidant Activity

The antioxidant potential of Cassia fistula has been demonstrated in several oxidative stress models. Treatment with plant extracts increased the levels of superoxide dismutase (SOD), catalase (CAT), and reduced glutathione (GSH), while decreasing lipid peroxidation markers such as malondialdehyde (MDA). These findings indicate that the plant possesses significant free radical scavenging activity and protects tissues from oxidative damage. The antioxidant effect is primarily associated with the high content of flavonoids and phenolic compounds.

5.4 Hepatoprotective Activity

Hepatoprotective activity has been evaluated in carbon tetrachloride (CCl_4)-induced liver injury models in rats. Treatment with Cassia fistula extracts significantly reduced serum levels of AST, ALT, ALP, and bilirubin, indicating protection against hepatic damage. Histopathological examination showed reduced necrosis and fatty degeneration in treated animals. The hepatoprotective effect may be due to the antioxidant action of the phytoconstituents, which helps stabilize hepatocyte membranes and prevent oxidative injury.

5.5 Analgesic Activity

The analgesic activity of Cassia fistula has been assessed using hot plate and acetic acid-induced writhing tests in mice. The extracts produced a significant reduction in the number of writhes and increased reaction time in the hot plate test, indicating both peripheral and central analgesic effects. Inhibition of prostaglandin synthesis and modulation of pain pathways may contribute to the observed activity.

5.6 Antimicrobial Activity

Extracts of Cassia fistula have shown antimicrobial activity against several Gram-positive and Gram-negative bacteria as well as certain fungal species. The bark and fruit pulp extracts were found to inhibit the growth of organisms such as Staphylococcus aureus, Escherichia coli, and Candida albicans. Tannins, anthraquinones, and phenolic compounds are believed to play an important role in the antimicrobial action.

5.7 Wound-Healing Activity

The wound-healing potential of Cassia fistula has been studied using excision and incision wound models in rats. Topical application of leaf extract ointment accelerated wound contraction, shortened the epithelialization period, and increased tensile strength of the healed tissue. The activity may be related to the antimicrobial, antioxidant, and collagen-promoting properties of the plant constituents.

6. Summary of Experimental Animal Studies

Table 4: Summary of pharmacological activities of Cassia fistula in animal models.

Activity	Experimental model	Major outcome
Antidiabetic	STZ-induced diabetic rats	Reduction in blood glucose level
Anti-inflammatory	Carrageenan-induced paw edema	Reduction in paw swelling
Antioxidant	Oxidative stress models	Increase in antioxidant enzymes
Hepatoprotective	CCl_4-induced liver injury	Reduction in liver enzyme levels
Analgesic	Hot plate and writhing tests	Decrease in pain response
Antimicrobial	Bacterial and fungal infection models	Inhibition of microbial growth
Wound healing	Excision and incision wound models	Faster wound contraction and healing

7. Research Gaps

Although numerous studies have reported promising pharmacological activities, several limitations remain. Most investigations used different extraction methods, doses, and treatment durations, making comparison of results difficult. Standardized extracts containing known amounts of marker compounds such as rhein and emodin are not commonly used. In addition, chronic toxicity studies, pharmacokinetic investigations, and molecular mechanism studies are still limited. The lack of well-designed clinical studies also restricts the translation of experimental findings into therapeutic applications.

8. Future Perspectives

Future research should focus on the standardization of extracts, isolation of active constituents, and elucidation of molecular mechanisms responsible for the observed pharmacological effects. Advanced techniques such as HPLC, LC-MS, and metabolomic profiling may help identify bioactive compounds more accurately. Long-term safety studies and controlled clinical trials are necessary to establish the efficacy and safety of Cassia fistula in humans. The development of herbal formulations, nanoparticles, and targeted delivery systems may further enhance the therapeutic potential of this medicinal plant.

9. CONCLUSION

Cassia fistula Linn. is an important medicinal plant with a wide range of pharmacological activities supported by experimental animal studies. The plant exhibits significant antidiabetic, anti-inflammatory, antioxidant, hepatoprotective, analgesic, antimicrobial, and wound-healing properties. These activities are mainly attributed to the presence of anthraquinones, flavonoids, tannins, and phenolic compounds. Experimental evidence suggests that Cassia fistula has considerable potential for the development of safe and effective herbal therapeutic agents. However, further standardized preclinical studies and clinical investigations are required to validate its traditional uses and establish its role in modern medicine.

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