



Cassia Fistula Linn: A Comprehensive Review and Future Research Directions

Naina^{1*}, Sunaina², Phool Chandra³

¹Department of Pharmacology, Teerthanker Mahaveer College of Pharmacy, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh-244001, India. Email: nainarathore891@gmail.com

²Department of Pharmacology, Teerthanker Mahaveer College of Pharmacy, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh- 244001, India E-mail ID. - sunainarathore8171@gmail.com

³Department of Pharmacology, Teerthanker Mahaveer College of Pharmacy, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh-244001, India Email: - chandraphool@gmail.com

*Corresponding author's E-mail: nainarathore891@gmail.com

Article History	Abstract
Received: 06 June 2023 Revised: 05 Sept 2023 Accepted: 15 Dec 2023	<p><i>Cassia fistula</i> belongs to the family Fabaceae commonly known as Golden Shower, Amaltas. It is also called Pudding Pipe tree. In Ayurvedic system of medicine, different parts (leaves, flowers, Roots, and Fruit pulp) of <i>Cassia fistula</i> Linn have been recommended for the treatment of Jaundice, Gout, Fatty Liver, Liver Disorder, Bronchitis, Fever, Skin disease, and so on. The <i>Cassia fistula</i> Linn has also been suggested to possess, anti-diabetic, rheumatic disorder, leprosy, diuretics. It also has blood purifier action. <i>Cassia fistula</i> (Amaltas), a golden shower tree belonging to the Leguminosae family with 8-15 m height. <i>Cassia fistula</i> stem is greenish ever reddish-brown root. Compound leaf 3-8 pairs of leaflets, cylindrical pods and ovoid seeds. This article aims to provide a comprehensive review on the phytochemical and pharmacological aspects of <i>Cassia fistula</i>. The fruits, stem, bark, and leaves of this plant contain a variety of biologically active compounds such as Anthraquinone, flavonoids, flavan-3-ol derivatives, alkaloids, glycosides, tannin, saponins, reducing sugar and steroids those have various medicinal properties. The fruit and stem bark extract show various activities like antipyretic, anti-inflammatory, antioxidant, antidiabetic, hepato-protective, antimicrobial, antitumor, antiulcer etc. The article reviews the various activities of the plant.</p>
CC License CC-BY-NC-SA 4.0	Keywords: <i>Cassia fistula</i> , Phytoconstituents, Pharmacological activities, Traditional uses.

1. Introduction

Cassia fistula L. (Fabaceae, Caesalpinioideae), a very common plant known for its medicinal properties is semi-wild in nature. It is distributed in various regions including, South Africa, China, West Indies and Brazil. *Cassia fistula* is a deciduous, medium sized tree 10 /4 m in height and 1.8 m in girth, cultivated almost throughout India (R. W. Mwangi et al., 2021). Out of the 400 species, it is one (what comprises the genus *Cassia*. It is widely distributed in tropical countries of the world India, China, Ceylon, Egypt, Mauritius, South Africa, Mexico, Brazil, East, Africa, Thailand, Srilanka *Cassia fistula* is used traditionally for the treatment of many diseases but now scientific research envelope us to pyniore the hidden secondary metabolites and their role towards the organisms (pharmacological activities). Medicinally it has been various pharmacological activities like antimicrobial, antifungal, antipyretic, analgesic, larvicidal, anti-inflammatory, antioxidant, anti-tumor, hepatoprotective, hypoglycemic activities. The fruits, stem, bark, and leaves of this plant contain a variety of biologically active compounds such as anthraquinones, flavonoids, flavan-3-ol derivatives, alkaloids, glycosides, tannin, saponin, terpenoids, reducing sugar and steroids have various medicinal properties (Meena et al., 2022). The fruit and stem bark extract show various activities like antipyretic, anti-inflammatory, antioxidant, antidiabetic, hypolipidemic, hepato-protective, antimicrobial, antitumor, antiulcer etc (Barthakur et al., 1995).

It is also a purgative due to the wax loin and a tonic and has been reported to treat many other intestinal disorders like healing ulcers. According to the WHO, more than 70% of the world's population must

use traditional medicine to satisfy their principal health needs. In developing countries 80% of the population are using traditional medicine in primary medical problems. Plant drugs and herbal formulations are frequently considered to be less toxic and free from side effects than synthetic one (Yasmeen et al., 2023). In traditional medicine, *Cassia fistula* is one of the most commonly used plants in Unani and Ayurvedic medicines, this plant has been described to be useful against skin diseases, liver troubles, tuberculous glands and its use in the treatment of haematemesis, leucoderma and diabetes has been suggested (Chakraborty et al., 2022). Traditionally, the plant is also used as an infusion, decoction, or powder, either alone or in combination with other medicinal plants. In modern times, and in any controlled clinical trials, commercial preparations have tended to be standardized extracts of the whole plant (Rahman et al., 2020). The plant has been documented to possess analgesic, anti-inflammatory, antioxidant, antidiabetic as well as hepatoprotective activity. This review summarizes current scientific findings and suggests areas where further research is needed and also to verify the therapeutic efficacy of *Cassia fistula* (Chaerunisa et al., 2020).

Table 1 Taxonomical Classification

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

Table 2 Vernacular Names of *Cassia fistula*

English	Golden Shower, Purging <i>Fistula</i> <i>Cassia</i>
Bengali	Bundaralati, Sonalu
Hindi	Sonali, Amaltas
Khanna	kakke mara
Marathi	Banava
Tamil	Konai
Arab	khayar sambhar
Punjabi	Amaltas, kaniyaar
Urdu	Amaltas
Gujarati	Garmala

Geographical Sources

Cassia fistula L. (family Leguminosae) commonly known as Golden Shower (English), Amaltas (Hindi), purging cassia, India laburnum, pudding pipe tree (English). It is a deciduous plant. It is used as an (Amber et al., 2017) ornamental tree due to its beautiful yellow-colored flowers (Francis et al., n.d.). Height is about 25 to 30 feet. It distributed sub-tropical regions of the world West Indies to India (Garg et al., 2009). It is found as a forest at outer Himalaya 1300m ascending. In deciduous and mixed monsoon forests throughout greater parts of India, ascending to 1300 m in the outer Himalaya (Yohana Chaerunisa et al., 2020). In Maharashtra, it occurs as a scattered tree throughout the Deccan and Konkan. The plant is cultivated as an ornamental throughout India (R. Mwangi et al., n.d.).



Fig.1. Bark (Res & 2013, 2013)



Fig. 2. Seeds



Fig.3. Flower (Seethapathy et al., 2015)

Morphology

It is a deciduous tree with greenish gray 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 a cylindrical pod and seeds are 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 color, sticky, sweet and mucilaginous, dour characteristic, and somewhat disagreeable. Drug occurs in flat or curved thick pieces; outer surface smooth to rough with warty patches; greenish gray to red; inner surface rough, reddish with parallel striations; fracture, laminate; dour, sweet and characteristic; taste, astringent. A tree 6-9 m high; trunk straight; bark smooth and pale gray when young, rough and dark brown when old; branches spreading, slender. Leaves 23-40 cm long; main reaches pubescent; stipules minute, linear-oblong, obtuse, pubescent (Baid et al., 2021). 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; petioles 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 (Brauner et al., 2021). Calyx cm long divided to the base, pubescent; segments oblong, obtuse (Gobianand et al., 2010). Corolla 3.8 cm across, yellow; stamens all antheriferous. 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 colored, transverse dissepiments at intervals of about 0.5cm. Each compartment contains one seed which is flat, oval, reddish brown with a well-marked ripe. The seed contains a whitish endosperm in which the yellowish embryo is embedded (Danish, Singh, Mishra, ..., et al., 2011).

Traditional Applications

Seed

It contains cooling, antipyretic, laxative and carminative properties. It has a slightly sweet taste and is used for treating constipation.

Utilized for the treatment of skin diseases, abdominal pain, fever and lepro(Pawar et al., 2017).

Flower

It is used for treating fever, leprosy, and stomach pain and skin illnesses. It has laxative and wound recovering potential. Its extract is used to deal with stomach problems. Utilized to cure skin illnesses, stomach torment, fever as well as leprosy.

Fruit

It issued for treating leprosy, fever, stomach problems and skin diseases. Used for the treatment of skin illnesses, stomach discomfort, fever and leprosy.

Root

It is helpful against cardiovascular disorders, wounds and ulcers, rheumatic condition, tubercular organs and different skin illnesses. Valuable in contradiction of cardiovascular disarranged nausea (Deshpande et al., 2013).

Pulp

It is utilized in the treatment of malaria, black water fever and as an anti-pyretic. It is safe as laxative for kids and pregnant ladies and is also used in liver disorders, biliousness and rheumatism (Sunil et al., 2012).

Leaves

They possess the property to recover constipation.

Diabetes, joint and muscle pain (rheumatism).

Pink eye

Urinary tract diseases

Liver diseases

Skin health

Ayurvedic Medicine Uses

In Ayurvedic medicine, the Golden Shower Tree is known as "disease killer". Its fruit pulp is used as a mild laxative as well as cardiac conditions and stomach problems such as acid reflux. Flowers used for fever, root as a diuretic. The bark and leaves are used for skin diseases. The seeds are recognized as antibilious, aperitif, carminative, and laxative while the root is used for curing adenopathy, burning sensations, leprosy, skin diseases, syphilis, and tubercular glands. The leaves of the tree is used for erysipelas, malaria, rheumatism, and ulcers, the buds are used for biliousness, constipation, fever, leprosy, and skin disease and the fruit for abdominal pain, constipation, fever, heart disease, and leprosy. Thus, every part of this plant is recognized for its medicinal properties. The plant is being considered as a firewood source in Mexico. The reddish wood, hard and heavy, hypoglycemic activity on normal albino rats but not on alloxan produced diabetic albino rats, strong and durable, is suited for cabinetwork, farm implements. The bark has been employed in tanning, often in conjunction with avaram. The drug "Cassia fistula", a mild laxative, is obtained from the sweetish pulp around the seed (Grover et al., n.d.).

Pharmacogenetic Studies

A detailed study of all of *Cassia fistula* has been carried out *Cassia fistula* is a deciduous, ornamental tree with yellow golden flowers. Stem (trunk) is straight. When it is young, the bark is pale which turns into black on aging, Leaves are pinnate (Bhakta et al., 1998).

Habitat

Plants can withstand up to the precipitation level 480-2720 mm and temperature 18-28.5 Cat 5.5 -8.7 pm.

It can tolerate the period of drought.

Flower

Flower is golden yellow, racemes pendulous, glamorous (smooth), abolicent and 4-7 in diameter. Calyx is long (it is divided to base), blooming and oblong segments. Corolla (petals) are yellow.

Fruit

Leguminous with a sharp smell and several seeds embedded in it. Visionary It is a green door and turns into a dack on ripening. When flowers shed, ripening of pods occurs. Mucilaginous pulp is dark brown in color. It is sweet and sticky with a characteristic smell. Secondary metabolites (phytochemicals) occur in the form of flat or curved and thick pieces. Their outer surfaces are rough with inner smooth surfaces. Colors show variation from gray to red with reddish marks and characteristic taste. Pods are pendulous. Internally the pods are divided into segments internally. Each segment contains one seed. Each seed is present transversally embedded in dark sweet pulp. Seeds are ovate, broad and thick, yellow-colored embryos, embedded in white endosperm

Root

Root is brownish red. It has lenticels on horizontal pattern and rough externally. We can easily rub off the outer bark to expose the inner bark which is light pink in color. Porosity is characteristic of the wood, irregular and yellow in color (Reddy et al., 2018).

Stem

Externally old stem is dark brown or grayish white and rough but at the young stage, the external layer of the stem is compact having 0.2-inch thickness, smooth, greenish to pale gray wood shows porosity and off white in color.

Wood

Wood can be discussed in three forms: Sap wood, heart wood and timber. Timber is shiny, very strong, brittle, very small in dimensions, used in agricultural tools and construction of carts. It has the ability to split. Heartwood shows variability in color like yellowish red to brick red to brownish red with streaks darker in color. Annual rings are very distinctive. Sap wood is pale or dirty white (Iyengar et al., 1966).

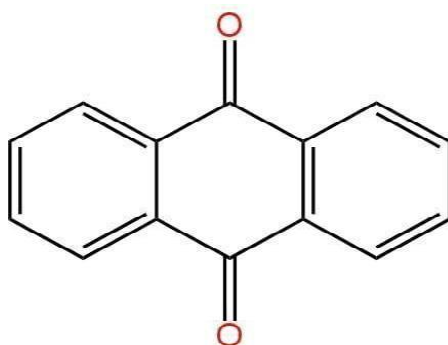
Phytochemical Constituents

The plant is widely used in traditional Indian medicinal systems reported to possess hepatoprotective, anti-inflammatory, antitussive, and antifungal, antibacterial and to improve wounds healing (Sikri et al., 2019). It is a rich source of tannins, flavonoids and glycosides, carbohydrates, linoleic, oleic, stearic, oxalic acids, tannins, oxy anthraquinones, anthraquinones derivatives. *Cassia fistula* contains rein glycosides fistula acids, sennosides A, B, anthraquinones, flavonoid-3-ol- derivatives, cetyl alcohol, kaempferol, anthraquinone glycosides, fistula, essential oils, volatile components, phytol (16.1%), 2-hexadecane (12%), crystals and 4-hydroxy benzoic acids hydrate (Aftab et al., 2019).

Table 3 Phytochemical present in *Cassia Fistula*

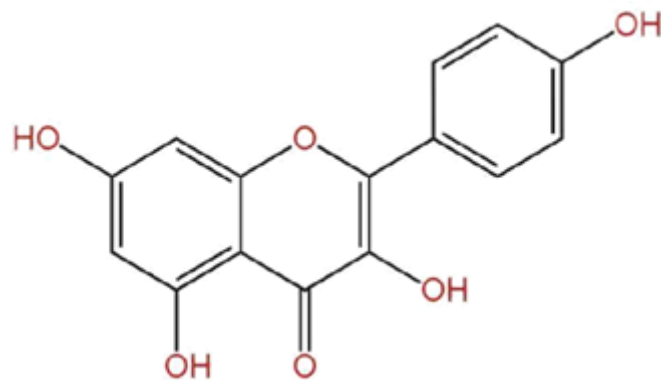
Part	Chemical Constituents	References
Bark and heart wood	Barbaloin and rhein, fistucacidin, waxy and resinous derivatives, Kaempferol, leucopelargonidin tetramer (with free glycol unit), fistulin procyanidin, lepeol	(Al-Marzoqi et al., n.d.; Hafez et al., 2019)
Sap wood	Leucoanthicyanidin-5, 4- dihydroxy flavan, hexacosanol, tannins and B-sitosterol	(Rudrappa Harisha et al., 2011)
Leaves	Rhein and its glycoside sennosides A, sennosides B, physcion, leucine	(Anitha et al., 2014)
Stem bark	Lupeol, B-sitosterol, hexacosanol tannin, saponins, terpenoids, reducing sugar and steroids	(Bahorun et al., 2005)
Pod	Rhein glycoside and fistulic acid, malvalic acid, fistulic acid, 3-formyl-1-hydroxy-8-methoxy anthraquinones	(Zafaryab et al., 2012)

Flowers	Cetyl alcohol, fistulin, rhein dianthroquinone glycoside, Kaempferol, anthraquinones, bianathraquinone and glycosides basic oils	(Ashraf Ali, 2014)
Fruit pulp	Protein, carbohydrates, arginine, leucine, methionine, carbohydrates (26.3%), arginine, protein (19.9%)	(Wijaya et al., 2000)
Seeds	Galactomannam composed of D - galactose and D – mannose, sterculic acid and vernolic oil	(Pawar et al., 2012)
Plant	Seven bioflavonoid and two triflavonoids, fistulin, unstable segments, phytol (16.1%), precious stones, 4-Hydroxy benzoic corrosive	(Danish, Singh, Mishra, & Srivastava, 2011)



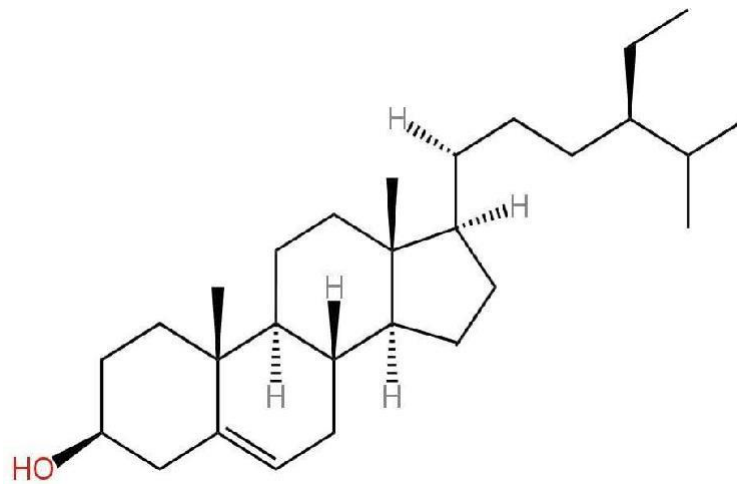
(i)

Anthraquinone



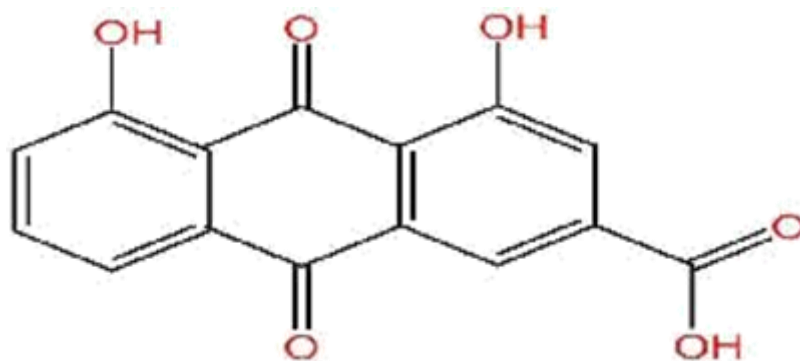
(ii)

Kaempferol



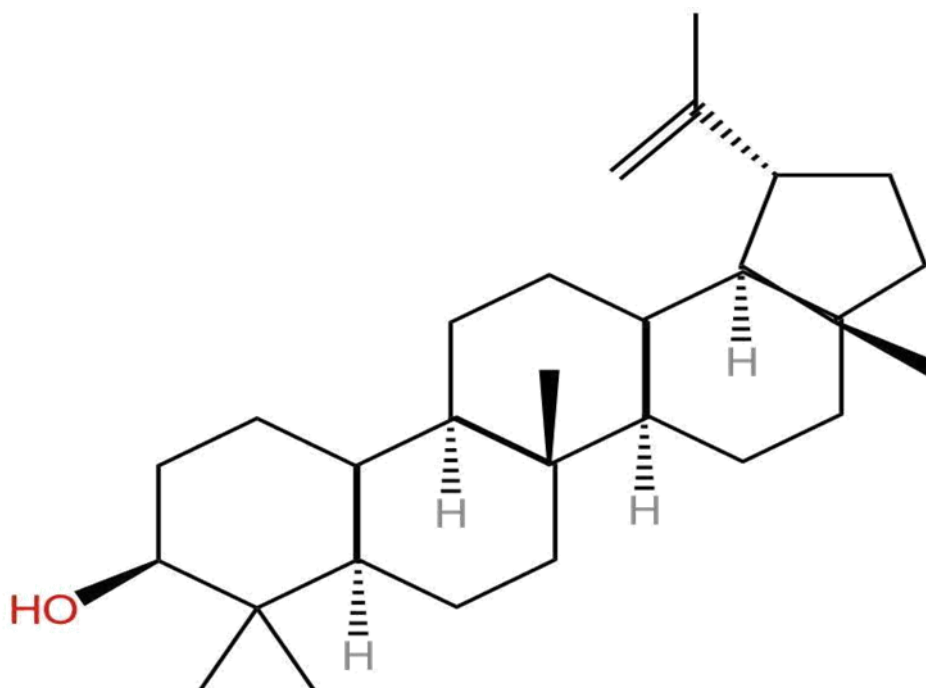
(iii)

Beta sitosterol



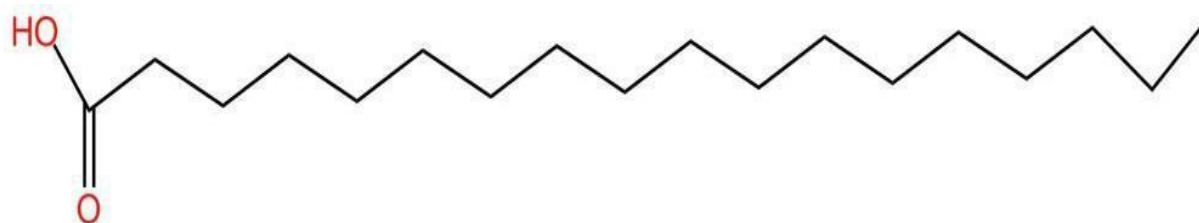
(iv)

Rhein

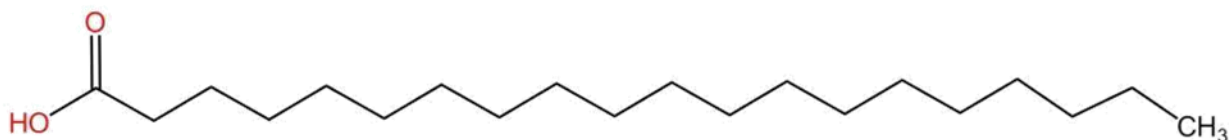


(v)

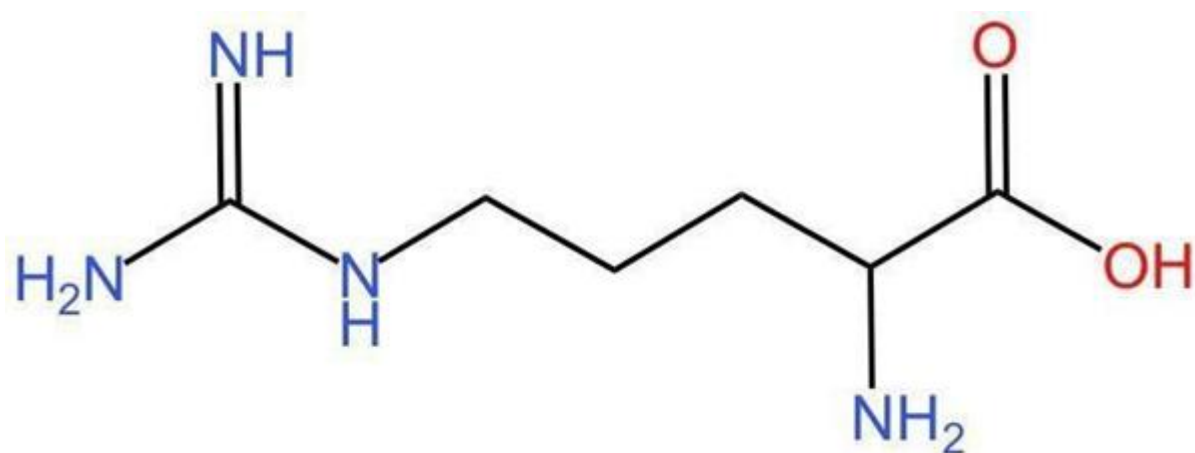
Lupeol



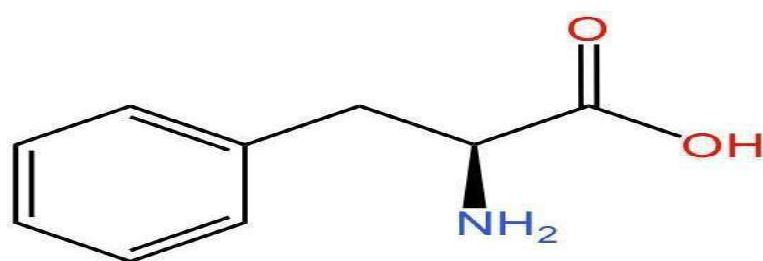
(vi)
Stearic acid



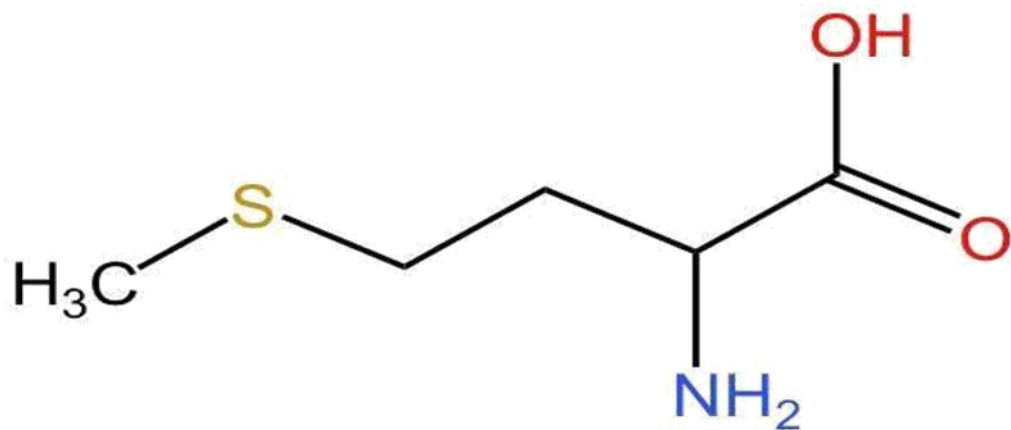
(vii)
Arachidic acid



(viii)
Arginine

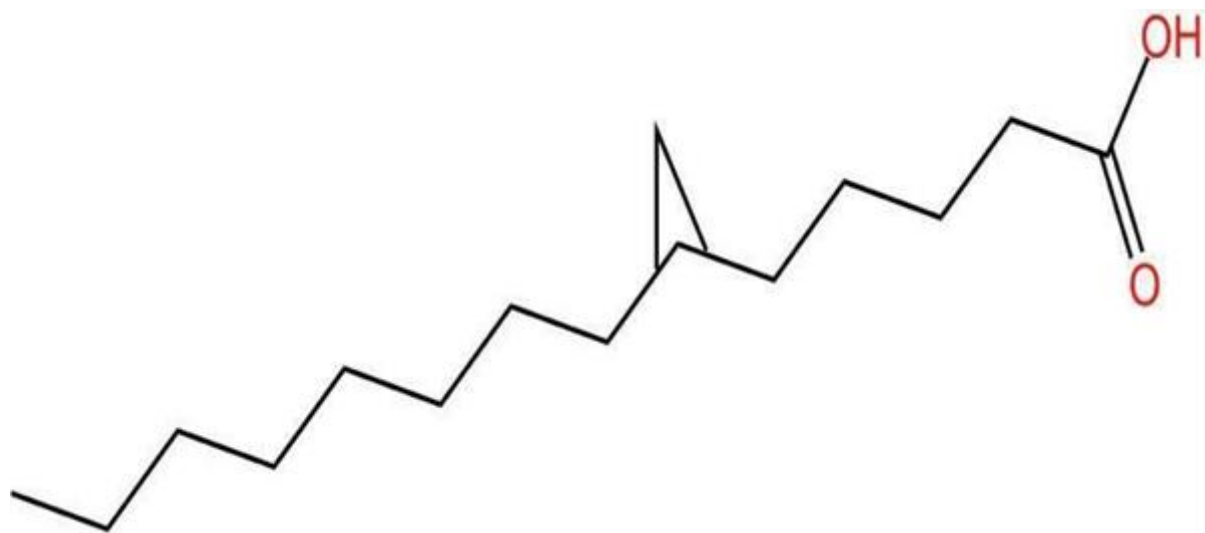


(ix)
Phenylalanine



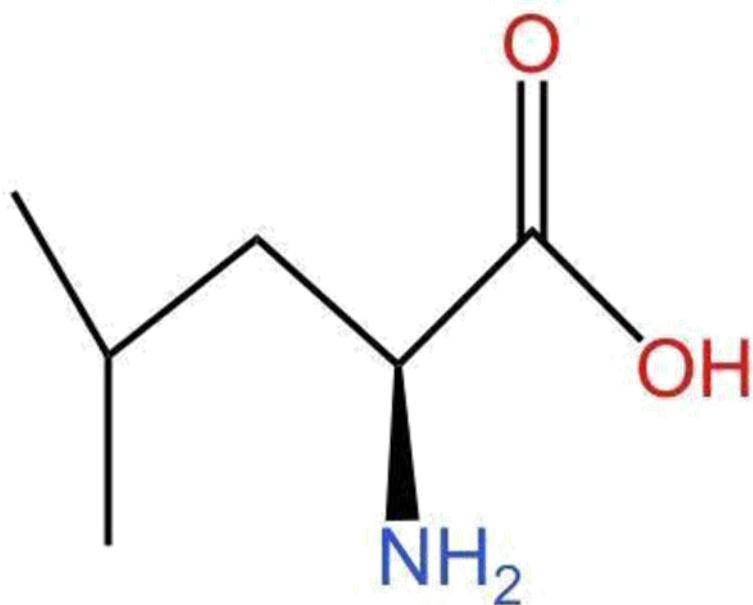
(x)

Methionine



(xi)

Malvalic acid



(xii)

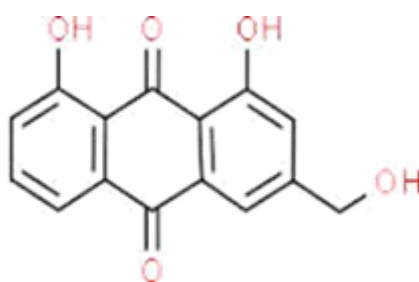
Leucine



(xiii)

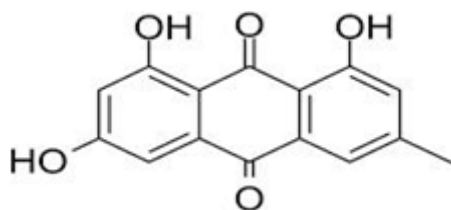
Heosano

1



(xiv)

Aloe emodin



(xv)

Emodin

Fig.4. Chemical structure of main Anthraquinone, Kaempferol and Rhein, Beta sitosterol fistucacidin derivatives of *Cassia fistula*.

Pharmacological Activities of *Cassia fistula*

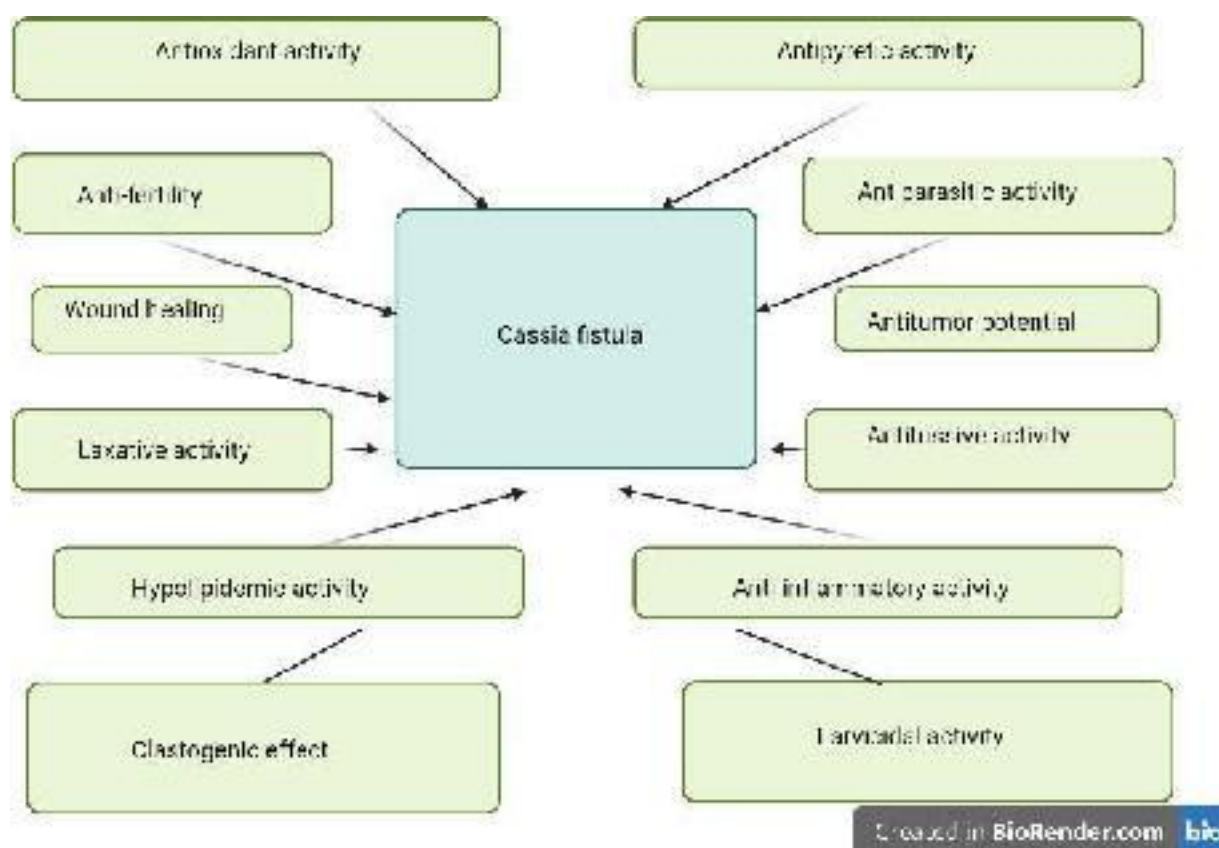


Fig.5. Pharmacological Activities of *Cassia fistula*

Antipyretic activity

The *Cassia fistula* pod was found to be devoid of antipyretic activity in experimental models. The pods extracts showed a marked antipyretic effect by causing a reduction in yeast-induced fever. The extract caused a better hypothermal activity against yeast-induced pyrexia in rats. Subcutaneous injection of yeast induced pyrexia by increasing synthesis of prostaglandin and is used to screen (Duraipandiyar & Ignacimuthu, 2007).

Antitussive activity

The methanol extract of *Cassia fistula* was investigated for its effect on a cough model induced by sulfur dioxide gas in mice. It exhibited significant antitussive activity when compared with control in a dose dependent manner (Sartorelli et al., 2007).

Anti-inflammatory activity

The anti-inflammatory activities of the aqueous (CFA) and methanolic extracts (CFM) of the *Cassia fistula* bark were assayed in Wistar albino rats. The extracts were found to possess significant anti-inflammatory effects in both acute and chronic models (Ilavarasan et al., 2005).

Wound Healing

Infection is the major problem to treat the wound. Antibiotic resistance by the pathogenic microorganism renders the drug ineffective. The alcohol extract of *C. fistula* leaves was analyzed for antibacterial effect against *Staphylococcus aureus* and *Pseudomonas aeruginosa*. *Cassia fistula* treated rats showed better wound closure, improved tissue regeneration at the wound site, and supporting histopathological parameters pertaining to wound healing, and thus confirming efficacy of *Cassia fistula* in the treatment of the infected wound (Ferdosi et al., 2021).

Antipyretic potential

The extract of *C. fistula* buds prepared in methanol was assessed for its antipyretic properties and effects on standard body temperature as well as pyrexia (fever) induced using yeast on rats using the two experimental groups. The two groups were given methanol extract at a dosage of 200–400 mg/kg body

weight. At the level of 200 mg/kg dosage, the methanolic extract triggered a significant decrease in the optimal temperature in the body for a period of 3 h. At a dose of 400 mg/kg, the extract triggered remarkable reduction in the normal temperature in the body for a period of 6 h following administration. For the experimental group of rats that were yeast-provoked to elevate the body temperature, the *C. fistula* extract exhibited a dose-dependent decrease of the temperature for a period of 4 h for the two doses. The results from their study correlates those obtained using paracetamol, the standard agent with antipyretic effects. In another study, assessed the antipyretic activities of *C. fistula* pods. Their results established that pod extract prepared in methanol exhibited antipyretic properties that were significantly higher compared to the untreated groups (Dave & Ledwani, 2012).

Antioxidant activity

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. Thus, the stem bark had more antioxidant activity (Tari et al., 2012).

Anti-fertility

Cassia fistula reversibly suppresses fertility in male rats. Withdrawal of extract restored all the altered parameters, including organ weights, fertility, circulatory level of hormones and tissue biochemistry, to control levels after 120 days. Oral administration of aqueous extract of seeds of *Cassia fistula* to mated female rats from day 1- 5 of pregnancy at the doses of 100 and 200 mg/kg body weight resulted in 57.14% and 71.43% prevention of pregnancy, respectively, whereas 100% pregnancy inhibition was noted at 500 mg/kg bw. (Asif et al., 2017).

Anti-leishmaniac activity

The effectiveness of *Cassia fistula* in the treatment of leishmaniasis, the efficacy of concentrated boiled extract and hydroalcoholic extract of *C. fistula* on leishmaniac was compared with intraregional injection of Glucantime (meglumine antimonite) in this study. Results indicate that the *C. fistula* fruit gel increases the efficacy of intraregional meglumine antimonite for the treatment of cutaneous leishmaniasis. Combination therapy with intraregional meglumine antimonite and *C. fistula* fruit gel should be considered for the treatment of acute cutaneous leishmaniasis (Tanveer et al., 2019).

Clastogenic effect

Anthraquinone glycosides of *Cassia fistula* were investigated for their ability to induce a Clastogenic effect on the bone marrow cells of Swiss albino mice. The endpoints screened were chromosomal aberrations and frequency of aberrant cells. Oral exposure to doses of these anthraquinones and their equivalent amount in leaf and pod extracts did not induce significant numbers of chromosomal aberrations or aberrant cells. The results indicate that Anthraquinone sennosides B and rhein are weakly genotoxic. Pure sennosides B and rhein were weakly Clastogenic. Crude extracts of *C. fistula* (leaves and pods) each containing sennosides B and rhein were also weak clastogens. The CA/cell and % DC were lower than those induced by an equivalent amount of pure sennosides B. Therefore, these phytolaxatives do not behave as potent clastogens and pods or leaves of *C. fistula* can be used as an alternative source of sennosides (Garima & Rashmi, 2019).

Antitumor potential

Cancer diseases have become a huge burden and a leading cause of death around the globe and particularly in third world countries. Due to changes in lifestyles as well as eating habits along with accessibility of therapeutic treatment for numerous communicable diseases, cancer is beating other illnesses as a topmost cause of indisposition and mortality even in technologically advanced countries. Chemo- therapy, radiotherapy, and surgery that are reputable modalities for therapy to manage various cancers are expensive, mutilating, and are associated with grave side effects. These therapy modalities are likewise connected to residual morbidity as well as recurrent relapses. A study was done to determine the activities of methanolic extract of *C. fistula* seeds on the lifespan of mice with tumors as well as the Ehrlich ascites carcinoma growth. The results of Irshad et al. indicated that the extract prolonged the lifespan, reduced the volume and size of the tumor in addition to decreasing the number of viable cells with tumors. Cytological studies likewise showed reduction of mitotic activity in addition to decrease of the vacuoles in the intra-cytoplasm alongside membrane blebbing on the treated cells bearing tumors. There was improvement on hematological parameters after treating the tumor cells using methanolic extract. These hematological parameters comprised of red blood cells counts, cell count on bone marrow as well as the content of hemoglobin of the mice with tumor bearing cells. The

results of this study propose that the extracts of seeds of *C. fistula* prepared using methanol could be used to treat cancerous cells, because they have antitumor effects.

An investigation was conducted by Duraipandiyar et al. on adenocarcinoma cell line found in human colon including COLO 320 D to test the anticancer potential of rhein, isolated and purified from *Cassia* species as an anthraquinone. The results indicated that rhein was cytotoxic at a 200 µg/ml concentration and the cytotoxicity improved with extended incubation in which after 72 h of incubation, they observed 80.25% cytotoxicity. Rhein repressed the proliferation of the cells using a mechanism that appears to take in directly the mitogen activated protein (MAP) kinase pathway. An amount of 1 µ/ml of rhein significantly curtailed proliferation of cells accompanied by MAP kinase activation. Rhein has an inherent capacity to avert DNA damage using anti-Rhein lysinate that suppresses the growth of cancer cells in the breast. In addition, performed a different study to assess the anticancer properties of various fruit extracts of *C. fistula* on cell lines such as breast cancer and human cervical cancer. Their results indicated that seeds and pulp suppressed the two cancer cell lines and up-regulated the p53 and Bax genes, down-regulated the Bcl-2 gene as well as increasing caspase-3, 7 & 10, and the activities of nine enzymes. Moreover, Al-fatlawi et al. reported that Rhein inhibited the growth of cancerous cell lines including hepatocellular carcinoma (HepG2), human cervical cancer (SiHa) along with breast adenocarcinoma (MCF-7), in a fashion that was dose-dependent (Maity et al., 2009).

Laxative activity

Cassia fistula infusion on isolated guinea-pig ileum. The acute and sub-chronic toxicity of the infusion of *C. fistula* and *Cassia acutifolia* sp. Del. Pod-(Senokot tablet) as the reference drug were also determined. The results obtained for *C. fistula* infusion when compared with senokot tablet showed that the infusion of *Cassia fistula* pods possessed very low levels of toxicity, having the LD50 of 6600 mg/kg and also without any pathological effects on the organs examined microscopically. It is therefore concluded from the study that *C. fistula* pod infusion could be safely utilized as laxative drugs and as a substitute for the official Senna (Rizvi et al., 2015).

Larvicidal activity

Cassia fistula (at 0.5, 1.0 and 2.0%, topically applied) was evaluated on the viability and hatching of eggs (0, 1 and 3 days old) of *D. koenigii*. Application of leaf extracts of the plant inhibited hatching of the eggs, and increasing concentration of the extract resulted in increased non-viability of 3-day-old egg reported the methanolic leaf extract of *Cassia fistula* was tested for larvicidal and ovicidal activity against *Culex quinquefasciatus* and *Anopheles stephensi*. The extract was found to be more lethal to the larvae of *A. stephensi* than *C. quinquefasciatus* with LC50 values of 17.97 and 20.57 mg/l, respectively. Mean percent hatchability of the ovicidal activity was observed 120 h after treatment. The percent hatchability was inversely proportional to the concentration of extract and directly proportional to the eggs. The egg raft of *C. quinquefasciatus* was found to be more hatchable than *A. stephensi*. The results show that the leaf extract of *C. fistula* is promising as a larvicidal and ovicidal agent against *C. quinquefasciatus* and *A. stephensi* (Karthikeyan et al., 2010).

Hypocholesterolemia and hypoglycemics activity

Hypocholesterolemia and hypoglycemic effects of the hexane extract of stem bark of *C. fistula*, in normal and streptozotocin induced diabetic rats. Hexane -1 extract of *C. fistula* bark at doses 0.15, 0.30, 0.45 g/kg body weight for 30 days suppressed the -1 elevated blood glucose levels in diabetic rats. The extract at 0.45 g/kg was found to be comparable with glibenclamide, the reference drug. The lipid profile (total cholesterol, triglyceride, HDL-cholesterol, LDL and VLDL-cholesterol) after the extract treatment at 0.45 g/kg body weight showed remarkable improvement compared to the diabetic control animals. Antioxidant and polyphenol content present in the extracts might contribute to the antihyperglycemic and antilipidemic properties. Thus, the results suggest that *Cassia fistula* barks would be effective in the treatment of diabetes and in prevention and management of coronary artery diseases (Li et al., n.d.).

Antiparasitic activity

The extract of *Cassia fistula* fruits (Leguminosae) led to the isolation of the active isoflavone biochanin A, identified by spectroscopic methods. This compound showed 50% effective concentration (EC50) value of 18.96 micro g/mL against promastigotes of *Leishmania (L.) chagasi*. The cytotoxicity of this substance against peritoneal macrophages resulted in an EC50 value of 42.58 micro g/mL. Additionally, biochanin A presented an anti- *Trypanosoma-cruzi* activity, resulting in an EC50 value of 18.32 micro g/mL and a 2.4-fold more effectiveness than benznidazole (Irshad et al., 2011).

Hypolipidemic activity

Cassia fistula legume on serum lipid metabolism in cholesterol fed rats. Oral feeding of cholesterol (500 mg/kg b.wt./day) dissolved in coconut oil (0.5 ml/rat/day) for 90 days caused a significant ($P < 0.001$) elevation in total and LDL-cholesterol, triglycerides and phospholipid in serum of rats. Administration of *C. fistula* legume extract at the doses 100, 250 and 500 mg/kg b.wt./day along with cholesterol significantly prevented the rise in the serum total and LDL-cholesterol, triglycerides and phospholipid in a dose dependent manner. The ratio of HDL-cholesterol/total cholesterol ratio was elevated in serum of *C. fistula* extract treated groups as compared to cholesterol alone fed control rats (Morshed et al., 2012).

4. Conclusion

Before the modern medicines were introduced, herbal remedies exclusively managed treatment and management of various diseases. It is projected that roughly 80% of the population around the globe who reside in the extensive rural areas in the underdeveloped and developing nations still depend largely on medicinal plant species and their products. *Cassia fistula* is a medicinal plant traditionally used largely in India and other nations and has colossal potential for wound healing, anti-oxidant and hepatoprotective properties. The plant species is extensively used in medicinal systems around the world and various studies have-reported that the plant species contain anti-inflammatory, Hepato Protective, antitussive, antibacterial, anti-fungal properties and similarly used for healing of wounds. It is clearly known as an excellent source of glycosides, tannins, and flavonoids, which might be medically imperative or/and nutritionally valuable. From literature described above, it is established that *C. fistula* possess different therapeutic properties which can be manipulated particularly in the treatment of gastrointestinal illnesses. Many investigations confirm that *C. fistula* is a valuable herbal plant for managing hepatic conditions and demonstrates other medical properties. From various studies, extracts of *C. fistula* have therapeutic active ingredients. However, more studies should be carried out to sufficiently assess the potential efficacy of the different extracts derived from *C. fistula*. The information in this article provides a basis upon which selection of specific plant species to investigate the prospective discovery of novel natural bioactive compounds can be based on.

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