



A Phytopharmacological Evaluation of *Cassia fistula*. A Comprehensive Review

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ABSTRACT

The aim of this study is to provide a comprehensive and recent review on *Cassia fistula*'s traditional medicinal uses, pharmacognostical studies, Phytochemical profile and pharmacological activities. *Cassia fistula* (Amaltas), a golden shower tree belongs to Leguminosae family with 8-15 m height. *Cassia fistula* stem is greenish grey, reddish brown root, compound leaf, 3-8 pair of leaflets, cylindrical pods and ovoid seeds. Phenol, alkaloids, lipids, proteins, flavonoids and carbohydrates are bioactive constituent of *Cassia fistula*. It is more significant in curing different ailments and acts as antifungal, antibacterial, analgesic, hepatoprotective, anti-inflammatory etc.

Keywords: *Cassia fistula*, Traditional uses, Phytochemicals, Pharmacognosy, Pharmacological activities.

INTRODUCTION

Natural plants are the nature's gift having medicinal importance. They help the humans to lead healthy life. Those plants who are wider in distribution help us lot for the remedy of different diseases. Here some traditional systems are Siddha, Ayurveda and Homeopathy Unani. Traditionally many plants are being evaluated and used. One of them is *Cassia fistula*.

Cassia fistula is a flowering plant belongs to sub family Caesalpiniaceae of the leguminous family (Fabaceae) commonly known as Amaltas. Out of the 400 species, it is one that 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, Sri Lanka *Cassia fistula* is used traditionally for the treatment of many diseases but now scientific research enables us to explore the hidden secondary metabolites and their role towards the organisms (pharmacological activities).¹⁻²

Distribution

Cassia fistula L. (family Leguminosae) commonly known as Golden Shower (English), Amaltas (Hindi), purging cassia, India laburnum, pudding pipe tree (English). It is deciduous plant. It is used as ornamental tree due to its yellow colored beautiful flowers. Height is about 25 to 30 feet. It is distributed sub-tropical regions of the world west Indies to India. It is found as forest at outer Himalaya 1300m ascending.³

Botanical Description.

The leaves are 1 to 1.5 m long, alternate, pinnate. Leaflets 7 to 15 cm long and 2.5 to 3 cm in width. *Cassia fistula* has cylindrical fruit which is pendulous septate and brown. The length of the fruit is about 25 to 45 cm in diameter is about 1-3 centimeter. Deciduous means that they shed their

leaves annually. Seeds are reddish brown in color and lenticular in texture. The stem Bark is brown in color.⁴

Synonyms

Cassia exceisa kunth

Vernacular names of cassia fistula

Telegu *Kondrakayi, iRaelachettu, Aragvadamu, Koelapenna*

Sanskrit *Nripadruma*

Arab *Khayarsambhar*

Oriya *Sunaari*

Punjabi *Amaltaas, Kaniyaar, Girdnalee*

Bengali *Bundaratati, Sonalu, Soondali, Sondal*

English *Indian Laburnum, Purging, Cassia fistula, Golden Shower.*

Guajarati *Garmala*

Hindi *Sonhali, Amultus*

Kannad *Kakkemara*

Marathi *Bahava*

Tamil *Shrakkonnai, Konai, Irjviruttam*

Classification

Species: *Cassia fistula*

Genus: *cassia*

Order: Fabales

Family: Fabaceae

Kingdom: plantae



TRADITIONAL USES

Traditionally *Cassia fistula L.* used to treat heart disorders, pruritic, leukoderma, as a laxative, purgative, abdominal lump, metabolic disorders and tuberculosis. It is used as broad spectrum anti-microbial agent, hematemeses, having scavenging properties against free radicals, uterine and menstrual disorder thoracic obstructions, skeletal features, cure of burns, depression, dysuria as well as extract is used for pest control. The root is used as purgative and laxative. It is used as a remedy for fever, retained excretions, and biliousness, joints pain, chest pain, dysentery, migraine, hyperglycemia. Leaves extract can be used for the black wart fever, rheumatism, ring worms, eczema, these are also act as anti-tussive, wound healer, having hypoglycemic activity and erysipelas. Seeds are effective in treatment of jaundice, swollen throats and oral sores. Seeds are slightly sweet used as cooling, carminative, laxative and used to treat swollen throats, skin diseases and biliousness. Bark used as anti-inflammatory, antioxidant and antidiabetic drug. Pulp used as antipyretic, antifungal, antiviral, anticandidal, leprosy, diabetes, abdominal, urinary disorders, obstruction and hepatoprotective. Pods are used as antipyretic and to treat diabetes mellitus as well as laxative. Extract of a fruit is used as estrogenic and antiestrogenic, also used as purgative and antifungal drug. It is also known as killer of disease. *Cassia fistula* is also effective against tuberculosis.^{1,3-18}

Synergistic effect

Solanum xanthocarpum and *Cassia fistula* show synergistic effect.¹⁹ They show anti-inflammatory activity at very low concentration of medicine. *Cassia fistula* as Amoxy-cassia were used to increase the immunity of the host traditionally.¹⁷ *Cassia fistula* and fluconazole show synergistic effect.²⁰

PHARMACOGNOSTIC STUDIES

A detail study of all of *Cassia fistula* has been carried out parts. *Cassia fistula* is deciduous, ornamental tree with yellow golden flowers. Stem (trunk) is straight. When it is young, the bark is pale which turn into black on ageing. Leaves are pinnate.

Habitat

Plants can withstand up to the precipitation level 480-2720 mm and temperature 18–28.5 ° C at 5.5 -8.7 pH. 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 sharp smell and several seeds embedded in it. Visionary it is green pod and turn into black on

ripening. When flowers shed, ripening of pods occurs. Mucilaginous pulp is dark brown in color. It is sweet and sticky with characteristic smell. Secondary metabolites (phytochemicals) occurs in a form of flat or curved and thick pieces. Their outer surfaces are rough with inner smooth surfaces. Color show variation from grey 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 embryo, embedded in white endosperm.

Root

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

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 grey 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 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.²¹

Phytochemistry

Various researchers explore different chemical constituents in *cassia fistula* which are as follows.

Whole plant

It contains Citronelol, leinoleic acid, anthroquinone, alloin wax, phenolic compounds, free sugar, galactoman, free aminoacids, saponin, gum cardiac glycosoids, alkaloids, glycosoids, kemferol, emodinII, iron, calcium, phosphate, resins, tannins, steroids, terpenoids, rhein, sennoside A and B¹ Flavan 3-ol derivatives.²²⁻²³

Root

Root has been analyzed to have rhonthocyanadin. Flavan 3-ol derivatives, flavanoids, 7-methylphysicon, betulinic acid and Bsitosterol, rhamnetein, 3-Ogentiobioside. Root bark contains phloba phenes and oxyanthroquinone.^{3,24}

Flower

Anthroquinone, oxyanthroquinone, rhein, volatile oil, tannins, isoflavanoids, glycosoids, phenolic compounds, potassium, calcium, iron, manganese. A bianthraquinone, glycoside, fistulin together with kaempferol and rhein, proanthocyanadins, catechins tannins, fistulic acids,



anthrones, sennosides, alkaloids, Aurantiamide acetate, Bsitosterol, B D Glucoside and triterpenes.^{3,5,24-27}

Fruit extracts and pulp, pulp powder and pods

Phytochemicals present are rhein, 5, 3, 4-trihydroxy-6-methoxy-7-O- α -L-rhamnopyranosyl-(12)-O- β -D-galactopyranoside.²⁴ Four new compounds, 5-(2-hydroxyphenoxymethyl)furfural, (2'S)-7-hydroxy-5-hydroxymethyl-2-(2'-hydroxypropyl) chromone, benzyl-2-hydroxy-3,6-dimethoxybenzoate, together with four other compounds two oxy anthroquinon, 5-hydroxymethylfurfural, (2S)7-hydroxy-2-(2-hydroxy propyl)-5-methyl chromone, steroid, amino acid, flavanoids, a spartic acid, glutamic acid, lysine.⁴ A polar compound including, triacontane, 16-hentriacontanol, sitosterol 5-nonatetracontanone, 2-hentriacontanone along with an oil (probably an isoprenoid unit), tetramer, alloin, leucopelargonidin tonic.^{8,18}

Flavanoids, phenolic compounds, proanthocyanadins such as epiafzelechinsa, procyanidines B-2 as secondary metabolite, sennosides, anthrones, L1 (Hexane), L2(CHCL3), L3CHCL3, L4, sennoside A and B barbaloin, aloin, formic acid, butyric acid, oxalic acid, ethyl ester, tannin and pectin.^{3,15,24,28-29} Pulp also contain sugar, albuminous starch, oxalate of calcium, sugar, gum, astringent matter gluten, water, coloring matter.³ The pods contain 5-nonatetracontanone, 2-hentriacontanone, diterpene, 3-beta-hydroxy-17-norpinar-8(9)-en-15-one, nonatetracontanone, 2-hentriacontanone, triacontane, 16-hentriacontanone, and B sitosterol, kempferol, dihydrokaempferol, quercetin derivatives, an anthraquinone derivative, characterised as 3-formyl-1-hydroxy-8-methoxy-anthraquinone was isolated.¹⁸ Diterpenes, Edible fruit tissue contains potassium, calcium, iron, manganese and also of aspartic acid, glutamic acid and lysine amino acids 1,8-dihydroxy-3-anthraquinone carboxylic acid.^{18,24} Proanthocyanidins containing flavan-3-ol (epiafzelechin and epicatechin) observed in pods together with the common flavan-3-ols and proanthocyanidins like catechin, epicatechin, procyanidin B-2 and epiafzelechin alloin and tonic.^{24,30} Alkaloids, flavanoids, tannins, steroid, terpenoid, anthroquinone.³¹

Leaves

Leaves contain isozanin, rifampicin flavonoids, steroids, triterpenoids, anthroquinone, rhein volatile oils both in aglycone and glycoside forms such as rhein, sennosides, chrysophanic, aloe-emodin and sennosides, (-)-epiafzelechin 3-O- β -D-glucopyranoside biflavonoids and two triflavonoids together with (-)-epiafzelechin, (-)-epicatechin and procyanidin B-2 from the leaves, L1(Hexane), L2(CHCL3), L3CHCL3, L4, sennoside A and B.^{2,5,24,32-33} The cuticular wax of leaves contain hentriacontanoic, triacontanoic, nonacosanoic and heptacosanoic acids.³ The leaf oil composed only seven components identified as eugenol, (E)-phytol, camphor, limonene, salicylic alcohol (linalool and 4-hydroxybenzyl alcohol. Four new compounds as 5-(2-

hydroxyphenoxymethyl) furfural, (2'S)-7-hydroxy-5-hydroxymethyl-2-(2'-hydroxypropyl) chromone, benzyl 2-hydroxy-3,6-dimethoxybenzoate, and benzyl 2 β -O-d-glucopyranosyl-3,6-dimethoxybenzoate, together with four known compounds, 5-hydroxymethylfurfural, (2'S)-7-hydroxy-2-(2'-hydroxypropyl)-5-methylchromone are present.¹⁸

Seeds

Galactomann, amino acid freesugar¹, iron, anthroquinon, gum, alkaloids, glucosoid saponins, phosphate, sodium, Resin⁴, terpeoids, dianthroquinone, sennoside A, Sennoside B, fistulic acid, ceryl, alcohol, kaempferol, bianthroquinone, tannins, fatty acids isoflavanoids, flavanoids, glycosoids, vanthroquinons, steroids, terpenoids and phenolic compounds⁹, glycerides with linoleic, oleic, stearic and palmitic acid, globulin, albumin, cephalin, lecithin, phospholipids, carbohydrates, lecithins are sugar binding proteins that agglutinates cells, proteins²⁵, proanthocyanadins, Terpenoids and steroids, with typical sterols such as stigmasterol, β -sitosterol, campesterol, fucosterol, lathosterol and ergosta-4,22-dien-3-one. Other typical compounds were 5-(4,8-dimethylnonyl)-5-methyl dihydro-2 (3H)-furanone, tetramethyl-hexadeca-1,6,10,14-tetraen-3-ol, 3-(6-hydroxy-3,7-dimethyl-octa-2,7-dienyl)-4-methoxy-phenol, and 2,5-furandione, 3-dodeceny, which were present in the seed oil.^{1,3,34-35,37} The seed oil contains cyclopropenoid fatty acids, vernolic, malvalic and stercularic acids.³ Seeds are rich in glycerides with linoleic, oleic, stearic and palmitic acids as major fatty acids together with minor traces of caprylic and myristic acids and carbohydrates like galactomann.¹² Chrysophanol, chrysophanein, oxyanthroquinone.^{12,18} Seeds contain Napins (protein) that has antifungal activity.³⁶

Bark

Two flavanol glycosides, 5, 7, 3', 4'-tetrahydroxy-6, 8-dimethoxyflavone-3-O- α -arabinopyranoside, 5, 7, 4'-trihydroxy-6,8,3'-trimethoxyflavone-3-O- α -L-rhamnosyl (1 \rightarrow 2)-O- β -D-glucopyranoside and a xanthone glycoside, Flavanoids, hexacosanol, β -sitosterol, lupeol, L1(Hexane), L2(CHCL3), L3CHCL3, L4, tannins contain phlobaphenes, oxyanthraquinone, 1,8-dihydroxy-3, 7-dimethoxyxanthone-4-O- α -L-rhamnosyl(1 \rightarrow 2)-O- β -D-glucopyranoside phenolic compounds, flavanoids, proanthocyanadin.^{3,24}

Twenty-seven compounds including eight long-chain hydrocarbons, 1-hexacosanol, 1-octacosanol, palmitic acid, stearic acid, oleic acid, linoleic acid, heptacosyl eicosanoate, glyceryl-1-tetraeicosanoate; three sterols, β -sitosterol, stigmasterol, β -sitosteryl-3-O-D-glucopyranoside, one triterpene, lupeol, eight anthraquinones, chrysophanol, emodin, physcion, citreorosein, rhein, rhein methyl ester, ziganein, 1,4,5-trihydroxyanthraquinone, two coumarins, isoscopoletin, scopoletin, three aromatic compounds, isovanillic acid, vanillic acid, and 2,4-dihydroxybenzaldehyde and two chromones, 2,5-dimethyl-7-hydroxychromone, 2,5-



dimethyl-7-methoxychromone, isolated and identified from the bark.

Flower pollens

Phenylalanine, methionine, glutamic acid and proline, carbohydrate, lipid and free amino acid were observed.

Heart wood

Fistucacidin, an optically inactive leucoanthocyanidin (3,4,7,8,4'-pentahydroxyflavan) was first extracted from the heartwood.¹⁶

Arial parts

Twenty-seven compounds including eight long-chain hydrocarbons, 1-hexacosanol, 1-octacosanol, palmitic acid, stearic acid, oleic acid, linoleic acid, heptacosyl eicosanate, glyceryl-1-tetraeicosanoate; three sterols, beta-sitosterol, stigmasterol, beta-sitosteryl-3-O-D-glucopyranoside; one triterpene, lupeol; eight anthraquinones, chrysophanol, emodin, physcion, citreosein, rhein, rhein methyl ester, ziganein, 1,4,5-trihydroxyanthraquinone; two coumarins, isoscapoletin, scopoletin; two chromones, 2,5-dimethyl-7-hydroxychromone, 2,5-dimethyl-7-methoxychromone; three aromatic compounds, isovanillic acid, vanillic acid and 2,4-dihydroxybenzaldehyde were isolated and identified from the Arial parts of *Cassia fistula*.³

PHARMACOLOGICAL ACTIVITIES

ANTIMICROBIAL ACTIVITIES

Antibacterial activity

This study evaluated the antibacterial activity of purified lectins (CSL-1, CSL-2, CSL-3) from *Cassia fistula* seeds. 14 pathogenic bacteria were used for this purpose. Overall results showed that CSL-3 was much active against all bacteria specially *Bacillus megaterium*, *streptococcus*, *β-haemolyticus* and *Shigella boydii*. But mortality rate in brine shrimps was observed using CSL-2 proving it highly toxic (6.68 µg/ml) than other lectins.³⁵

Another study is to determine antibacterial activity of *Cassia fistula* (in Khuzestan, Iran) by using its methanolic and ethanolic extract against three Gram +ve bacteria and five Gram -ve bacteria by Disc diffusion method. *E. coli* and *K. pneumoniae* were much affected by extracts. Tube dilution assay was used for determination of minimum inhibitory concentration (MIC) and Minimum bactericidal concentration (MBC). Overall results confirmed presence of antibacterial agent in *Cassia fistula*.¹⁴

Antifungal activity

Flower of *Cassia fistula* was studied for its antifungal activity by using ethyl acetate extract against *Trichophyton mentagrophytes*, *Trichophyton simli*, *Trichophyton subrum* and *Epidermophyton floccosum*. Isolated Rhein prevent the growth of above-mentioned fungi with MIC value of 12.5 µg/ml, 62.5 µg/ml and 31.25 µg/ml respectively.²⁷

Antifungal activity of *Cassia fistula* was tested on *Candida* species. Phytochemical analysis of *Cassia fistula* oil, carried out by using gas chromatography coupled with mass spectrometry (GC-MS), revealed the presence of β-sitosterol, stigmasterol, ergosterol, betulinic acid, lupulol, fucosterol, friedelin and α-amyrin. MIC value of pulp and seed oil suggested the prevention of oil extract by ergosterol biosynthesis in cell wall of *Candida*. Active compound in *Cassia fistula* showed antifungal activity.³⁷

Cassia fistula leaves were investigated for antifungal activity by using crude methanolic extract against some pathogenic fungi. Results declared extract with IC₅₀ of 0.9 mg/ml that proved *Cassia fistula* potentially strong inhibitor against penicillium marneffeii fungi. As well as *Cassia fistula* effected conidial germination of *Murosporium gypseum* and caused collapsing and shrinking of hyphae and macroconidia.³⁸

In other study, Broth dilution and agar cup method was used to determine antifungal action of *Cassia fistula* by using petroleum ether, chloroform, ethanol, methanol and aqueous solvents against *Candida* and *Aspergillus* species. Favorable antifungal activity was shown by all extract against *Candida* species while maximum activity was evaluated in *Aspergillus* species by methanol followed by ethanol and aqueous extracts. So, it was concluded that treatment of candidiasis and aspergillosis proved effective antifungal activity of *Cassia fistula* leaves.³⁹

Antibacterial and Antifungal activities

Cassia fistula flowers were tested for its antibacterial and antifungal activity by using its hexane, chloroform, ethyl acetate, methanol and aqueous extracts in both fungi and bacteria. Antibacterial activity was confirmed in Gram +ve bacteria with low MIC while among Gram -ve bacteria, only in *pseudomonas aeruginosa*. Antifungal activity was confirmed in *Trichophyton mentagrophytes* and *Epidermophyton floccosum* (0.5 mg/ml MIC) due to isolated 4-hydroxy benzoic acid hydrate, confirmed by x-ray crystallography.¹⁶

Antipyretic activity

This study reported about antipyretic activity of *Cassia fistula* Linn. pods by using its methanolic extracts in rats. Antipyretic activity was confirmed and found higher (p<0.05) than control due to individual or combined action of glycosides, amino acids, flavonoids and steroids in extracts.⁸

Anti-inflammatory activity

Due to many side effects produced by drugs, there is strongly need of better safety providing anti-inflammatory compounds. This study evaluated anti-inflammatory activity of *Cassia fistula* and *solanum xanthocarpum* Schrad and Wendle by using dried pulp and aqueous extracts respectively, individually as well as in combination. Experiments involved carragenan-induced paw edema model in rats, dose response curves and isobologram. Results declared that extracts of both



(*Solanum and Cassia fistula*) in 1:1 combination at 500 mg/kg dose showed 75% inhibition as compare to Diclofenic (81% inhibition) than used individually. Interaction indices declared synergistic effect of combination.¹⁹

In another study, anti-inflammatory activity of *Cassia fistula* flower (in India) against Wistar mice and rats was studied. Vascular permeability models (induced by acetic acid), granuloma (induced by cotton pellet), ear oedema (induced by croton oil) and hind paw oedema (induced by carrageenan) were used for investigating isolated Rhein from *Cassia fistula* flower. Results showed the lower level of malondialdehyde, carrageenan-induced cyclooxygenase (COX-2) and inducible nitric oxide synthase due to anti-inflammatory activity. It further supported by increased activity of glutathione peroxidase and catalase superoxide dismutase due to decreasing IL-1 β , IL-6 and TNF- α .²⁶

Antipyretic and Anti-inflammatory activity

This study reported about anti-inflammatory and antipyretic activity of *Cassia fistula* in rats by using its ethanolic extract (ELE). Antipyretic activity was determined against Pyrexia (induced by TAB vaccine) and anti-inflammatory activity was determined against carrageenan induced rat paw oedema and cotton pellet granuloma model. Comparing results with diclofenac and indomethacin declared that ethanolic extracts produced anti-inflammatory activity. ELE at various concentrations proved effective in reducing induced pyrexia and body temperature. It declared *Cassia fistula* Linn. extract as anti-inflammatory and antipyretic active.⁴⁰

Analgesic activity

This study evaluated analgesic activity of *Cassia fistula* by using methanolic pod extract (CF-MA) in albino rat and mice. Tail clip and Hot plate method was used and results showed more inhibition ($P < 0.01$) in pain, at concentration of 250 mg/kg and 500 mg/kg. So, CF-MA were potentially proved as analgesic active.³⁰

Antihyperglycemic and Analgesic activity

Ethanolic extracts of *Cassia fistula* stem barks was studied for analgesic and antihyperglycemic activity in mice and rats using acetic acid-induced writhing method and Oral glucose tolerance test (OGTT) method respectively. Sugar in blood was lowered in normal and diabetic rats at 250 mg/kg and 500 mg/kg extract, that confirmed antihyperglycemic activity. 62% and 45% writhing inhibition produced at 400 mg/kg and 200 mg/kg extracts respectively, from that analgesic activity was declared.⁴¹

Hypolipidemic activity

High fat diet was induced hyperlipidemia in rats and investigated for antioxidant and hypolipidemic activity of ethanolic extract of *Cassia fistula* fruit extract (CFE). In this study, Oil red O staining of adipose tissues and Serum lipid profile were used that confirmed hypolipidemic activity by comparing with atorvastatin drug. CFE increased serum

profile, MDA and enzyme activity in liver. Oil red O staining decreased adipocytes lipid accumulation. Results showed that both activities proved effective at CFE dose of 500 mg/kg.⁴²

Antiplasmodial activity

Antiplasmodial activity of *Cassia fistula* using crude extract of leaf, fruit and bark was studied in *Plasmodium falciparum* (DIO). Leaf extract of *Cassia fistula* were concluded having highest activity against chloroquine sensitive strains. Evaluating CHCl_3 extract of leaf was carried out by flash column chromatography and centrifugal partition chromatography, that isolated 3 active principles (1) Phytol IC_{50} $18.9 \pm 0.60 \mu\text{M}$ (2) Di-lineolyl galactopyranosyl-glycerol IC_{50} $5.8 \pm 0.27 \mu\text{M}$ (3) lutein IC_{50} $12.5 \pm 0.35 \mu\text{M}$. Cytotoxicity analysis of three principles proved phytol and lutein as non-toxic for Chinese Hamster Ovarian (CHO) cell line that supported anti-plasmodial activity.²⁹

Anticonvulsant and Anxiolytic activity

A study reported about *Cassia fistula* (used by India and Tanzania) for analyzing anticonvulsant and anxiolytic activity using ethyl acetate fraction (EAFCF), from which flavonoid were evaluated. Subcutaneous pentylenetetrazol test (PTZ test) for anticonvulsant, open field test (OFT) and elevated plus maze (EPM) for anxiolytic was performed. Results declared. Tonic clonic seizures confirmed anticonvulsant activity while anxiolytic activity was confirmed by open arm nutrient and spent time.¹⁵

Antiparasitic activity

This study related with isolation of isoflavone biochanin A by using CH_2Cl_2 (dichloromethane) extract of *Cassia fistula* fruit, followed by identification using spectroscopic method. Results showed the EC_{50} of 18.96 $\mu\text{g/ml}$ and cytotoxicity of 42.58 $\mu\text{g/ml}$. Isoflavone biochanin A proved active as antiparasitic agent as well as anti-Trypanosoma-cruzi activate with more effectiveness than benzidazole.²⁸

Antidiabetic activity

A study was reported on antidiabetic activity of ethyl acetate and alcoholic extract of bark of *Cassia fistula*. Activity was studied against alloxan-induced diabetic rats in which glucose level in blood was effectively decreased and normal lipid blood were gained. Comparing activities with glibenclamide drug, resulted the more effective antidiabetic activity of ethyl acetate fraction due to flavonoid moiety.¹⁰

Indian medicinal plants have used to treat global health problem, Diabetes Mellites. To analyze antidiabetic activity, 70% ethanolic extract of *Cassia fistula* pod were used against rats. Streptozotocin (60 mg/kg) used for diabetes induction in male Wistar rats. Diabetic rats were treated with three different doses of extracts. Comparing results with glibenclamide revealed that extracts not only decreased HbA1c and blood glucose level but also

improved oral glucose tolerance test (OGTT). It supported anti-diabetic activity of *Cassia fistula* pod extract.¹²

Immunomodulatory activity

Fruit of *Cassia fistula* synergistically combined with Amoxicillin (Amoxy-cassia, Patent # 1371240, GOP) to evaluate immunomodulatory effect. Immune induced in BALB/c mice using sheep RBC. Hemolytic Plaque assay was used for calculating activated anti-SRBC producing cell by treating animal with synergetic extract. Hemagglutination test was used to analyze the antibody titer presence in all animals and notably higher in those mice serum which were treated with Amoxy Cassia. However further detailed study is required.¹⁷

Antifertility activity

This study used the fertile female albino rats and reported the effect of petroleum ether seed extract of *Cassia fistula* in them. Experiments included orally intake (for 1-5 days) of 100, 200 and 500 mg/kg extracts in mated rats. It resulted in decreasing of number of uterine implants, live fetuses and fertility index. Results showed that weak estrogenic activity was observed when taking in alone. When taking along with 0.1 mg/kg estradiol valerate, it showed the very less antiestrogenic activity. It was concluded from above study that because of anti-implantation activity, extracts of *Cassia fistula* seed showed antifertility activity.¹¹

As laxative

Cassia fistula as laxative drug was studied by using decoction leaf extract of *Cassia fistula* Linn. (collected from 10 Thailand provinces). UV-VIS spectrophotometer method was used for extract analysis which contained total anthraquinone glycosides with 0.62-2.01% of dry weight (1.52% average dry weight). It was concluded that anthraquinone in *Cassia fistula* decoction extract was responsible for its laxative property.³³

In other study, in vitro laxative properties of aqueous extracts of *Cassia fistula* pod (cultivated in Nigeria) was evaluated in isolated guinea-pig ileum. Results of *Cassia fistula* infusion compared with Sanokot tablet (reference drug) which showed comparable low toxicity in *Cassia fistula* infusion with LD₅₀ of 6600 mg/kg. Thus, *Cassia fistula* was proved to use as laxative drug.⁷

Anticandidal activity.

Anticandidal activity was analyzed by using seed extract of *Cassia fistula* against *Candida albicans* through time-kill assays followed by SEM and TEM observation. Growth of *C. albicans* was completely inhibited in time kill assay by seed extract of *C. fistula* at 6.25 mg/ml. extracts treated *C. albicans* showed wide change in outer cell wall and cytoplasmic contents, as compared to control. Yeast growth was also inhibited in vitro that showed antifungal activity of extracts. Antifungal activity showed 6-fold decreased candidiasis in 2.5 g/kg extract treated animals.⁹

Anthraquinone derivative Rhein in *Cassia fistula* make it to produce antimicrobial activity. This study involves analysis of seed and fruit pulp extract of *C. fistula* phytochemically as well as determination of its anticandidal activity on *Candida species like C. albicans, C. tropicalis* and *C. glabrata* (with ATCC 10261, 750 and 90030 respectively) using Cytotoxicity and ergosterol estimation assay, growth curve studies and minimum inhibitory concentration (MIC). Results showed the presence of phenolic components and Rhein in extracts as well as confirmed the anticandidal activity of *C. fistula* fruit and seed extract.³¹

Flu resistant strains (FRSs) of *Candida albicans* were sensitive to *Cassia fistula* leaves extract. In vitro CF leaf extract were used against FRSs but also along with fluconazole (Flu). Different solvents were used for preparing CF extract. Micro dilution method was used to estimate IC₅₀ value. Results showed the concentration of cellular lipid and phospholipid of FRS decreased as well as DNA content also decreased (H3 uptake analysis). This study would be effective in CA by production of a *Candida drug* of synergistic combination of CF leaves and flu.²⁰

Antileishmanial activity

Leishmaniasis, visceral form (IV), a fatal disease badly effects the population. Present study evaluated the fruit extract of *Cassia fistula* against this dramatic disease. Antileishmanial activity showed by hexane extract against promastigotes form of *Leishmania L. chagase*. Sterol and clerosterol were isolated by bio guided fractionation. with IC₅₀ Amastigotes of 18.10 µg/ml show susceptibility while with IC₅₀ promastigotes of 10.03 µg/ml showed inhibitory concentration. Cholesterol was found less toxic and harmful than pentamidine by 3-6-fold. Any antifungal activity was not reported in clerosterol.⁴³

Antiulcer activity

Antiulcer activity of *Cassia fistula* Linn. was studied by using ethanolic leaf extract (ELE) against gastric ulcer in different groups of rats that was induced by pylorus ligation. Before pyloric ligation, ELE were administered in 200, 500 and 750 mg/kg along with Ranitidine (30 mg/kg). Examination of gastric juice after 4 hours of pylorus ligation led to the observation of pH, free acidity, gastric volume and acidity, due to strong mucosal defense. Sialic acid and fucoso decreased and hexane, hexosamine, carbohydrate ratio, C:P and non-amino polysaccharide increased in ELE pretreatment. CAT decreased by increasing LPO and SOD. Results proved that 750 mg/kg of ELE showed best and effective antiulcer as compared to ranitidine treatment. In addition to above changes, inhibition of lipid peroxidation and free radical scavenging were also noted.⁴⁴

Larvicidal & Ovicidal activity

Ovicidal and Larvicidal activity of leaf of *Cassia fistula* was determined by using its methanolic extracts which was lethal to larvae of *Culex quinque fasciatus* and *Anopheles Stephens* with LC₅₀ value of 17.97 and 20.57 mg/l respectively. Egg raft of *quinque fasciatus* showed great



hatchability after 120 of treatment which confirmed extracts as Ovicidal and Larvicidal activity.¹³

Anti-estrogenic activity

Ovariectomized female rats were used for investigated the antiestrogenic activity of *Cassia fistula* using petroleum ether extract of seeds on their uterine histoarchitecture. Extracts had been analyzed alone as well as in combination with 0.1 mg/kg of EDV (estradiol valerate). Mild estrogenic activity was observed in case of using extracts while antiestrogenic activity was observed when using along with EDV, it made them responsible for anti-conceptive effect.²³

Antioxidant activity

The stem, leaf, bark and root of *Cassia fistula* belonging to different ages were studied by for total phenolic, total tannin content (using Folin-ciocaltea) & antioxidant activity (using free radical DPPH array). Overall results showed that bark extract of all included age class with mean IC50 value of 0.04 g/ml produced high antioxidant activity.⁴⁵

Hydro alcohol extract of *Cassia fistula* seeds was analyzed by using three methods. Folin- ciocaltere reagent was used for measuring phenol content, DPPH was used to analyze antiradical activity and Oyaizu method was used to analyze reducing power of extract results declared that Radical medicated diseases ware treated effectively by *Cassia fistula*, as it was being as free radical scavenger.³⁴

In other study, antioxidant activity of fruit pulp powder of *Cassia fistula* using its extract (100mg/kg/EW) was studied in young adult mice. That was in vitro study carried for 2 hr. up to 30 days before combination of stresses. Results declared that Superoxide dismutase (SOD), Catalase (CAT) and Glutathione (GSH) reduced. Highly phenolic and flavonoid content in *Cassia fistula* lowered malondialdehyde and made *C. fistula* highly antioxidant.⁴

Phytochemical and in vitro antioxidant activity of dried flower powder of *Cassia fistula* Linn. was evaluated using hydro alcoholic extract. For investigating antioxidant activity, three methods were employed. Ciacaltea reagent was used to measure phenolic contents, DPPH assay was used to measure antiradial activity and Oyaizu method was used to evaluate extract's ferric reducing power. Results indicated the radical scavenging activity of flower extracts, which have phenol that were considered a reason for antioxidant activity.²⁵

Hepatoprotective activity

A study investigated the hepatoprotective activity of *Cassia fistula* by using 400 mg/kg hexane extract of *C. fistula* leaf. In rats, being hepatotoxicated (with paracetamol), experimental results reflected the lowering of transaminases (GOT & SGPT), bilirubin & alkaline phosphate's serum level.³²

Present study evaluated the ethanolic extract of *Cassia fistula* leaves in DIH in rats. Out of four groups of rats,

Group A and Group B were control and ant tuberculous (ATT) group respectively. Group C and D were experimental groups, received ethanolic extract and INH/RIF (50 mg/kg) at 500 mg/kg and 400 mg/kg respectively. Observation of blood samples at 30th day reflected the amount of serum ALT, AST and AP increasing in Group B, slight decrease in group C and significantly decreasing in Group D. 500 mg/kg EECF proved hepatoprotective.²

Anti-tumor activity

Here a study reported the antitumor activity of *Cassia fistula* seed using its methanolic extract on Ehrlich asutes caranoma (ECA) growth and life space of mice having tumor. Some improvement (lowering of mitotic activity intracytoplasmic vacuoles and appearance of membrane blebbing) had been noticed, which led to increase in life span and reduction in volume of tumor in ECA. Also bone marrow cells, red blood and hemoglobin increased numerically.¹

Anticancer activity

In this study, Methanolic extracts of *Cassia fistula* were used against human prostate cancer cells and proved anticancer agents in MTT assay. Treatment of 30ug human cancer cells resulted in less viability of 5.06%. Anticancer agents. Identification of linoleic acid and Citronellal was carried out by using GC-MS. Anticancer activity was confirmed by using acridine orange test. Overall treated cancer cells showed increased activity of caspase (-3,7,9, and 10) and fragmentation in Genomic DNA.²²

In this study, ethyl acetate extract of flower of *Cassia fistula*, anticancer activity against colon cancer cellines was reported. Isolated Rhein (from EAE) as anti-cancer agents was identified using spectroscopic methods. Experimental results showed cytotoxicity of 40.59%, 58.26%, 65.40%, 77.92% and 80.25% of 200 µg/ml Rhein at 6, 12, 24, 48,42h incubation time. Rhein showed less cytotoxic effects for VERO cells while induced apoptosis in COLO 320DM (colon adenocarcinoma cell line) at 6.25 & 12.5 µg/mL concentration. It approved that Rhein is anticancer agents.⁵

Other study observed anti-cancer activity of butanol and ethyl acetate extracts of *Cassia fistula* fruit pulp and seed against SiHa (human cervical and breast cancer cells, MCF-7). Compounds like Rhein, 2(3H)-furanone and thymol and oleic acid were present in ethyl acetate extract of pulp and seeds as anticancer agents, while inositol butanol and palmitic acid found in n-butanol extract of seed. Whereas inositol and 2- pyrrolidone were found in butanol extracts of pulp. Experimental results revealed the effectiveness of fruit pulp and seed extracts again human cancer cell lines by preventing the growth of cancer cells. Apoptosis regulatory genes and caspase enzymes modulated to cause cell death.⁶



Wound-healing potential

Pathogenic microorganism resist antibiotic that require now effective drugs to develop. In this study, evaluation of wound healing potential of *Cassia fistula* carried out in albino Rat Model. *Pseudomonas aeruginosa* and *Staphylococcus aureus* ATCC 29213 were treated with alcoholic extracts of *C. fistula* leaves. Healing procedure was evaluated by gelatin zymography, histologically and biochemically. All results proved that *Cassia fistula* show healing activity by wound closure & improved tissue regeneration.⁴⁶

CONCLUSION

Many traditional systems like Siddha, Ayurveda, Homeopathy and Unani help in detailed study and evaluation of medicinal herbs. One of therapeutically important herb is *Cassia fistula*. It is flowering plant belongs to Leguminosae family and commonly known as Amaltas. It is cultivated in India, china, Ceylon, Egypt, Mauritius, South Africa, Mexica, Brazil, Thailand and East America. Present article is recent review of traditional uses, phytochemical profile and pharmacognostical studies of *C. fistula*. As well as literature survey about its pharmacological activities also carried out in this recent review. *Cassia fistula* is used to treat many diseases, some are constipation, skin diseases, leprosy, burning sensation, fever and syphilis. Complete profile of phytochemical constituent of *cassia fistula's* root, stem, leaf, flower and seed also studied in this article. Pharmacognostical literature revealed the fact that *Cassia fistula* is ornamental tree with golden yellow flower, green pods, ovate and brown seeds, brownish red root and dark brown old stem. *Cassia fistula* is found biologically potential by having many pharmacological activities i.e., antioxidant, antibacterial, antifungal, anti-inflammatory, antiparasitic, antifertility, anticonvulsant etc., proved *Cassia fistula* of important therapeutic value.

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REFERENCES

- Gupta M, Mazumder UK, Rath N, Mukhopadhyay DK, Antitumor activity of methanolic extract of *Cassia fistula* L. seed against Ehrlich Ascites Carcinoma Journal of Ethnopharmacology 72, 2000, 151–156.
- Jehangir A, Nagi AH, Shahzad M, Zia A, The Hepato-Protective Effect OF *Cassia Fistula* (AMALTAS) Leaves in Isoniazid and Rifampicin Induced Hepatotoxicity in Rodents, Biomedica, 26, 2010, 25 – 29.
- Danish M, Singh P, Mishra G, Srivastava S, Jha KK, Khosa RL, *Cassia fistula* Linn. (Amalthus)- An Important Medicinal Plant: A Review of Its Traditional Uses, Phytochemistry and Pharmacological Properties, J. Nat. Prod. Plant Resour., 1 (1), 2011, 101-118.
- Maheep B, Sunil V, Yogesh V, Durgesh S, Kanika S, Antioxidant Activity of Fruit Pulp Powder of *Cassia fistula*, PHCOG J, 2, 2010, 219-228.
- Duraipandiyar AV, Baskar AA, Ignacimuth S, Muthukuma C, Al-Harbi NA, Anticancer activity of Rhein isolated from *Cassia fistula* L. flower, Asian Pacific Journal of Tropical Disease, 2012, 517-523.
- Irshad MD, Mehdi SJ, Al-Fatlawia AA, Zafaryab MD, Alia A, Ahmada I, Singh M, Rizvi MMA, a Phytochemical Composition of *Cassia fistula* Fruit Extracts and its Anticancer Activity Against Human Cancer Cell Lines, Journal of Biologically Active Products from Nature, 4(3), 2014, 158-170.
- Akanmu MA, Walewa EO, Elujoba AA, Adelusola KA, Toxicity Potentials of Cassia Fistula Fruits as Laxative with Reference to Senna, African Journal of Biomedical Research, 7, 2004, 23– 26.
- Singh MP, Singh A, Alam G, Patel R, Datt N, Antipyretic activity of *Cassia fistula* Linn. Pods, Journal of Pharmacy Research, 5(5), 2012,2593-2594.
- Jothy SL, Zakariah Z, Chen Y, Sasidharan S, In Vitro, in Situ and in Vivo Studies on the Anticandidal Activity of *Cassia fistula* Seed Extract, Molecules, 17, 2012, 6997-7009.
- Malpani SN, Manjunath KP, Antidiabetic Activity and Phytochemical Investigation of *Cassia Fistula* Linn. Bark, IJPSR, 3(6), 2012, 1822-1825.
- Yadav R, Jain GC, Antifertility Effect And Hormonal Profile of Petroleum Ether Extract of Seeds of *Cassia fistula* in Female Rats, International Journal of PharmTech Research, 1, 2009, 438-444.
- Jangir RN, Jain GC, Evaluation of Antidiabetic Activity of Hydroalcoholic Extract of *Cassia fistula* Linn. pod in Streptozotocin-Induced Diabetic Rats, Pharmacogn J. 9(5), 2017, 599-606.
- Govindarajan M, Jebanesan A, Pushpanathan T, Larvicidal and ovicidal activity of *Cassia fistula* Linn. leafextract against filarial and malarial vector mosquitoes, Parasitol resource, 102, 2008,89–292.
- Seyyednejad S, Motamedi H, Vafei M, Bakhtiari A, The Antibacterial Activity of *Cassia fistula* Organic Extracts, Jundishapur J Microbiol, 7(1), 2004, 1-4.
- Kalaiyarasias C, Karthikaa K, Ragupathia G, Anticonvulsant and anxiolytic activities of ethyl acetate fraction of *Cassia fistula* Linn. pods in mice, Pharmacognosy Communications, 5(1), 2015, 76-82.
- Duraipandiyar V, Ignacimuthu S, Antibacterial and antifungal activity of *Cassia fistula* L.: An ethnomedicinal plant Journal of Ethnopharmacology, 112, 2007, 590–594.
- Ali NH, Kazmi SH, Faizi S, Modulation of Humoral Immunity by *Cassia Fistula* and Amoxy-Cassia, Pak. J. Pharm. Sci., 21(1), 2008, 21-23.
- Sharma DK, Numerations on phytochemical, pharmacological and ethnobotanical properties of *Cassia fistula* Linn: yellow shower, The Journal of Phytopharmacology, 6(5), 2017, 300-306.
- Anwikar S, Bhitre M, Study of the synergistic anti-inflammatory activity of Solanum xanthocarpum Schrad and Wendl and *Cassia fistula* Linn, International Journal of Ayurveda Research, 1(3), 2010, 167-171.



20. Bansal Y, Saini P, Bansal K, Synergism between *Cassia fistula* And Fluconazole "A New Approach Against Candidiasis, *IJPSR*, 5(3), 2014, 1000-1005.
21. Sharma DM, Onkar DJM, Sharma DO, An Overview Of Botanical And Therapeutic Aspects Of Aragvadh-[*Cassia Fistula* Linn], *World Journal Of Pharmaceutical And Medical Research*, 5(3) , 2019, 82-87.
22. Kulkarni A, Govindappa M, Ramachandra YL, Koka P, GC-MS Analysis Of methanol Extract of *Cassia Fistula* and Its In Vitro Anticancer Activity on Human Prostate Cancer Cell Line, *Indo American Journal of Pharmaceutical Research*, 5, 2015, 937-944.
23. Yadav R, Jain GC, Effect of Petroleum Ether Extract of *Cassia Fistula* Seeds on Uterine Histoarchitecture Of Ovariectomized Female Rats, *Indian Journal of Fundamental and Applied Life Sciences*, 3 (1), 2013, 167-174.
24. Bahorun T, Neergheen VS, Aruoma O, Phytochemical constituents of *Cassia fistula*. *African Journal of Biotechnology*, 4 (13), 2005, 1530-1540.
25. Bhalodia NR, Nariya PB, Acharya RN, Shukla VJ, Evaluation of in vitro Antioxidant activity of Flowers of *Cassia fistula* Linn, *International Journal of Pharm Tech Research*, 3(1), 2011, 589-599.
26. Antonisamy P, Agastian P, Kang CW, Kim NS, Kim JH, Anti-inflammatory activity of Rhein isolated from the flowers of *Cassia fistula* L. and possible underlying mechanism, *Saudi Journal of Biological Sciences*, xxx (2017), xxx-xxx.
27. Duraipandiyan V, Ignacimuthu S. Antifungal activity of Rhein isolated from *Cassia fistula* L. flower, *Webmed Central PHarmacology*, 1(9), 2010, 1-8.
28. Sartorelli P, Carvalho CS, Reimão JQ, Ferreira MJP, Tempone AG, Antiparasitic activity of biochanin A, an isolated isoflavone from fruits of *Cassia fistula* (Leguminosae), *Parasitol Res*, 104, 2009 ,311-314.
29. Gracea MH, Lateganb C, Graziose R, Smithb PJ, Raskinc I, Lila MN, Antiplasmodial Activity of the Ethnobotanical Plant *Cassia fistula* *Natural Product Communications*, 7 (10), 2012, 1263-1266.
30. Sheikh NW, Patel RD, Upwar NI, Mahobia NK, Seth MV, Panchal UR, Analgesic study of methyl alcohol extract of *Cassia fistula* Pod, *Journal of Pharmacy Research*, 3(9), 2010, 2218-2219.
31. Irshad MD, Shreaz S, Manzoor N, Khan LA, Moshahid M, Anticandidal activity of *Cassia fistula* and its effect on ergosterol biosynthesis, *Pharmaceutical Biology*, 49(7), 2011, 727-733.
32. Bhakta T, Banerjee S, Mandal SC, Maity TK, Saha BP, Pal M, Hepatoprotective activity of *Cassia fistula* leaf extract, *Phytomedicine*, 8(3), 2001, 220-224.
33. Saculpanich A, Gritsanapan W, Determination of anthroquinone glycosides content in *cassia fistula* leaf extracts for alternative source of laxative drug, *international general of biomedical and pharmaceutical sciences*, 2009, 42-45.
34. Bhalodia NR, Acharya RN, Shukla VJ, Evaluation of in vitro Antioxidant Activity of hydroalcoholic seed extracts of *Cassia fistula* Linn. *Free Radicals and Antioxidants*, 1(1), 2011, 68-76.
35. Ali MA, Sayeed MA, Absar N, Antibacterial activity and cytotoxicity of three lectins purified from *cassia fistula* linn. seeds, *J Med Sci*, 3(3), 2003, 240-244.
36. Tanveer S, Latif A, Ashiq K, Qayyum M, Bajwa MA, A Comprehensive Review On Pharmacological And Phytochemical Potential Of *Cassia Fistula* Linn: A Magical Herb, *International Journal of biology, Pharmacy and Applied Sciences*, 8(6), 2019, 1134-1157.
37. Irshada CMD, Ahmada A, Zafaryaba MD, Ahmad F, Manzoor N, Singh M, Rizvia MMA, Composition of *Cassia fistula* Oil and its Antifungal Activity by Disrupting Ergosterol Biosynthesis *Natural Product Communications*, 8 (2), 2013, 261-264.
38. Phongpaichit P, Pujenjob N, Rukachaisirikul V, Ongsakul M, Antifungal activity of leaf extract of *Cassia alata* L., *Cassia fistula* and *Cassia tora* L, *Phongpaichit*, 26(5) ,2004, 741-748.
39. Panda SK, Brahma S, Dutta SK, Selective antifungal action of crude extracts of *Cassia fistula* L. A preliminary study on *Candida* and *Aspergillus* species, *Malaysian Journal of Microbiology*, 6(1), 2010, 62-68.
40. Gobianand K, Vivekanandan P, Pardeep K, Mohan CVR, kerthikeyan S, anti inflammatory and antipyretic activity of Indian medicinal plant *cassia fistula* linn(golden shower)in wistar albino rats, *international general of pharmacology*, 6(5), 2010, 719-725.
41. Ali MA, Sagar HA, Khatun MCS, Azad AK, Begum K, Ibne Wahed MI, Antihyperglycemic And Analgesic Activities of Ethanolic Extract of *Cassia Fistula* Linn. Stem Bark, *IJPSR*, 3(2), 2012, 416-423.
42. Abid R, Mahmood R, Shivashankara H, Kumar S, Hypolipidemic and antioxidant effects of ethanol extract of *Cassia fistula* fruit in hyperlipidemic mice, *Pharmaceutical Biology*, 2016.
43. Sartorelli P, Andrade SP, Melhem MC, Prado FO, Tempone AG, Isolation of Antileishmanial Sterol from the Fruits of *Cassia fistula* using Bio guided Fractionation, *Phytotherapy Research*, 21, 2007, 644-647.
44. Karthikeyan S, Gobianand K, Antiulcer activity of ethanol leaf extract of *Cassia fistula*, *Pharmaceutical Biology*, 48(8), 2010, 869-877.
45. Tzekiat L, Chiange LK, Total Phenolics, Total Tannins and Antioxidant Activity of *Cassia Fistula* L. Extracts of Bark, Stem, Leaf and Root Under Different Age Classes, *Asian J Pharmaceut Res Health Care*, 5, 52-57.
46. Kumar MS, Sripriya R, Raghavan HV, Sehgal PK, Wound Healing Potential of *Cassia fistula* on Infected Albino Rat Model, *Journal of Surgical Research*, 131, 2006, 283-289.

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