

A Phytopharmacological Review on *Cassia* Species

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Abstract:

The use of medicinal plants has gained more importance because of its natural origin and high therapeutic significance. The various species of the genus *Cassia* has many novel phytochemical constituents which has high pharmacological activities such as anti inflammatory, antioxidant, antimicrobial, antidiabetic etc., useful for the treatment of many health disorders. This review describes the importance of the genus *Cassia* and various experimental research carried out in different species of this genus which will provide information to develop a new herbal drugs.

Key Words: Medicinal plants, *Cassia*, Phytoconstituents, Pharmacological activity

INTRODUCTION

Nature has been a source of medicinal agents for thousands of years and an impressive amount of new drugs have been isolated from natural sources, many based on their use in traditional medicine [1]. Medicinal plants play a vital role for the growth of new drugs. Indian medicinal plants are now known to have great potential for preparing clinically helpful drugs that might even be used by allopathic physicians [2]. *Cassia* species (*Caesalpinaceae*) are well known medicinal plant commonly found in India and other tropical countries. Different medicinal properties have been attributed to this plant in the traditional system of Indian medicine. Various anthraquinones have been isolated from the seeds of *Cassia* species. Sennosides, which are well known for their medicinal importance, have been detected in the leaves of this plant [3]. The genus *Cassia* comprises of 580 species of herbs, shrubs and trees. It is widely dispersed throughout the world, of which only twenty species are native to India. Many of the *Cassia* species own a good amount of medicinal properties and a few among them supply tanning materials, which are of great economic importance [4].

Importance of *cassia* species

Cassia species are already reported in the ancient ayurvedic literatures and literature survey indicated its use against various skin diseases such as ringworm, eczema, and scabies. Since of the high incidence of skin diseases, especially among the weaker section of the Indian population, it was felt worthwhile undertaking research on this plant [5]. According to ayurveda the leaves and seeds are acrid, laxative, antiperiodic, anthelmintic, ophthalmic, liver tonic, cardiogenic and expectorant. The leaves and seeds are useful in leprosy, ringworm, flatulence, colic, dyspepsia, constipation, cough, bronchitis, cardiac disorders. In India, *Cassia* species is used as a natural pesticide in organic farms. The extracts of *Cassia* species have been used as a therapy for various skin ailments, rheumatic disease and as laxatives [3]. The extract of *Cassia* species leaves has been found to possess significant hepatoprotective activity and anti-inflammatory activity. Whole plant is employed in the treatment of impetigo, ulcers, helmenthiasis and as a purgative [6].

Taxonomical classification

The taxonomical classifications of the genus *Cassia* were as follows:

Kingdom: Plantae

Class: Eudicots

Class: Rosids

Order: Fabales

Family: Fabaceae

Subfamily: Caesalpinioideae

Genus: *Cassia.L*

Cassia auriculata

The chloroform extract of *Cassia auriculata* has antibacterial activity against *Bacillus subtilis*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli* and antifungal activity against *Candida albicans* and *Aspergillus niger*. The phytochemical constituents present in this plant are found to be alkaloids, carbohydrates, fixed oils, fats, tannins, gum & mucilage, flavonoids, saponins, terpenoids, lignin and sterols [7].

The Methanolic extract of *Cassia auriculata* was found to have maximum antibacterial activity against *Vibrio cholerae* and *Staphylococcus aureus* [8], *Bacillus cereus*, *Escherichia coli*, *Klebsiella pneumonia* and *Proteus mirabilis* with the zone of inhibition of 12-20mm [9]. The chloroform extracts was found to have minimum activity against *Pseudomonas aeruginosa*. The ethyl acetate extract has higher level of total phenolic compounds and total flavonoid content which shows possess higher antioxidant activity [8]. The methanol, chloroform and aqueous extracts were shown to have carbohydrates, proteins, alkaloids, flavonoids, steroids, saponins and tannins which may be a reason for antimicrobial and antioxidant activity [9].

Cassia fistula

This plant is used for the treatment of abdomen tumours, glands, liver and throat cancer. It also used to cure burns, constipation, convulsions, diarrhea, dysuria and epilepsy. Ayurvedic medicines recognizes as carminative and laxative. It is also used to cure leprosy, skin diseases and syphilis. Phytochemical investigations proved an important valuable medicinal plant. It is known to be important source of secondary metabolites particularly phenolic compounds. It has rich basis of tannins, flavonoids and

glycosides. Pharmacological activities contain antibacterial, antidiabetic, antifertility, anti-inflammatory antioxidant, hepatoprotective, antitumor, antifungal activities [10].

The plant has a high therapeutic value and it exerts an antipyretic and analgesic effect. The leaf extract of the plant was reported as an antitussive agent and it has wound healing properties. [11].

The leaf extract has antifungal activity against *Trichophyton rubrum* and *Microsporum gypseum* with the 50% inhibition concentration (IC₅₀) of hyphal growth at 0.5 and 0.8 mg/ml, respectively, whereas the extract of *Cassia fistula* was the most potent inhibitor of *Penicillium marneffeii* with the IC₅₀ of 0.9 mg/ml [12].

The Aqueous, methanol and petroleum ether extract shows antibacterial activity against

Escherichia coli, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Pseudomonas fluorescens*, *Clavibacter michiganensis* sub sp. *Michiganensis*, *Xanthomonas oryzae* pv. *Oryzae* and *Xanthomonas axanopodis* pv. *Malvacearum* and antifungal activity against *Aspergillus flavus*, *A. niger*, *A. nidulans*, *A. flaviceps*, *Alternaria carthami*.

The methanol extract has shown high activity of free radical inhibition of 69%, the methanol extract inhibited the heat induced albumin denaturation and red blood cell membrane stabilization with 88.61 and 79.33 g/ml. Proteinase activity was extensively inhibited by the methanol (83.88) extract and also xanthine oxidase (44.83) and acetylcholinesterase (18.98) followed by aqueous and petroleum ether extracts. The highest antilipoxygenase activity was noticed from methanol extract (62.16). The results found that phytochemicals (alkaloids, saponins, flavonoids, anthraquinone and phenolic compounds) present in *Cassia fistula* extract may be responsible for the antimicrobial, antioxidant and anti-inflammatory activity [13].

Antioxidant activity:

The extract of various parts of the plant has 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. The reason for low antioxidant activity in the flower and pulp fractions could be the presence of some prooxidants, such as chrysophanol and reducing sugars which dominate the antioxidant compounds present in the extracts [8].

Antifungal and Antibacterial activity:

Cassia fistula has Antifungal activity against *Trichophyton mentagrophytes* (MIC 0.5 mg/ml) and *Epidermophyton floccosum* (MIC 0.5 mg/ml). Three lectins, i.e. CSL-1, CSL-2 and CSL-3, purified from the *Cassia fistula* seeds, were tested for their antibacterial activities against different pathogenic bacteria, i.e. *Bacillus subtilis*, *B. megaterium*, *Streptococcus haemolyticus*, *Streptococcus aureus*, *Sarcina lutea*, *Shigella sonnei*, *Escherichia coli*, *Klebsiella sp.*, *Shigella shiga*, *Shigella boydii*, *Shigella flexneri*, *Shigella dysenteriae*, *Salmonella typhi* and *Pseudomonas aeruginosa*, using 30 micro g/disc. CSL-3 was active against all bacterial strains and showed strong activity against *Bacillus megaterium*, *Streptococcus haemolyticus*

and *Shigella boydii*. CSL-2 showed poor activity against most of the bacterial strains and has strong activity against only *Streptococcus haemolyticus*. CSL-1 was inactive against all the bacterial strains except *Streptococcus haemolyticus* and *Sarcina lutea* [8].

Anti tumour activity

The Methanolic extract of *Cassia fistula* seed has an antitumor activity. Hematological studies have exposed that methanolic extract at the dose of 100 mg/kg has shown better results than at the doses of 200 and 300 mg/kg. The exact mechanism by which methanolic extract mediates its antitumor effect is still to be elucidated. Cytological changes indicate that methanolic extract might be having a direct tumoricidal effect on the tumour cells [8].

Antifertility activity:

The petroleum ether extract of *Cassia fistula* seeds possesses pregnancy terminating cause by virtue of anti-implantation activity [8].

Effect on skin diseases: On the basis of the results of this study it may be concluded that, the *Cassia fistula* is having significant effect in ameliorating the skin diseases due to pitta origin and is safe drug of choice of purgation therapy [14].

Cassia italica

The GC-MS analysis of methanolic leaf extract of this plant revealed the presence of 17 compounds. Some of the phytochemicals screened were Phytol, Squalene and n-Hexadecanoic acid, many of these compounds were used in industry for various applications like flavor, antioxidant, anti-inflammatory, antimicrobial, pesticide and cancer preventive [15].

The ethanolic extract of the whole plant parts of *Cassia italica* was investigated for anti-inflammatory, analgesic and prostaglandin (PG) release by rat peritoneal leucocytes, antineoplastic and antiviral. It was found that, in rats, the extracts reduced carrageenin-induced paw swelling (100 mg/kg bw-31%) and fever (100 mg/kg bw-37%). A dose-dependent inhibition of PG release effect was observed using rat peritoneal leucocytes [16].

Six bioactive compounds were identified from *Cassia italica*, each active compound was evaluated for anticancer properties using Ehrlich ascites carcinoma cell (EACC) line and Hepatoma cell (HepG2) line. The identified compounds showed variable antioxidant activities. It is apparent that *Cassia italica* can be used for the treatment of cancer [17].

Cassia javanica

The various phytochemical constituents found were anthraquinone glycosides, flavonoids, alkaloids, sterols, tannins, saponins and reducing sugars in different parts of the plant. *Cassia javanica* possesses various pharmacological activities like antidiabetic, antioxidant, anticancer and antimycotics, antipyretic, laxative and antimalarial drug and for the treatment of gastric pain. It is also known to decrease virulence of pathogenic organisms [18].

Cassia siamea

The pharmacological activity of *Cassia siamea* has antimicrobial, antimalarial, antidiabetic, anticancer, hypotensive, diuretic, antioxidant, laxative, anti-inflammatory, analgesic, antipyretic, anxiolytic, antidepressant, and sedative activities.

The phyto constituents include Chromone (anhydrobarakol), Chromone alkaloids (barakol, Cassiarin A-B), anthraquinones (chrysophanol, emodin), bianthraquinones (Cassiamin A-B), flavonoids and phenolic compounds. Barakol was known as the major constituents of leaves and flowers of *Cassia siamea* [19].

Cassia siamea is a shrub belonging to the Fabaceae family, native of Southeast Asia. It has antimicrobial, antimalarial, antidiabetic, anticancer, hypotensive, diuretic, antioxidant, laxative, anti-inflammatory, analgesic, antipyretic, anxiolytic, antidepressant, and sedative activities. Chromone (anhydrobarakol), Chromone alkaloids (barakol, Cassiarin A-B), anthraquinones (chrysophanol, emodin), bianthraquinones (Cassiamin A-B), flavonoids and phenolics compounds are the main constituents reported in this plant. Barakol was identified as the major constituents of *Cassia Siamea* of leaves and flowers.

Dried stems of *Cassia siamea* mixed with the fruit of *Xylopiiaethiopica* is pulverized and administered as laxative. The decoction of the stem bark is drunk against diabetes. The leaves decoction is drunk against malaria, flowers decoction is drunk or used in body bath against malaria and liver disorders. This decoction is also effective against insomnia and asthma. The seeds are used as intestinal worm sand as antidote for snake and scorpion bites [19].

Cassia spectabilis

The flowers of *Cassia spectabilis* has piperidine alkaloids, (-)-3-O-acetylspectraline (-)-7-hydroxyspectraline, and iso-6-spectraline and spectraline. The green fruit of this plant also has 3-O-acetylspectraline and spectraline. The DNA-damaging activity of these compounds was evaluated using mutant yeast, *Saccharomyces cerevisiae*, assay [20].

Alkaloids are present in higher amounts in ethanol, methanol and ethyl-acetate extracts of *Cassia spectabilis*. Tannins is moderately present saponin is present in higher amounts in ethanol, methanol extracts and absent in ethyl-acetate extract of *Cassia spectabilis*. Anthraquinones and Anthocyanosides are absent [1].

Cassia alata

Ethanol extract of *Cassia alata* leaves was exhibited antimicrobial activity against *Trichophyton mentagrophytes* var., *interdigitale*, *Trichophyton mentagrophytes* var., *mentagrophytes* *Trichophyton rubrum*, *Microsporum canis*, *Microsporum gypseum*, *Fusarium solani*, *Aspergillus niger*, *Cladosporium werneckii*, *Penicillium sp* [21].

The leaf extract has antifungal activity against *T. rubrum* and *M. gypseum* with the 50% inhibition concentration (IC₅₀) of hyphal growth at 0.5 and 0.8 mg/ml, respectively, whereas the extract of *Cassia fistula* was the most potent inhibitor of *P. marneffeii* with the IC₅₀ of 0.9 mg/ml [9].

Cassia nigricans

The ethyl acetate extract of the leaves of *Cassia nigricans* has Emodin which is found to be highly cytotoxic with the LC₅₀ (lower – upper limits) of 42.77 (11.80 – 72.94) µg/ml. It also has significant antimicrobial activity on some common pathogens. The isolation of this compound from the leaves of *Cassia nigricans* is used for the treatment of skin diseases and gastro-intestinal disorders [22].

Cassia tora

The BuOH-soluble extract of the seeds of *Cassia tora* has three naphthopyrone glucosides, *Cassiaside*, *rubrofusarin-6-O-β-D-gentiobioside*, and *toralactone-9-O-β-D-gentiobioside*, were isolated from as active constituents [23].

Ethanol extract of *Cassia alata* leaves has antifungal activity against *Trichophyton mentagrophytes* var. *interdigitale*, *Trichophyton mentagrophytes* var. *mentagrophytes*, *Trichophyton rubrum*, *Microsporum canis*, *Microsporum gypseum*, *Fusarium solani*, *Aspergillus niger*, *Cladosporium werneckii*, *Penicillium sp*. In vitro, the extract exhibits high activity against various species of dermatophytic fungi but low activity against non-dermatophytic fungi [24].

Cassia nodosa

The anti-oxidant and cytotoxic activity of *Cassia nodosa* flowers, leaves, stem bark methanolic extracts and their fractions (petroleum ether, methylene chloride, ethyl acetate and n-butanol) was first investigated. Results were obtained specially for stem bark methanolic extract as a strong cytotoxic agent against MCF-7 and VERO cell lines. Chrysophanol (IV) displayed the highest activity as antioxidant (anti-hemolytic and DNA protective agent). This was the first time to isolate Kaempferol-3-O-α-L-rhamnopyranosyl (1→2)-β-D-glucoside (I) from ethyl acetate fraction of leaves. Isolation of 4,5-dihydroxyanthraquinone-2-carboxylic acid (rhein) (III) and 1,8-dihydroxy-3-methyl anthraquinone (chrysophanol) (IV) was achieved from methylene chloride fraction of flowers and stem bark, respectively. Kaempferol 3-O-α-L-rhamnoside (II) was isolated from ethyl acetate fraction of leaves besides compound (I) [25].

Cassia javanica

Cassia javanica was proved to be effective hypoglycemic agent. Diabetes was induced in rats by single intraperitoneal injection of STZ. Single and multiple doses of test drug (0.5 g/kg body weight/day) were given to normal and diabetic rats. The results of test drug were compared with standard hypoglycemic drug-glibenclamide (0.01g/kg/day). In preliminary phytochemistry, antidiabetic compounds were detected. The result showed highly significant reduction (37.62%) in blood glucose level of diabetic rats in ten days. This effect was considerably good in comparison with standard drug (63.51%) [26].

Cassia sophera

The crude and ethyl acetate extracts of matured seed coat of *Cassia sophera* has larvicidal activity of against *Culex*

quinquefaciatus. All the graded concentration (0.6%, 0.7%, 0.8%, 0.9%, 1%) showed significant ($p < 0.05$) larval mortality. The result of preliminary qualitative phytochemical analysis of the seed coat revealed the presence of some secondary metabolite such as saponin, alkaloid and cardiac glycosides. The results support that the tested plant extract can be used for control of larval form of *Culex quinquefaciatus* [27].

Cassia sophera distributed in deciduous and mixed-monsoon forests throughout greater parts of India. It is widely used in traditional medicinal system of India as analgesic, anticonvulsant, antioxidant, anti-inflammatory, hepatoprotective and antiasthmatic activity etc. It has a rich source of flavanoids and anthraquinones [28].

Dried methanol extract of leaves of *Cassia sophera* L. was dissolved in distilled water, and then fractioned by re-extracting with n-hexane, chloroform, and ethyl acetate, subsequently. The free radical scavenging activity (FRSA) of methanol extract and various fractions of methanol extract was evaluated by 1, 1-diphenyl-2-picrylhydrazyl (DPPH) assay. The Free radical scavenging activity of ethyl acetate fraction was superior to all other fractions ($IC_{50} = 15.42$ g/ml), which was superior than synthetic antioxidant butylated hydroxyanisole, BHA (18.25 μ g/ml). The total phenolic content in EtOAc fraction (13.25%) was the highest as compared to other extracts. This result suggests that this plant could supply as a source of natural antioxidants and preservative agents [29].

Cassia augustifolia

The water-soluble polysaccharides were isolated and fractionated from *Cassia augustifolia* L. leaves. Methylation analysis of one of the sub fraction showed the presence of 1, 4-linked galacturonic acid (31.0%), 1,2-linked rhamnose (14.5%), 1,2,4-linked rhamnose (15.8%), 1,3,6-linked galactose (15.3%), smaller amounts of 1,3-linked arabinose, 1,5-linked arabinose, and terminal galactose and arabinose residues. Mild acid hydrolysis of S1A indicated that the backbone consists of 1, 4-linked galacturonic acid and 1, 2-linked rhamnose residues in the ratio of 1:1. Every second rhamnose is connected via C-4 to arabinogalactan sidechains. The antitumor activity of this polysaccharide fraction was tested against the solid Sarcoma-180 in CD1 mice; it exhibited a significant antitumor activity with an inhibition rate of 51% [30].

A novel oleanen type triterpenoid glycoside has been isolated from butanolic seed extracts of *Cassia augustifolia*. Its structure was elucidated as 3-O- $\{\beta$ -D-glucuronopyranosyl-(1 \rightarrow 4)- $\{\beta$ -D-galactopyranosyl-(1 \rightarrow 2)- $\{\beta$ -D-xylopyranosyl-(1 \rightarrow 3)- β -D-glucopyranosyl}-2, 16 α -dihydroxy 4, 20-hydroxy methyl olean-12-ene-28-oic acid. The isolated saponin has antifungal activity with maximum inhibition against *Colletotrichum dematium* [31].

Cassia reningeria

A new flavonoid kaempferol-7-O-glucoside was identified and characterized and it has significant antimicrobial activities. The higher level of total quercetin (0.34 mg/gdw), kaempferol (0.60 mg/gdw), kaempferol-7-O-

glucoside (0.21 mg/gdw) were identified. The isolated flavonoids were effective against *Escherichia coli*, *Aspergillus flavus*, *Aspergillus niger*, *Fusarium moniliformae* and *Rhizoctonia bataticola*. Kaempferol was more effective against *A. flavus*, *A. niger*, *F. moniliformae* and *R. bataticola* [32].

Cassia australis

The different compounds such as flavones, flavonols, and their glycosides and condensed tannins was identified from EtOAc, n-BuOH and EtOAc-Pp fractions. EtOAc and n-BuOH fractions inhibited Mayaro virus (MAYV) production respectively, by more than 70% and 85% at 25 μ g/mL. EtOAc-Pp fraction inhibited MAYV production by more than 90% at 10 μ g/mL, displaying a stronger antiviral effect [33].

CONCLUSION

The pharmacological, medicinal and traditional importance reported in present review confirms the therapeutic value of *Cassia* species. The genus *Cassia* is widely used in traditional medicinal system as Hepatoprotective, anti-inflammatory, antimicrobial, antioxidant activity and also it has a wide spectrum of pharmacological activities. The detailed information regarding the pharmacology and phytoconstituents of *Cassia* species can be useful for the development of new traditional medicine and for the benefit of the mankind. This review summarizes some significant pharmacological studies on the genus *cassia* and phytoconstituents isolated from various species, which can be further investigated for the improvement of new novel herbal drugs.

CONFLICT OF INTEREST

All authors declare no conflict of interests.

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