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Review Paper

Ethnopharmacological Activities in Cassia fistula

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ABSTRACT

Cassia fistula, also referred to as the golden shower tree, emphasizing its traditional applications, phytochemical makeup, and medicinal qualities that have been scientifically proven. A common medicinal herb utilized in many traditional medical systems, such as Ayurveda, Unani, and folk practices, is Cassia fistula. The plant's pods, leaves, bark, and flowers are among its elements that have been used to cure a variety of conditions, from fever and inflammation to skin infections and constipation. The review summarizes and talks about the ethnobotanical value of C. fistula in various cultures, which is backed up by current pharmacological research. The plant's antibacterial, anti-inflammatory, antioxidant, antidiabetic, hepatoprotective, and laxative properties are attributed to its abundance of bioactive substances, which include flavonoids, anthraquinones, glycosides, and tannins. Research shows that these pharmacological effects are consistent with traditional applications, confirming the plant's potential for medical usage. However, standardization and clinical translation are hampered by differences in extraction techniques, doses, and research models. With a variety of pharmacological uses supported by both conventional and scientific evidence, Cassia fistula has great potential as a natural medicinal agent. To create safe, efficient plant-based medications, more clinical research and standardization of its extracts are necessary. The necessity of integrative methods to connect ethnomedicine with contemporary pharmacology is highlighted by this review.

INTRODUCTION

Nowadays, there is a growing demand for and acceptance of medicinal plants. Plants undoubtedly serve vital purposes and have a significant influence on ecosystems. Humans and other living things cannot function properly without plants. Regardless, medicinal plants in particular have long been utilized as a general indicator of the health of ecosystems.[1] As long as humans have existed, plants and their components have been used in primary healthcare. Numerous medicinal plants have demonstrated therapeutic

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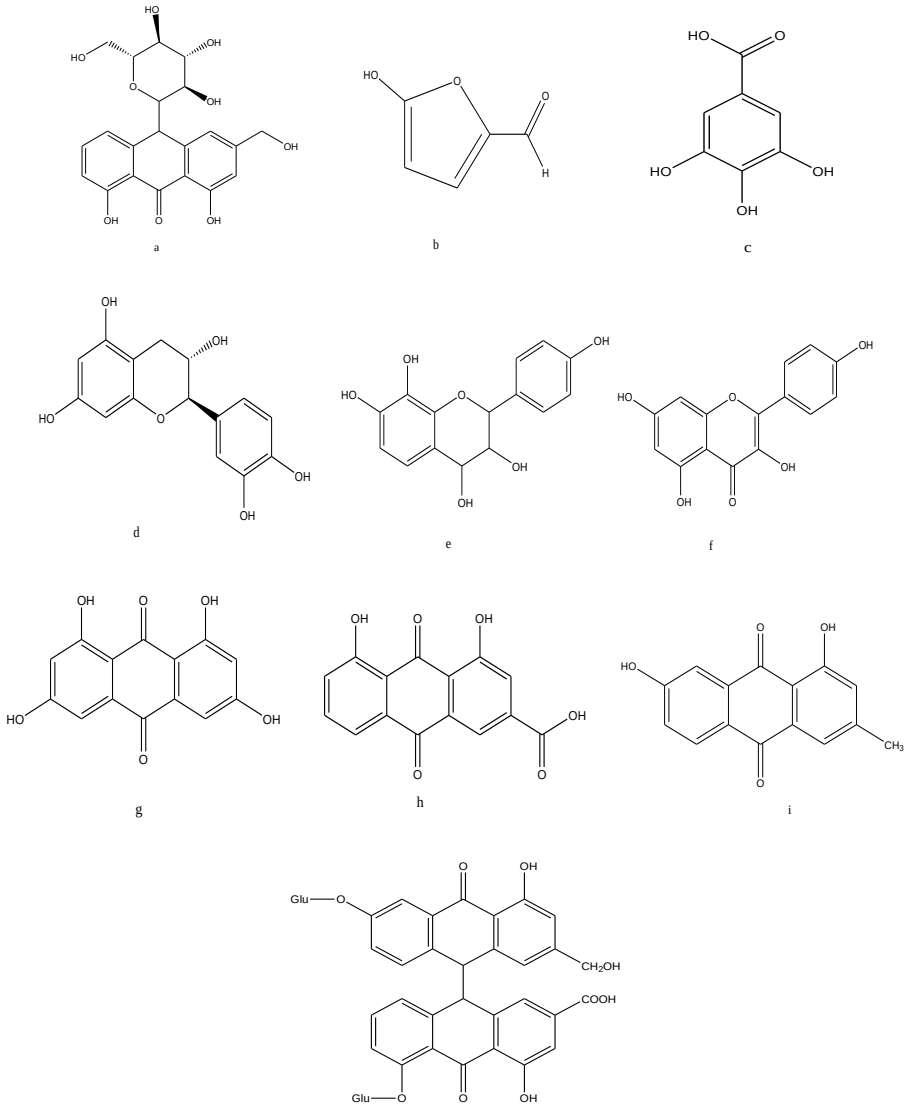
benefits in the health control through biological properties including antioxidant, anti-inflammatory, and antidiabetic.[2] Cassia fistula also called Amaltash in Hindi, member of Fabaceae family. This is a native flowering plant that is edible in India and the surrounding countries. Grown throughout the nation, this ornamental plant is highly popular. Grown in South Indian states, this multipurpose plant is used to make vibrant garlands that women of all ages wear. The plant is Kerala's state flower. In other parts of the world, plants are also grown. The C. fistula plant produces long, abundant, hanging bunches of yellow flowers in late spring. [3] Grown practically everywhere in India, Cassia fistula is a deciduous tree that can reach heights of 24 m and girths of 1.8 m. One of the most widely distributed trees in India's forests, it typically grows in deciduous forests across the majority of the country. [4] Moreover, research has explored the analgesic (pain-relieving) capabilities of *C. fistula*. For example, studies on extract of ethanol of stem bark of plant showed significant pain-relieving effects in experimental settings. The extract led to a dose-dependent decrease in pain responses, which researchers attribute to the bioactive compounds like flavonoids and triterpenoids present in it.[5] Cassia fistula possesses a wide range of medicinal uses because of its various pharmacological characteristics such as antiulcer, healing of wounds, antipyretic, antitussive, anti-inflammatory, antioxidant, anticancer, antifungal, antibacterial, antipruritic, antiepileptic and antisterility. The plant's roots are used as a diuretic and to cure heart problems, ulcers, and glandular tuberculosis. Its leaves and bark are used for healing skin conditions. Its fruit pulp is used to treat a variety of stomach issues as a moderate laxative. Its blossoms are used to treat fever, stomach problems, and leprosy. Its seeds have cooling, antipyretic, and laxative qualities. Tannins, glycosides, flavonoids, linoleic, oleic, stearic, and carbohydrate compounds are all abundant in the plant. Glycosides, free rein, sennosides A and B, isoflavone acid, oxyanthraquinone derivatives, lepeol, hexacosanol, tannins, B-sitosterol, arginine, protein, leucine, flavonoid-3-ol-subordinates, astringents, fistular acids, gluten substances, kaempferol, malvalic acid, sterculic acid, anthraquinones, biantroquinones, and glycosides of essential oils are also present. [6]

PLANT PROFILE

- Scientific Name *Cassia fistula.*
- Common Names Golden Shower tree, Indian laburnum,
- Amaltas [Hindi], Konna [Malayalam], Kondrai [Tamil] [7]
- Kingdom Plantae
- Class Magnoliopsida
- Order Fabales
- Family Fabaceae
- Genus Cassia
- Species Fistula
- Plant type Semideciduous or Deciduous
- Height 11-16 metres
- Leaves Pinnately compound, 15-60 cm long
- Flowers Bright yellow, fragrant, arranged in pendulous racemes 20-40 cm long
- Fruits Cylindrical, dark brown pods, 30–60 cm long, containing numerous
- seeds
- Native Range Indian subcontinent and Southeast Asia
- Habitat Tropical and subtropical regions, prefers well-drained soils
- Flowering Season Before the beginning of summer

- Pollinators Bees (e.g., carpenter bees), butterflies
- Cultural Significance National flower of Thailand ("Ratchaphruek")
- Integral to Kerala's Vishu festival
- Medicinal Uses Laxative, antipyretic, antimicrobial
- Used in traditional medicine to treat pain, fever, and skin conditions [8]
- Phytochemicals Flavonoids, alkaloids, tannins, saponins, glycosides, phenolic compounds
- Economic Use Ornamental plant, wood used for construction, medicinal applications [9]
- Conservation Status Not threatened

STRUCTURES



a- Barbaloin, b- 5-hydroxymethylfurfural, c- Tannins, d- Catechin, e- Fistucacidin f- Kaempferol, g- Physcion, h- Rhein, i- Chrysophanol, j- Sennoside A

Cassia fistula tree

Cassia fistula leaves

PLANT ORGANS	PHYTOCHEMICALS PRESENT	REFERENCES
Leaves	1,8-di-OH-3-carboxyanthraquinone, 1,8-di-OH-3-methylanthracene-9,10-dione, 1,8-di-OH-6-methoxy-3-methylanthraquinone, $C_4H_8O_2$,HCOOH, HOOC-COOH, (9S,9'S)-5,5'-bis[(2S,3R)-2,3-dihydroxy-4-oxobutyl]-9,9'-bis(hydroxymethyl)-8,8'-dihydroxy-6,6'-dimethylpyrano[2',3':6,7]naphtho[2,3-d]dioxin-9,9'-dione, quercetin-3-O-glucoside, myricetin-3-O-glucoside, 4-hydroxycinnamic acid ester etc	10, 12-17
Flowers	(2R,3S,4R)-2-(3,4-di-OH-phenyl)-3,4-dihydro-2H-chromene-3,5,7-triol tetramer, 3,5,7-tri-OH-2-(4-hydroxyphenyl)-4H-chromen-4-one, n-heptacosanoic acid, (3S,3aR,4S,4aR,6aR,6bS,7S,9aR,10S,10aR)-10-hydroxy-2,3,3a,4,4a,6a,6b,7,9a,10,10a-undecahydro-6,6-dimethyl-9-methylidene-1H-cyclopentaannulene-3,7-dicarboxylic acid etc	13,15,16
Bark	1,8-di-OH-anthraquinone, 1,8-di-OH-anthracene-9,10-dione, 3,4,5,7-tetra-OH-flavan, 3,4,7,8,4'-pentahydroxy-2-phenylchroman, lup-20(29)-en-3β-ol	13,16
Pods	1,8-dihydroxy-3-(3-hydroxy-3-methylbutanoyl)-6-methoxy-9,10-anthracenedione, (2R,3S)-2-(3,4-dihydroxyphenyl)-3,4-dihydro-2H-chromene-3,5,7-triol (catechin)	15,16
Fruits	1,8-bis(β-D-glucopyranosyloxy)-6-methylanthraquinone, 1,8-di-OH-3-hydroxymethylanthracene-9,10-dione, 1,8-dihydroxy-3-methylanthracene-9,10-dione, hexacosan-1-ol,	11,13,14,17
Roots	Rhamnetin-3-O-gentiobioside is 5,7,4'-trihydroxy-3-methoxyflavone-3-O-β-D-gentiobioside	19

Seeds	1,8-di-OH-3-methyl-6-methoxyanthraquinone, 2-octylcycloprop-1-ene-1-octanoic acid, 2-octyl-9,10-methyleneoctadecanoic acid, (2S)-7-OH-2-(2-hydroxypropyl)-5-methyl-4H-chromen-4-one	16,20
Heartwood	(2S,3R,4R)-2-(4-OH-phenyl)-3,4-dihydro-2H-chromene-3,5,7,8-tetraol	15
Pulp	(10S)-1,8-di-OH-3-(hydroxymethyl)-10-[(2S,3R,4R,5S,6R)-3,4,5-trihydroxy-6-(hydroxymethyl) oxan-2-yl]-10H-anthracen-9-one	15,16

PHARMACOLOGICAL ACTIVITIES

Antimicrobial action

This research assessed the antimicrobial properties of CSL-1, CSL-2, and CSL-3 purified lectins derived from Cassia fistula seeds. This objective involved the use of pathogenic bacteria. In genera results indicated that CSL-3 exhibited significantly higher activity against all microbes especially Shigella boydii, Bacillus megaterium, streptococcus, and β-haemolyticus. However, the mortality rate of brine shrimp seen with CSL-2 showed how hazardous it is.[21]A different study uses the Disc diffusion technique to evaluate the antibacterial properties of Cassia fistula (in Khuzestan, Iran) against three Gram +ve bacteria and five Gram -ve bacteria using its methanolic and ethanolic extract. K. pneumoniae was significantly impacted by E. coli and extracts. The minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) were determined using the tube dilution test. Overall results confirmed that Cassia fistula has an antibacterial ingredient.[22]

Antifungal Activity

Using ethyl acetate extract, the antifungal activity of Cassia fistula flowers was investigated over Epidermophyton floccosum, Trichophyton mentagrophytes, Trichophyton simli, and Trichophyton subrum. The above-mentioned fungi are inhibited by isolated Rhein, which has MIC values of 12.5 µg/ml, 62.5 µg/ml, and 31.25 µg/ml, respectively.[23]Candida species were used to investigate Cassia fistula's antifungal properties. Phytochemical investigation using gas chromatography coupled with mass spectrometry (GC-MS) revealed that the oil from Cassia fistula included β-sitosterol, stigmasterol, ergosterol, betulinic acid, luperol, fucosterol, friedelin, and α-amyrin. The pulp and seed oil's MIC value indicated that ergosterol production in Candida cell walls prevented oil extract. Cassia fistula's active ingredient exhibited antifungal properties.[24]

Pain Reliever Activity

This study used methanolic extracts from Cassia fistula Linn. pods to report on its antipyretic properties in rats. Glycosides, amino acids, flavonoids, and steroids may function alone or in combination in the extracts was shown to have antipyretic effect, which was proven to be higher ($p<0.05$) than control.[25]

Antiinflammatory Activity

There is an urgent need for improved safety when it comes to anti-inflammatory substances because of the numerous adverse effects that medications might cause. Using dried pulp and aqueous

extracts, respectively, Solanum xanthocarpum with Cassia fistula In this study, the anti-inflammatory qualities of Schrad and Wendle were evaluated both independently and in combination.Rats with carragenan-induced paw edema were used in the experiments, along with dose response curves and isobolograms. According to the results, when taken in a 1:1 combination at a dose of 500 mg/kg, the extracts of Solanum and Cassia fistula demonstrated 75% inhibition, compared to 81% inhibition when taken separately with diclofenic. The synergistic effect of the combination was declared using interaction indices.[26]Another study examined Cassia fistula flowers' anti-inflammatory properties on Winster mice and rats in India. In order to study isolated Rhein from Cassia fistula flower, vascular permeability models were employed, which included acetic acid-induced vascular permeability, granuloma caused by cotton pellets, hind paw congestion caused by carrageenan, and ear oedema caused by croton oil. The findings showed that carrageenan-induced cyclooxygenase (COX-2), inducible nitric oxide synthase, and malondialdehyde all had less of an anti-inflammatory effect. It is further supported by the increased activity of glutathione peroxidase and catalase superoxide dismutase due to a reduction in IL-1β, IL-6, and TNF-α [27]

Analgesic Activity

In this work, Cassia fistula's analgesic effects were tested in albino rats and mice using methanolic pod extract (CF-MA). The results showed that at 250 mg/kg and 500 mg/kg, the tail clip and hot plate methods there was a greater inhibition ($P<0.01$) in pain. Thus, CF-MA may have demonstrated analgesic activity. [28]

Antihyperglycemic and Analgesic activity

The analgesic and antihyperglycemic properties of ethanolic extracts of Cassia fistula stem bark were investigated in mice and rats, respectively, employing the oral glucose tolerance test (OGTT) and the acetic acid-induced writhing method. Antihyperglycemic action was demonstrated by lower blood sugar levels in both normal and diabetic rats at 250 mg/kg and 500 mg/kg extract. The extracts at 400 mg/kg and 200 mg/kg, respectivelywere found to have analgesic effects, which generated 62% and 45% writhing inhibition.[29]

Hypolipidemic activity

The ethanolic extract of Cassia fistula fruit extract (CFE) caused hyperlipidemia in rats given a high-fat diet.was examined for its hypolipidemic and antioxidant properties. This study used serum lipid profiles and oil red O staining of adipose tissues to confirm hypolipidemic activity by comparing them to the atorvastatin medication. Serum profile, MDA, and liver enzyme activity were all elevated by CFE. Lipid formation in adipocytes was reduced by oil red O labeling. The outcomes demonstrated the effectiveness of these activities at a CFE dosage of 500 mg/kg.[30]

Antiplasmodial activity

Plasmodium falciparum (DIO) was used to test Cassia fistula's antiplasmodial activity using a crude The ethanolic extract of Cassia fistula fruit extract (CFE) caused hyperlipidemia in rats fed a high-fat dietThree active principles were identified through the evaluation of the leaf's $CHCl_3$ extract using centrifugal partition chromatography and flash column chromatography (1). (2) IC50 for di-lineolyl galactopyranoryl-glycerol is 5.8±0.27 μM (3). IC50 for lutein: 12.5±0.35 μM (4) IC50 for phytol: 18.9±0.60μM. For the Chinese Hamster Ovarian (CHO) cell line, cytotoxicity research

using three principles demonstrated that phytol and lutein were non-toxic and supported anti-plasmodial action.[31]

Anticonvulsant and Anxiolytic activity

Cassia fistula, which is utilized in Tanzania and India, was the subject of a study that examined its anticonvulsant and anxiolytic properties utilizing the ethyl acetate fraction (EAFCF), from which flavonoids were extracted. The open field test (OFT), elevated plus maze (EPM) for anxiolytics & subcutaneous pentylenetetrazol (PTZ test) for anticonvulsants were conducted. Results are announced. Anticonvulsant action was proven by tonic colonic seizures, and anxiolytic action was confirmed by time and open-arm nutrition.[32]

Anthelmintic activity

The isoflavone biochanin A was isolated in this study using a CH2Cl2 (dichloromethane) extract of Cassia fistula fruit, and it was then identified using a spectroscopic technique. According to the results, the cytotoxicity was 42.58 µg/ml and the EC50 was 18.96 µg/ml. Benzidazole is less effective than isoflavone biochanin A as an antiparasitic and anti-Trypanosomacruzi drug.[33]

Antihyperglycemic Activity

It was discovered that ethyl acetate and an alcoholic extract of Cassia fistula bark had antihyperglycemic qualities. Activity was examined against rats with diabetes produced by alloxan, in which the blood's glucose level was successfully lowered and its lipid levels returned to normal. Due to the flavonoid moiety, the ethyl acetate fraction exhibited more potent antidiabetic efficacy when compared to the glibenclamide medication.[34]. Indian medicinal herbs have been utilized to treat diabetes mellitus, a worldwide health issue. Rats were given a 70% ethanolic extract of Cassia fistula pods to test for antidiabetic effects. Male Wistar rats were given 60 mg/kg of streptozotocin to induce diabetes. Three distinct extract dosages were administered to diabetic rats. Results compared to glibenclamide showed that extracts enhanced the oral glucose tolerance test (OGTT) in addition to lowering blood glucose and HbA1c. It bolstered Cassia fistula pod extract's anti-diabetic properties. [35]

Immunomodulatory Activity

Amoxicillin and Cassia fistula fruit work together synergistically to assess the immunomodulatory effect (Amoxy-cassia, Patent # 1371240, GOP). Sheep RBC was used to promote immunity in BALB/c mice. Animals treated with synergistic extract had their activated anti-SRBC-producing cells measured using the hemolytic plaque assay. The antibody titer presence in all animals was examined using the Hemagglutination test, which showed that the serum of mice treated with Amoxy Cassia had a noticeably greater level. However, more thorough research is needed.[36]

Antifertility Activity

The effects of Cassia fistula petroleum ether seed extract on fertile female albino rats were investigated in this study. For one to five days, mated rats were given extracts orally at dosages of 100, 200, and 500 mg/kg. As a result, the fertility index, live fetuses, and uterine implants all declined. The results showed that there was only minimal estrogenic activity when taken alone. When used with 0.1 mg/kg of estradiol valerate, it showed very little antiestrogenic effect.. The aforementioned investigation found that extracts of Cassia fistula seeds exhibited antifertility action due to their antiimplantation activity.[37]

Laxative Property

The laxative qualities of Cassia fistula Linn. were examined using a decoction leaf extract collected from eleven Thai regions. The UV-VIS spectrophotometer method was used to analyze the extract, which contained total anthraquinone glycosides with 0.62-2.01% of dry weight (1.52% average dry weight). Anthraquinone was found to be the cause of the laxative effect of the Cassia fistula decoction extract.[38] Another study evaluated the in vitro laxative properties of aqueous extracts of Nigerian-grown Cassia fistula pods using the isolated ileum of guinea pigs. Thus, it was demonstrated that Cassia fistula was a helpful laxative.[39]

Anticandidal Activity

Cassia fistula seed extract was used to test for anticandidal activity against Candida albicans employing time-kill experiments, followed by TEM and SEM analysis. C. fistula seed extract at 6.25 mg/ml completely inhibited Candida albicans in the time kill test. The cytoplasmic contents and outer cell wall of extract-treated Candida albicans showed notable alterations in comparison to the control. In vitro, yeast growth was also suppressed, demonstrating the extracts' antifungal properties. In rats treated with 2.5 g/kg extract, antifungal activity shown a 6-fold reduction in candidiasis.[40]Rhein, an anthraquinone derivative, gives Cassia fistula its antibacterial properties. This study uses growth curve studies anticandidal activity of C. fistula seed and fruit pulp extract on Candida species like Candida albicans, Candida tropicalis, and Candida glabrata (with ATCC 10261, 750, and 90030, respectively) using minimum inhibitory concentration (MIC), cytotoxicity, and ergosterol estimation assays. The findings confirmed the fruit and seed extract of C. fistula's anticandidal action and showed that the extracts included Rhein and phenolic components.[41]

Candida albicans flu-resistant strains (FRSs) showed sensitivity to the extract of Cassia fistula leaves. In vitro CF leaf extract was utilized in conjunction with fluconazole (Flu) and again with FRSs. CF extract was prepared using a variety of solvents. The IC50 value was estimated using the microdilation method. According to the results, the amount of DNA in FRS as well as its cellular lipid and phospholipid concentrations dropped (H3 uptake analysis). By producing a Candida medication that combines CF leaves and flu in a synergistic way, this study would be successful in CA. [42]

Antileishmanial Activity

The populace suffers greatly from leishmaniasis, visceral type (IV), a deadly illness. The current study assessed Cassia fistula fruit extract's ability to fend against this severe illness. Hexane extract shown antileishmanial actionagainst Leishmania L. chagase in its promastigotes phase. The sterol and cholesterol were separated via bioguided fractionation. IC50 promastigotes showed inhibitory concentration at 10.03 µg/ml, whilst IC50 amastigotes showed susceptibility at 18.10 µg/m. It was discovered that cholesterol was three to six times less poisonous and damaging than pentamidine. There was no evidence of any antifungal activity in clerosterol. [43]

Gastroprotective Activity

Cassia fistula gastroprotective properties were investigated by using ethanolic leaf extract (ELE) to prevent stomach ulcers in several rat groups caused by pylorus ligation. ELE was given at 200, 500, and 750 mg/kg in addition to ranitidine (30 mg/kg) prior to pyloric ligation. Due to robust mucosal defense, analysis of the stomach juice

following four hours of pylorus ligation revealed measurements of pH, acidity, stomach volume, and free acidity. Sialic acid and fucoso decreased during ELE pretreatment, but hexane, hexosamine, carbohydrate ratio, C:P, and non-amino polysaccharide increased lipid peroxidation and free radical scavenging were shown to be reduced in addition to the previously described changes.[44]

Insecticidal Activity

Using its methanolic extracts Cassia fistula leaves were evaluated for their insecticidal properties. With comparable LC 50 values of 17.97 and 20.57 mg/l, these extracts were lethal to larvae of Culex quinque fasciatus and Anopheles Stephens. After 120 treatments, the quinque fasciatus egg raft demonstrated excellent hatchability, confirming the extracts' ovicidal and larvicidal properties. [45]

Anti-estrogenic Activity

The antiestrogenic effect of Cassia fistula was investigated in female rats with ovariectomies using a petroleum ether preparation of the seeds. Examined were the extracts alone and in combination with 0.1 mg/kg of EDV (estradiol valerate). Extracts were found to have little estrogenic action when used alone, but antiestrogenic activity when used in conjunction with EDV, which led to their anti-conceptive effect.[46]

Antioxidant Activity

The antioxidant activity (using the free radical DPPH array), total phenolic content, and total tannin content (using Folin-ciocaltea) of Cassia fistula stems, leaves, bark, and roots of varying ages were investigated. Overall findings demonstrated that bark extract generated high antioxidant activity across all age classes included, with a mean IC50 value of 0.04 g/ml. [47]Three techniques were used to analyze Cassia fistula seed hydro alcohol extract. The phenol content was measured using the folic acid reagent, the antiradical activity was examined using DPPH. The results showed that Cassia fistula was an effective treatment for radical-medicated diseases because it acted as a free radical scavenger.[48]

In a different study, young adult mice were used to test the antioxidant properties of Cassia fistula. The in vitro investigation lasted from two hours to thirty days prior to the combination of stressors. The results indicated a reduction in superoxide dismutase (SOD), catalase (CAT), and glutathione (GSH). Cassia fistula's strong phenolic and flavonoid content reduced malondialdehyde and increased its antioxidant capacity. [49]Hydro-alcoholic extract was used to assess the antioxidant properties of Cassia fistula. To look into antioxidant activity, three different approaches were used. Phenolic contents were measured using the Ciacalteu reagent, antiradial activity was measured using the DPPH assay, and the extract's ferric reducing power was assessed using the Oyaizu method. The findings demonstrated the floral extracts' capacity to scavenge radicals, as they contain phenol, which was thought to be the cause of the antioxidant activity.[50]

Hepatoprotective Activity

In one research, the hepatoprotective qualities of Cassia fistula leaf were investigated using a 400 mg/kg hexane extract. According to experimental findings, rats who were hepatotoxicited (with paracetamol) had lower levels of bilirubin, alkaline phosphate, and transaminases (GOT & SGPT).[51]In the current investigation, rats with DIH were given an ethanolic extract of Cassia

fistula leaves. Of the four rat groups, Group A was the control group and Group B was the ant tuberculous (ATT) group. Experimental groups C and D received 500 mg/kg and 400 mg/kg of ethanolic extract and INH/RIF (50 mg/kg), respectively. Serum levels of ALT, AST, and AP were growing in Group B, somewhat declining in Group C, and drastically declining in Group D, according to blood sample observations at day 30. EECF at 500 mg/kg demonstrated hepatoprotection.[52]

Antineoplastic Activity

Research examined effects of C.fistula seed's methanolic extract on Ehrlich asutes caranoma (ECA) growth & tumor-bearing rats life span. There had been some improvement (reduction of intracytoplasmic vacuole mitotic activity and development of membrane blebbing), which resulted in a longer life span and a smaller tumor volume in ECA. Additionally, hemoglobin, red blood, and bone marrow cells all grew quantitatively. [53] Cassia fistula methanolic extracts were employed in this investigation to fight human prostate cancer cells and shown anticancer properties in the MTT test. The vitality of 30 ug human cancer cells was reduced by 5.06%. anti-cancer substances. GC-MS was used to identify citronellal and linoleic acid simultaneously. The acridine orange test was used to confirm the anticancer activity. Overall, caspase activity was elevated in treated cancer cells (-3,7,9, and10), and genomic DNA fragmentation was observed.[54]This study revealed anticancer efficacy against colon cancer cellines using an ethyl acetate extract of Cassia fistula flowers. Using spectroscopic techniques, isolated Rhein (from EAE) was found as an anti-cancer agent. At 6, 12, 24, 48, and 42 hours of incubation. Rhein caused apoptosis in the colon cancer cell line COLO 320DM at concentrations of 6.25 and 12.5 µg/mL, while it had less cytotoxic effects on Vero cells. Rhein's anticancer drugs were approved.[55]

Wound-healing Potential

Antibiotic-resistant pathogenic microorganisms necessitate the development of currently effective medications. This study used an albino rat model to assess Cassia fistula's capacity for wound healing. Using alcoholic extracts of C. fistula leaves Staphylococcus aureus ATCC 29213 and Pseudomonas aeruginosa were treated. The healing process was assessed histologically, biochemically, and via gelatin zymography. All findings demonstrated that Cassia fistula has healing activity through enhanced tissue regeneration and wound closure.[56]

CONCLUSION

Cassia fistula exemplifies the remarkable therapeutic potential inherent in traditional medicinal plants when subjected to rigorous scientific investigation. This comprehensive review demonstrates that the ethnobotanical significance of the Golden Shower tree extends far beyond its ornamental and cultural value across the Indian subcontinent and Southeast Asia. The accumulated evidence from numerous pharmacological studies validates the widespread traditional use of various plant parts—roots, bark, leaves, flowers, seeds, fruits, and pods—in addressing diverse health condition. The phytochemical profile of Cassia fistula reveals a complex mixture of bioactive compounds including anthraquinones, flavonoids, glycosides, tannins, and alkaloids, which collectively contribute to its multifaceted pharmacological activities. The plant exhibits remarkable versatility in treating conditions spanning from common ailments such as fever, pain, and constipation to more serious disorders including

diabetes, microbial infections, and cellular proliferation abnormalities. Notably, the antidiabetic efficacy documented in experimental models rivaled or exceeded that of synthetic pharmaceuticals such as glibenclamide, suggesting the potential for drug development based on this resource.Furthermore, the synergistic relationships observed between Cassia fistula extracts and conventional medications—as demonstrated in immunomodulatory and anticandidal studies—indicate opportunities for integrated therapeutic approaches. The safety profile suggested by low toxicity values in multiple studies supports the traditional use of this plant in folk medicine systems. However, the predominance of in vitro and animal-based studies underscores the critical need for translational research, including well-designed human clinical trials with standardized extraction protocols and optimized dosing regimens. Such investigations would accelerate the conversion of empirical traditional knowledge into evidence-based therapeutic interventions, potentially contributing to the global pharmacopeia with affordable, sustainable treatment options derived from this botanically rich heritage.

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