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Mukhan Wati
Department of Chemistry, Chaudhary Charan Singh Haryana Agricultural University Hisar, Haryana, India

Komal Duhan
Department of Zoology, Chaudhary Charan Singh Haryana Agricultural University Hisar, Haryana, India

M Khabiruddin
Department of Chemistry, Chaudhary Charan Singh Haryana Agricultural University Hisar, Haryana, India

Correspondence
Komal Duhan
Department of Zoology, Chaudhary Charan Singh Haryana Agricultural University Hisar, Haryana, India

A review on importance of medicinal plants

Mukhan Wati, Komal Duhan and M Khabiruddin

Abstract
This article aims to provide a comprehensive review on the phytochemical and pharmacological aspects of *Cassia fistula* and its sister species. In traditional medicine have been used as antipyretics, analgesic, laxative, diabetes, hematemesis, leucoderma and intestinal disorder. The different parts of these plant contain a variety of biologically active compounds such as phenols, flavonoids, alkaloid, glycosides, tannin, saponin and terpenoids, those have various medicinal properties. The fruit, seeds and defatted seed cake and stem bark extracts shows various activities like antipyretic, anti-inflammatory, antioxidant, antidiabetic, hypolipidemic, hepato-protective, antimicrobial, antitumor, antiulcer etc.

Keywords: *Cassia fistula*, phenol, flavonoids, antioxidant activity

Introduction
Cassia fistula Linn. Also known as golden shower, Indian laburnum, belongs to the family Leguminoceae. The plant is a moderate sized deciduous tree, distributed throughout India and is reported to be aperient, astringent, laxative, purgative and vermifuge, Indian laburnum is a folk remedy for burns, cancer, constipation, convulsions, delirium, diarrhea, dysuria, epilepsy, gravel, hematuria, pimples and glandular tumors (Duke and Wain, 1981) [1]. Species of *Cassia* are rich sources of flavonoids, anthraquinones and polysaccharides. The flavonol and xanthone glycosides have been reported from the bark of the plant. A stem bark powered contained tannins, lupeol, hexacosanol, β-sitosterol. The pulp contains protein 19.94%, carbohydrate 26.30%, arginine, leucine, and glutamic acid. Pods contain fistulic acid, sugar, astringent matter, gluten, matter; Seed contain vernolic oil, sterculic and malvalic acids.
A majority of the ascribed biological effects of *C. fistula* extracts have been attributed to their primary and secondary metabolite composition. Primary metabolite analysis has essentially been focussed on the seed, pollen, fruit, leaf and pod. The seeds are rich in glycerides with linoleic, oleic, stearic and palmitic acids as major fatty acids together with traces of caprylic and myristic acids (Abu Sayeed *et al*, 1999) [2]. It has been reported that the stem bark of *C. fistula* is also a potential source of lupeol, ß-sitosterol and hexacosanol (Sen and Shukla, 1968) [3].

Phytochemistry of *Cassia fistula* and its sister species
Akinyede and Amoo, (2009) [4] reported that *Cassia fistula* seeds and defatted seed flours contain ash 4.52% and 4.71%, protein 26.25% and 28.09%, fibre 7.47% and 7.68%, carbohydrate 49.80% and 53.44%, moisture content 5.28% and 5.69% respectively. The respective mineral contents (mg/kg) were P 1.52 and 1.76, Zn 270.67 and 241.82, Fe 179.529 and 242.50, Mn 37.21 and 41.73, Mg 947.38 and 896.00, Na 118.42 and 145.31, Ca 924.99 and 1001.20, K 837.61 and 899.18. The respective phytic acid and tannin contents were 0.26% and 0.21%; 7.70% and 8.18%. The water absorption capacity, oil absorption capacity, emulsion capacity, least gelation capacity, foaming capacity and foaming stability (after 4 hours) of full fat and deffated fat were: 512% and 558%, 216.20% and 218.08%, 40% and 20%, 10% and 8% (m/v), 33.33% and 37.25%, 27.45% and 29.49% respectively. The protein solubility of full fat and deffated fat was least between pH 4 and highest between pH 7-10. Defatting significantly influenced the chemical composition and functional properties of *C. fistula*.
Wankhade *et al*, (2014) [5] have reported the antioxidant properties of 90% ethanol extracts of leaves, and 90% methanol extracts of stem bark, pulp and flowers. The antioxidant activity power was in the decreasing order of stem bark > leaves > flowers > pulp and was well correlated with the total polyphenolic content of the extracts. Thus, the stem bark had more antioxidant activity.
Jose and Reddy, (2013) [6] reported that the DPPH free radical scavenging activity of the leaf extracts of *C. fistula* are sorted in descending order: Leaf methanol extract > Leaf ethyl acetate

extract > Leaf chloroform extract > Leaf petroleum ether extract. Out of the four samples tested *C. fistula* leaf methanol extract showed the highest scavenging activity (% inhibition 84.99%, 82.05%, 76.02% and 71.11% at 1.0, 0.5, 0.25 and 0.125 mg/ml concentration respectively), Petroleum ether extract of leaves exhibited least DPPH radical scavenging ability with % inhibition 72.37%, 69.57%, 46.14% and 42.64% at 1.0, 0.5, 0.25 and 0.125 mg/ ml respectively. By comparing the IC_{50} value of the leaf extracts of *C. fistula* with that of the authentic antioxidant L-ascorbic acid, it was found that the antioxidant activity of methanol extract of leaves (IC_{50}: 88.23 µg/ml) was quite comparable with that of L-ascorbic acid (IC_{50}: 70.40 µg/ml). IC_{50} value of ethyl acetate extract of leaves (IC_{50}: 101.56 µg/ml) is not significantly different from that of L-ascorbic acid (IC_{50}: 70.40 µg/ml).

Ali, (2014) [7] has been reported that the seeds contain approximately 2% anthraquinones, 24% crude protein, 4.5% crude fat, 6.5% crude fiber, and 50% carbohydrates. The stem bark contains two flavonol glycosides and a xanthone glycosides. The leaves have been documented with 15.88% crude protein, 6.65% crude fat, 20% crude fiber, and 39.86% carbohydrates. In addition, the plant also contain fistulic acid, rhein, rheinglucoside, galactomannan, sennosides, tannin, phlobaphenes, oxyanthraquinone substances, emodin, chrysophanic acid, fistuacacidin, barbaloin, lupeol, beta-sitosterol and hexacosanol. The plant is rich in phenolic antioxidants such as anthraquinones, flavonoids and flavan- 3-ol derivatives. Antioxidant activities of the aqueous and methanolic extracts exhibited significant antioxidant activity in DPPH, Nitric oxide and Hydroxyl radical induced invitro assay methods. Both extracts showed dose-dependent protective effect against lipid peroxidation and free radical generation in liver and kidney homogenates. Antioxidant activity of *C. fistula* Linn flowers in alloxan induced diabetic rats. Fruit pulp powder of *C. fistula* was investigated for its antioxidant activity both in vitro and in vivo.

Bhalerao and Kelkar, (2012b) [8] reported that the edible fruit tissue of the Indian laburnum fruit was rich source of potassium, calcium, iron and manganese than fruits like apple, apricot, peach, pear and orange. The protein (19.94%) and carbohydrate (26.30%) contents are indicative of the potential of the fruit to be an important source of nutrients and energy. The investigation suggest that the antioxidant properties of 90% ethanol extracts of leaves and 90% methanol extracts of stem bark, pulp and flowers was in the decreasing order of stem bark > leaves > flowers > 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. Thus, the stem bark had more antioxidant activity in terms of reducing power, inhibition of peroxidation, O_2 and DPPH radical scavenging ability.

Ilavarasan *et al*, (2005) [9] reported that the aqueous and methanolic extracts of the *C. fistula* bark showed promising free radical scavenging effect of DPPH in a concentration dependant manner up to a concentration of 250 µg / ml. The *C. fistula* methanolic extracts (CFM) showed more scavenging activity than the *C. fistula* aqueous extracts (CFA). The reference standard ascorbic acid also demonstrated a significant radical scavenging potential in the concentration of 1µg / ml. The DPPH radical inhibition (%) was 50.13%, 52.12% and 78.12% for CFA, CFM and ascorbic acid, respectively.

Barthakur *et al*, (1995) [10] reported that the fruit of *C. fistula* was a good source of Fe and Mn, and their concentrations were considerably higher than those in apple, apricot, peach, pear and orange and also revealed the presence of aspartic acid, glutamic acid and lysine constituted 15.3%, 13.0 % and 7.8%, respectively, of the total amino acids in the pulp. The seeds constituted the same amino acids with 16.6%, 19.5% and 6.6%, respectively.

Abu Sayeed *et al*, (1999) [2] reported that the seed oil of *C. fistula* contain monoglycerides (0.91%-0.98%), diglycerides 2.51%-3.32%) and triglycerides (89.16%-91.01%), by using silicic acid column chromatography. The neutral lipids were accounted for over 89.80% of the total weight of the lipid employed. Saturated and unsaturated fatty acids present in the oil were separated and varied from 23.79% to 28.20% and 63.28% to 66.71%, respectively. The fatty acid composition of the oil was analyzed by Gas Liquid Chromatography (GLC). The major fatty acids found in the oil were and palmitic acid (11.41%), stearic acid (14.33%), oleic acid (29.62%) and linoleic acid (42.42%). In addition to the above, caprylic acid (0.76%) and myristic acid (1.44%) were also present in minor amounts.

Noorhajati *et al*, (2012) [11] reported that the antioxidant activities of *C. fistula* stem bark extract were evaluated with lipid peroxides test using ferric thiosyanat method (FTC) and butylated hydroxy toluene (BHT) as standard equivalent antioxidant capacity. Stem bark maceration successively used solvent extraction with normal hexane (non polar), ethyl acetate (semi-polar) and methanol (polar). The ethyl acetate extract (Ea) shows higher antioxidant activity than the n-hexane extract (Hx) and methanol extract (MeOH). Therefore, the sequence of antioxidant activity is as follows ethyl acetate extract > methanol extract > n-hexane extract, with antioxidant activity 65.98%, 58.19% and 32.66% which were equivalent to the standard synthetic antioxidant BHT (100 ppm). There is a correlation between antioxidant activity of an extract with the content of the total phenol in each extract. From the assay of phenolic extracts with the method of Folin-Ciocalteu reagent (FCR) and also using afzelechin standard as a comparision, they found that the ethyl acetate extract has the highest total phenolics and entire sequences were as follows: Ea> MeOH> Hx.

Arya *et al*, (2011) [12] have reported DPPH radical scavenging and deoxyribose damage protection properties using aqueous extract of root and results showed effective conc. (EC_{50}) of 59±2.7mg/ml and 30% protection against deoxyribose damage at a conc. of 125mg/ml. The elevated DPPH radical scavenging ability of the stem bark and leaves extract might be due to the presence of high conc. of tannins, proanthocyanidins, flavonols and xanthones. The DPPH scavenging activities indicated the ability of *C. fistula* extracts to act as radical scavenger and metal quencher thereby, protecting free radical mediated damage.

Medicinal importance

Cassia fistula

The flower, pod and root is prescribed as a tonic, astringent, febrifuge and strong purgative (Gupta, 2010) [13] and useful in fever, heart diseases, joint pain, migraine and blood dysentery. The fruits are reported to be used for asthma (Anonymous, 2007) [14], in the treatment of diabetes, (Ayurvedic Pharmacopeia of India, 2001) chest complaints, liver complaints and eye diseases. Seed powder is used in amoebiasis (Khare, 2007) [16].

Cassia nigricans

Cassia nigricans Vahl, also known as *Chamaecrista nigricans* (Vahl) Greene is called *Jiwo Tsamiya* or *Shuwakan Gargari*. It's a woody herbaceous annual herb, or under shrub, between 1.22 and 1.52 m high with small yellow flowers. It is widespread in tropical Africa, including Nigeria, Arabia and India. It has brown, hairy pubescent stem. The leaf has 10-18 pairs of symmetrical oblong leaflets. Each leaflet is about 15-26 mm long and 5-6 mm broad. The midrib is central. The rachis and petiole are about 7 cm long. The seeds inside are ten in number (Irvine, 1961). Due to its high therapeutic value, *Cassia nigricans* is used in ulcers, gastro intestinal disorders, antioedema activities diarrhoea and skin diseases (Jacob *et al*., 2002). An infusion is given for the treatment of sore throat.

Cassia angustifolia vahl

Cassia angustifolia Vahl commonly known as *'senna'* is one of the medicinally important, drought-resistant shrub. It is a native of Saudi Arabia and has been naturalized in India. *Cassia angustifolia* is an small shrub with pale substrate or obtusely angled or ascending branches. Leave usually 5-8 leaflets overall, lanceolate, glabrous, axillary erect. The flowers are in blossoms, big in size and yellow colored. The pods are 1.4 to 0.8 in wide, greenish brown contain 5-7 obovate dark brown and smooth seeds. *Senna* is used as a febrifuge in splenic enlargements, anemia, typhoid, cholera and is an excellent blood purifier. It is also employed in the treatment of constipation, amoebic dysentery, as an anthelmintic and as a mild stimulant (Anonymous, 1992) [14]. The infusion of the plant is used in treating bronchitis, dysentery, fevers and hemorrhoids.

Cassia tora

Cassia tora occurs as a waste land rainy season plant growing in the dry soil throughout the tropical parts throughout India, China Sri Lanka and West tropics. The plant is an annual herbaceous herb. Due to its moist quality, sweet flavor and cold property, *Cassia tora* is used to cure blurring vision. (Kirtikar and Basu, 1998) [19]. It forms the most popular ingredient in the Ayurvedic preparation – '*Chakramadha tailam*'. The seeds are reputed in the Chinese medicine as antiasthenic, asperient, diuretic and an effective agent in lowering cholesterol and reducing blood pressure (Foster and Chongxi, 1992).

***Cassia auriculata* Linn**

Cassia auriculata commonly known as *Tanners senna* is distributed throughout hot deciduous forests of India and holds a very prestigious position in Ayurveda and Siddha systems of medicine. It is profusely branched, tall, evergreen shrub generally 1.2-3.0 m in height. It is a common plant that flowers with large bright yellow flowers throughout the year. The leaves are alternate, stipulate, very numerous, closely placed, slender, pubescent. Leaflets 16-24, very shortly stalked 2-2.5 cm long 1-1.3 cm broad. The fruit is a short legume, 7.5-11 cm long, 1.5 cm broad, pale brown. 12-20 seeds per fruit are present each in its separate cavity. The plant has been widely used in traditional system of medicine as a cure for rheumatism (Kirtikar and Basu, 2006) [21] and conjunctivitis (Pari and Lata, 2002) [22]. The various parts of the plant were reported to exert a beneficial effect to alleviate the symptoms of diabetes (Surana *et al*., 2008) [23] and serves as a important component of several antidiabetic polyherbal formulations - 'Diasulin' in the concentration range of 40 mg/dl which is proven to have antidiabetic activity (Uma and Udupa, 2005) [24]. The flowers are used to treat urinary discharges, nocturnal emissions and throat irritation. (Vedavathy and Rao, 1991) [25]. It is used for fever, menstrual problems, tuberculosis, as diuretic for anaemia, liver complaints and as a tonic for general weakness and illness (Kirthikar and Basu, 1999). The leaves, seeds and roots are useful in vitiated conditions of vata, kapha, leprosy, erysipelas, pruritus, wounds and ulcers, cough, strangury, bronchitis, asthma, pharyngodynia, constipation fever, hydrophobia and inflammation, diabetes, elephantiasis, ring worm and flatulence respectively. (Prajapati, Purohit Sharma and Kumar, 2003) [27].

***Cassia occidentalis* linn**

Cassia occidentalis L is commonly called Kasondi in India. It is an Ayurvedic plant with huge medicinal importance (Raghunathan and Mitra, 1999) [28]. It is a diffuse offensively odorous under shrub. The plant is distributed throughout India. The plant is sub glabrous, leaflets 3-5 pairs. Flowers are yellow, in short peduncled few flowered racemes; fruits cylindrical containing 20-30 seeds. It has been used for its efficacy in respiratory disorders. In ethno botanical literature it is effective in the treatment of pityriasis, psoriasis, diabetes and convulsions of children. (Agarwal and Paridhavi, 2005) [29].

Conclusion

In the present review, we have made an attempt to congregate the phytochemical and taxonomical information on *Cassia*, a species of medicinal herb used in the Indian system of medicine. Survey of literature revealed the presence of glycosides, alkaloids, flavonoids, triterpenoids and sterols in different species of *Cassia*. Presence of wide range of chemical compounds indicates that the active constituents isolated from the species could serve as a "lead" for the development of novel agents having good efficacy in various pathological disorders. An extensive survey of literature revealed that *Cassia* is an important source of many pharmacologically and medicinally important chemicals. Although many studies have claimed the use of some species of *Cassia* for the treatment of various diseases but still the pharmacological potential of the other plants species of the genus are required to be explored.

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