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PHYTOCHEMISTRY OF FLOWER, POD AND SEED OF *CASSIA FISTULA* L. (FAMILY -CAESALPINACEAE): A REVIEW

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ABSTRACT

The various plant parts of *Cassia fistula* are used by various tribal to treat various ailments including ringworm and other fungal skin infection. *C. fistula* is deciduous, medium sized, ornamental tree. The flowers of *Cassia fistula* are eaten raw. They possess purgative, febrifugal, astringent, and anti-bilious properties. The pulp of ripe fruit has a mild, pleasant purgative action and also used as antifungal drug. Seeds are used to treat skin diseases. Flower, pod and seed of *Cassia fistula* contains number of bioactive compounds such as anthraquinones, phenolic compounds, tannins and glycosides. This phytochemical reviews on *Cassia fistula* will provide important information which is beneficial for pharmaceutical industries**.**

KEYWORDS: Chemical composition, antioxidant, flavonoids, glycoloids, alkaloids, *Cassia fistula*.

INTRODUCTION

According to Alo *et al*., (2012)[1], WHO, from medicinal plants, herbal products are prepared by using various methods like purification, fractionation, extraction, concentration, or other biological or physical procedure which are used for herbal product or for the instant consumption.

MORPHOLOGY

C. fistula is deciduous, medium sized[2] ornamental[3] tree growing up to 30 to 40 feet. This genus belongs with caesalpiniaceae family which is used for its medicinal properties. It is about 6-9 meters tall with straight trunk and spreading branches. It has lovely lots of brilliant yellow shaded bloom and long stick like cylindrical fruit. Fruits containing pungent odour with sweet pulp and containing several black seeds.[4] This plant contain grayish bark. It is spread throughout larger areas of India in the outer deciduous and mixed mansoon forest rising to 1300m in outer Himalays.[5, 6]

1. Phytochemistry of flower

Narayanan and Seshadri, (1972)[7] isolated Kaempferol and a proanthocyanindin from the acetone extract of the flower of *C. fistula.* Kumar *et al*., (1966)[8] isolates a bianthraquinone fistulin, kaempferol and rhein from ethanol extract of *C. fistula* flower. Asseleih *et al*., (1990)[9] reported that, besides phenolic and their derivatives a certain amount of alkaloids are present in flower of *C. fistula.* Mondal *et al*., (1998)[10] reported that pollen of *C. fistula* flower plays allergenic role. It showed 12% protein composition with amino acids such as proline, phenylalanine, glutamic acid and methionine. It also contain free amino acid, lipid and carbohydrate. Rastogi and Mehrotra, (2004)[11] isolated βsitosterol (0.006), its β D glucoside (0.02%) and aurantiamide acetate (0.011) from flower of *C. fistula*. Khare, (2007)[3] reported that flowers of *C. fistula* gave ceryl alcohol, kaempferol, rhein and a bianthraquinone glycoside and fistulin.

Tzakou *et al*., (2007)[12] reported the chemical composition of essential oil of *C. fistula* flower and 44 floral compounds are recognized. The chief constituent of the flower oil were 2-hexadecanone (17.0%) and (E)-nerolidol (38.0%). Flowers of *C. fistula* contain rhein, anthraquinone, oxyanthraquinone, volatile oil and tannin.[13,14] Srinivasan *et al*., (2011)[15], isolated fistulic acid from flower of *C. fistula*. Duraipandiyan *et al*., (2011)[16] identified active compound rhein from ethyl acetate extract of *C. fistula* flower**.** Hydroalcoholic extract of *C. fistula* flower contained tannins, glycosides, phenolic compounds saponins, flavonoids, steroids, triterpenoids carbohydrates, reducing sugars, anthraquinones, amino acids and protein and chloroform extracts contained anthraquinones, phenolic compounds, tannins and glycosides.[17] Flower extract *C. fistula* shows the presence of glycoside, alkaloids, some phenolic compounds and some resinous matters.[18] Jeyanthi (2012)[19] showed that ethanolic extract of *C. fistula* flower contain flavanoids, alkanoids glycosides, saponins, phytosterols, steroids, tannins, proteins and triterpenoids.

Methanolic extract of *C. fistula* flower showed presence of alkaloids, flavonoids, saponins, phenols, Tannins, Thiols, triterpenoids.[20]

2. Phytochemistry of pulp of pod

Kaji *et al*., (1968)[21] reported that pulp of pod of *C. fistula* contains protein 19.94%, carbohydrate 26.30%, arginine, leucine, methionine, phenylalanine, tryptophan, aspartic and glutamic acid. Fistulic acid isolated from pod and characterized tertramer had free glycol unit. Fruit of *C. fistula* is an important source of nutrients and energy which contain protein (19.94%) and carbohydrate (26.30%) content.[22] Extract of fruit of *C. fistula* was contain carbohydrates, alkaloids, glycosides, flavonoids, amino acids, protein, tannin, phenolic compounds, saponins, mucilage, gums, triterpenoids, steroids, sterols, fat, fixed oil and vitamin C.[23] Barthakur *et al*., (1995)[24] reported the edible fruit tissue of *C. fistula* is a rich source of potassium, calcium, iron and manganese. Anonymous, (2007)[25] shows that in pod pulp of *C. fistula* fructose 26.2%, sucrose 31.3%, glucose 42.5%, high concentration of potassium (180g mg/100g dry basis) 2-hentriacontanone, 5-nonatetracontanone was present. The pod pulp of *C. fistula* are rich in anthraquinone derivatives such as rhein, sennidin and sennoside.[26] Luximon-Ramma *et al*., (2002)[27] reported that pods of *C. fistula* having highest total phenolic proanthocyanidin and flavonoid contents and antioxidant potentials (TEAC-Trolox equivalent capacity) 992(0.4/mol/g dry weight; (FRAP-Ferric reducing antioxidant power) 811(23/mol/g dry weight).

Khare, (2007)[3]; Agarwal and Paridhavi (2005)[28] showed that in *C. fistula* pod pulp sennosides A and B, anthraquinone, glycosides, rhein and its glucosides, barbaloin, butyric acid and their ethyl esters, aloin formic acid, oxalic acid, tannin and pectin present. Gupta and Jain, (2009)[29] reported the phytochemical constitute like galactomqannan, polyphenols, proanthocyanidin in *C. fistula* legume. Sumi and Saj, (2012)[30] showed that in pod of *C. fistula* steroids, coumarins, saponins, alkaloids tannins was present in methnolic extract. They also analysed protein, carbohydrate, phenol amino acid, chlorophyll, tannin. Srinivasan *et al*., (2011)[15], isolated fistulic acid from pod of *C. fistula*. Agrawal *et al*., (2012)[31] isolated fistulic acid from the alcoholic extract of pod of *C. fistula.* They assigned structure of fistulic acid was 1, 4-dihydroxy-6, 7-dimethoxy-2-methylanthraquinone-3-carboxylic acid. Singh *et al*., (2012)[32] showed that methanolic extract of *C. fistula* powdered pod was showed presence of glycoside, steroids amino acids, flavonoids. They also showed antipyretic activity of *C. fistula* pod was due to bioactive constitute present in it. Ripe fruit of *C. fistula* flavonoids, saponin, terpenoids and tannins was present.[33]

Bhalodia *et al*., (2012)[34] observed that, in hydroalcoholic extract of *C. fistula* pod pulp flavonoids, steroids, saponins, glycosides, anthraquinones, triterpenoids, tannins, gum, mucilage, protein, amino acids, carbohydrates and reducing sugars and in chloroform extract phenolic compounds, tannins, anthraquinones, glycosides compounds are present in large amount. Pods extract *C. fistula* shows the presence of glycoside, alkaloids, some phenolic compounds and some resinous matters.[18] Sumi and Saj, (2012)[30] investigated that pod of *C. fistula* showed the presence of steroids, coumarins, saponins, alkaloids and tannin. Kumar *et al*., (2012)[35] showed presence of anthraquinone glycosides and tannins in pod of *C. fistula.*

According to Modi and Khorana (1952)[36], rhein was recognized as a significant anthraquinone derivative in the pulp of *C. fistula*. From the pods of *C. fistula*, 1, 8-dihydroxy-3 anthraquinone carboxylic acid was separated. This was confirmed by Kapadia and Khorana (1996).[37] Proanthocyanidins containing flavon-3-ol (epiafzelechin and epicatechin) units with 2S-configuration obtained from *C. fistula* pod.[38] Misra *et al*., (1996)[39] separated 5-Non atetracontanone, Triacontane, 2-Hentriacontanone, Beta-sitosterol and 16-Hentriacontanone from fruit of *C. fistula* and they also isolated in (1997) a new diterpene 3 beta-hydroxy-17 norpimar-8(9)-en-15-one. Rani and Kalidhar (1998)[40] isolated an anthraquinone derivative characterized as 3-formyl-1-hydroxy-8-methoxy0- anthraquinone was isolated from the pod of *C. fistula*.

Lee *et al*., (2001)[41] reported that in the aril of *C. fistula*, eight long-chain hydrocarbons, three sterols, one triterpene, eight anthraquinones, two coumarins, two chromones and three aromatic compounds.

According to Rastogi and Mehrotra, (2004)[11], fruit pulp of *C. fistula* contains carbohydrates (26.30 %), proteins (19.94%) and they isolated leucine, tryptophan, arginine, phenylalanine, methionine, glutamic and aspartic acids from pod pulp *C. fistula*. They also isolated a new dimeric proanthocyannidin CFI along with (-)catechin, epiafzelechin, (+), kaempferol, 1, 8-dihydroxy-3-methylanthraquinone, its structure and dihydrokaempferol. According to Barthakur *et al*., (1995)[24], the secondary metabolites present in fruit of *C. fistula*. fistucacidin (3,4,7,8,4'-pentahydroxyflavanoxyanthraquinone, dihydroxyanthrax quinone(-) epiafzelechin, (-) epiafzelechi-3-oglucoside, (-) epicatechin, procyanidin B2, biflavonoids, triflavonoids, rhein, rhein glycoside,sennoside A, sennoside B, chrysophanol, physcion, Kaempferol, leucopelargonidin rhein, fistulin, alkaloids, triterpenes Rhein, volatile oil, waxy and resinous derivative. Sartorelli *et al*., (2009)[42] isolated the active isoflavone biochanin A. This compound showed 50% effective concentration value of 18.96µg/ml against promastigotes of *Leishmania* (L) *chagasi.* An optically inactive leuco-anthocyanidin (3, 4, 7, 8, 4' pentahydroxyflavan), fistucacidin was extracted from the heartwood of *C. fistula.*[43]

3. Phytochemistry of seed

In seeds of *C. fistula* a carbohydrate, galactomannan composed of 8 different Kinds of sugar components was found. The seeds of *C. fistula* were rich sources of cephalin and lecithin phospholipid and contained 11.8% carbohydrate.[6, 44] A novel trypsin inhibitor was extracted from seed of *C. fistula*.[45] According Khare, (2007)[3] seeds of *C. fistula* give galactomannan free sugars and free amino acids. Subramanion *et al*., (2011)[46] showed that seed extract with high LD50 value. Due to this, plant is not toxic to human. Jothy *et al*., (2011)[47] showed that in methanolic seed extract of *C. fistula* anthraquinones, flavonoids, saponins, tannins, terpenoids present. They also proved that, the MS (mass spectroscopy) analysis on the active fraction show roseanone with antiyeast activity.

Kaji *et al*., (1968)[21] mentioned that, seed oil of *C. fistula* contain vernolic, sterculic and malvalic acids. Abu Sayeed *et al*., (1999)[48] observed that *C. fistula* seed oil was fractionated into mono, di, and tri-glycerids. They divided saturated and unsaturated fatty acids. Large amount of fatty acids found in the oil were palmitic acid (11.41%), stearic acid (14.33%), oleic acid (29.62%) and linoleic acid (42.42%). Myristic acid (1.44%) and caprylic acid (9.76%) were present in small amounts.

Kuo *et al*., (2002)[49] revealed that 4 new compounds isolated from seed of *C. fistula* are benzyl 2β-O-D-gluco-pyranosyl-3-6-dimethoxybenzoate, 2'S-7-hyxdroxy-5-hydroxymethyl-2-(2'-hydroxypropyl) chromone, 5-(2-hydroxyphenoxymethyl) furfural and benzyl 2-hydroxy-3, 6-dimethoxybenzoate. There are 4 compounds isolated from seed of *C. fistula* are 5-hydroxymethylfurfural, (2'S)-7-hydroxy -2-(2' hydroxypropyl)-5 methylchromone and two oxyanthraquinones, chrysophanol and chrysophanein. Yadav and Verma, (2003)[50] isolated a new bioactive flavones glycoside 1 (mp252^{o}c, 254^{o}c,C_{28} H_{32} O_{16}), (M) + 624 (EIMS) from the acetone soluble fraction of the *C. fistula* defatted seeds which was characterised as a new bioactive flavones glycoside 5,3',4'-tri hydroxyl-6-methoxy-7-O-alpha-L-rhamnopyranosy1-(1->2)-O-beta-D-galactopyranoside. CSL-1, CSL-2, CSL-3 separated from seed of *C. fistula* and they also showed in (2004) the lectins has maximum hemagglutinating activities around pH 7.2 to7.5 and a temperature range of 20^{0} to35^{0}.[51]

CONCLUSION

Cassia fistula is an important traditional and medicinal plant. Flower, pod and seed of *Cassia fistula* contains number of bioactive compounds such as anthraquinones, terpenoids phenolic compounds, tannins and glycosides. This phytochemical reviews on *Cassia fistula* will provide important information which is beneficial for pharmaceutical industries**.**

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