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Review Article

RECENT ADVANCES IN THE PHYTOCHEMISTRY OF SOME MEDICINALLY IMPORTANT CASSIA SPECIES: A REVIEW

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Medicinal plants possess unlimited and untapped wealth of chemical compounds with high drug potential which make these plants useful as sources of biomedicines. *Cassia* species have been of keen interest in phytochemical due to their excellent medicinal values. All *Cassia* species are an important rich source of secondary metabolites, notably anthraquinone derivatives and has been used in Chinese and Ayurvedic preparations. A review of phytochemistry of some medicinally important *Cassia* species has been presented, considering the fact that there are about 580 species of this genus scattered all around the world. Only 46 species have been phytochemically studied. Hence, in the present article, an attempt has been made to overview phytochemical studies in *Cassia* species which serves as a potential source for contribution in the modern system of herbal medicine.

Keywords: Medicinal plants, *Cassia*, phytochemical and herbal medicine

INTRODUCTION

Plants are an important source of medicines and play a key role in world health (Constabel, 1990). Almost all cultures from ancient times to today have used plants as medicine. Today medicinal plants are important to the global economy (Srivastava *et al.*, 1995), as approximately 85% of traditional medicine preparations involve the use of plants or plant extracts (Vieira and Skorupa, 1993). The medicinal properties of plant species have made an outstanding contribution in the origin and evolution of many traditional herbal

therapies. Many plants contain a variety of phytopharmaceuticals, which have found very important applications in the fields of agriculture, human and veterinary medicine. Plants have great potential uses, especially as traditional medicine and pharmacopoeial drugs. A large proportion of the world's population depends on traditional medicine because of the scarcity and high costs of orthodox medicine (Hudaib *et al.*, 2008). Over the past few years, however, the medicinal plants have regained a wide recognition due to an escalating faith in herbal medicine in

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view of its lesser side effects compared to allopathic medicine in addition the necessity of meeting the requirements of medicine for an increasing human population. Plant-derived substances have recently become of great interest owing to their versatile applications. Medicinal plants are the richest bio-resource of drugs of traditional systems of medicine, modern medicines, nutraceuticals, food supplements, folk medicines, pharmaceutical intermediates and chemical entities for synthetic drugs. Medicinal plants have provided the modern medicine with numerous plant-derived therapeutic agents (Oladunmoye *et al.*, 2009). Natural products play a dominant role in the development of novel drug leads for the treatment and prevention of diseases (Gilani and Rahman, 2005). Interestingly it is estimated that more than 25% of the modern medicines are directly or indirectly derived from plants. It is worth mentioning that Indian medicinal plants are considered as a vast source of several pharmacologically principles and compounds that are commonly used as home remedies against multiple ailments. In the past few decades there has been a resurgence of interest in the study and use of medicinal plants in health care and in recognition of the importance of medicinal plants to the health system (Hoareau and DaSilva, 1999). This awakening has led to a sudden rise in demand for herbal medicines, followed by a belated growth in international awareness about the dwindling supply of the world's medicinal plants (Bodeker, 2002). Most of the pharmaceutical industry is highly dependent on wild populations for the supply of raw materials

for extraction of medicinally important compounds. The need to screen plants for pharmaceuticals is particularly urgent in the light of rapid deforestation and the concurrent loss of biodiversity. Moreover, only a limited number of medicinal plants have received detailed scientific scrutiny thereby prompting the World Health Organization to recommend that this area be comprehensively investigated. With an ever increasing global inclination towards herbal medicine for healthcare and their boom in recent years has imposed a great threat to the conservation of natural resources and endangered plant species. Currently 4,000-10,000 medicinal plants are on the endangered species list and this number is expected to increase (Canter *et al.*, 2005). The genetic diversity of medicinal plants in the world are getting endangered at an alarming rate because of ruinous harvesting practice and over-harvesting for production of medicines, with little or no regard to the future. Also, extensive destruction of the plant-rich habitat as a result of forest degradation, agriculture encroachments, urbanization, etc., is other factors. Ethano pharmacological studies on such herbs/medicinally important plants are an area of interest for the investigators throughout the world. Although in traditional medicine *Cassia* species have been well known for their laxative and purgative properties and for the treatment of skin diseases, Still *Cassia* invites attention of researchers worldwide for its phytochemistry and pharmacological activities ranging from antidiabetic to antiviral.

Table 1: Taxonomical Classification of the Genus *Cassia*: Scientific Classification

Kingdom :	Plantae
Sub Division :	Spermatophyta
Division :	Magnoliophyta
Class :	Magnoliopsida
Sub Class :	Rosidae
Order :	Fabales
Family :	Fabaceae/Leguminoceae
Sub family :	Caesalpinioideae
Genus :	<i>Cassia</i>

GENERAL BOTANICAL DESCRIPTION AND PROPERTIES OF *CASSIA* SPECIES

Cassia is a large genus of around 500 species of flowering plants in the family Leguminosae (Lodha *et al.*; 2010) (Table 1) and is widely distributed throughout Asia including India, Mauritius, China, East Africa, South Africa, America, Mexico, West Indies and Brazil. *Cassia* species belong to the family Caesalpinioideae. Caesalpinioideae is often treated as a sub-family, Caesalpinioideae, of the large family Leguminosae. It is closely related to Mimosaceae and Papilionaceae, but can be distinguished by few stamens and five free petals. Caesalpinioideae consist of trees, shrubs and a few woody herbs found in the tropics. Economically, woody Caesalpinioideae is important for its timber. *Cassia* and *Tamarindus* species are used for medicinal purposes. All the species of *Cassia* have bright yellow flowers of characteristic shape. The typical flower consists of five similar sepals and petals. *Caesalpinioideae* usually have very small bracteoles, neither resembling nor taking the place of the calyx, which is normally developed and more or less conspicuous. Stamens which are polymorphic are 10 in number with the upper

2-3 often reduced. Pods could be cylindrical or flattened, dehiscent or indehiscent, with or without septa between seeds, constricted or not between seeds. Leaves are paripinnate. Petiolar glands are present (Hutchinson, 1973; Ghanzanfar, 1989)

***Cassia*: Nature's Excellent Gift to Biological Sciences**

Cassia species have been of keen medicinal interest in phytochemical and pharmacological research due to their excellent medicinal values. Plants belonging to *Cassia* species are used extensively in various parts of the world against a wide range of ailments, the synergistic action of its metabolite being probably responsible for the plants beneficial effects. They are well known in folk medicine for their laxative and purgative uses (Hennebelle *et al.*, 2009; and Verma *et al.*; 2010). Besides, they have been found to exhibit anti-inflammatory (Somchit, 2003), antioxidant (Yen and Chuang, 2000), hypoglycemic (Jalalpure *et al.*, 2004), hyperglycemic (Somachit, 2003), antiplasmodial (Iwalewa *et al.*, 1997), larvicidal (Yang *et al.*, 2003), antimutagenic (Silva *et al.*, 2008) and anticancer activities (Prasanna *et al.*, 2009). They are also widely used for the treatment of wounds (Joshi 2000), skin diseases such as ringworm, scabies and eczema, gastro-intestinal disorders like ulcers, uterus disorders (Elujoba *et al.*, 1999) rheumatism, anorexia and jaundice (Pieme *et al.*, 2006). In the Ayurvedic system of medicine this plant is also used for the treatment of fever and headache. The Ayurvedic Pharmacopoeia of India indicated the fruit pulp for constipation, colic, chlorosis and urinary disorders.

Ayurvedic Preparations

Cassia species are well known for their medicinal

and therapeutic importance. The drug has been known to Arabs for many centuries and it is believed that it was introduced into Indian and European medicine through them. One of the preparations known of *Cassia* is known as Constivac (Lupin Herbal) a bowel regulator, relieves constipation. It is also one of the ingredients of the preparations known as Pilex, Purian (Himalaya Drug Company) for piles and detoxifier, respectively (Mohd Danish *et al.*; 2011).

The therapeutic potentials, including antioxidant, antimicrobial and anticarcinogenic properties of higher plants are due to the presence of secondary metabolites (Kaur and Arora, 2009). Phytochemicals are natural bioactive compounds found in plants, including the medicinal plants, fruits, vegetables, flowers, leaves, roots and fibres, and they act as a defense system against diseases, or more accurately protect plants against diseases (Krishnaiah *et al.*, 2009). Some of the most important bioactive phytochemical constituents are the glycosides, alkaloids, flavonoids, tannins, steroids, terpenoids, essential oils and phenolic compounds (Edeoga *et al.*, 2005). Species of *Cassia* are rich sources of polyphenols, anthraquinone derivatives (Bahorun *et al.*, 2005; Ayo, 2010), flavonoids and polysaccharides. These biologically active chemical substances, known as secondary metabolites in medicinal plants, form the foundations of modern prescription drugs (Sofowora, 1993). Phytochemical investigations of crude plant extracts shows the presence of active principles in the plant parts like bark, leaves, flowers, roots, fruits, seeds, etc. Phytochemicals are nonnutritive plant chemicals that

have protective or disease preventive properties. Plant produces these chemicals to protect itself but research works demonstrates that many phytochemicals can protect humans against diseases. Knowledge of the chemical constituents of plants is desirable because such information will be of value for the synthesis of complex chemical substances. (Krishnaiah *et al.*, 2009).

The phytochemical studies of the medicinal plants have provided some biochemical basis for their ethnopharmacological uses in the treatment and prevention of various diseases and disorders (Okigbo *et al.*, 2009). This paper reviews the phytochemical screening of the various medicinally important species of *Cassia*, considering the fact that there are about hundreds of species of this genus which are distributed all around the world and many of them which occur in India.

PHYTOCHEMISTRY OF MEDICINALLY IMPORTANT CASSIA SPECIES

***Cassia Fistula* Linn**

Cassia fistula popularly called "Indian Laburnum" has been extensively used in Ayurvedic system of medicine for various ailments. It is scattered in Maharashtra throughout Deccan and Konkan. It is a deciduous tree with greenish grey bark, compound leaves, leaflets are each 5-12 cm long pairs. The fruit is cylindrical pod and seeds many in black. The pods are pendulous, cylindrical, smooth, shining, brown-black, and indehiscent, with numerous (40-100) horizontal seeds. Seeds broadly ovate, 8 mm. long and 5 mm thick. (Kirtikar and Basu, 2006) (Figure 1).

Figure 1: Plant of *Cassia fistula* L

MEDICINAL USES

The flower, pod and root is prescribed as a tonic, astringent, febrifuge and strong purgative (Gupta, 2010) and useful in fever, heart diseases, joint pain, migraine and blood dysentery. The fruits are reported to be used for asthma (Anonymous, 2007), 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)

PHYTOCHEMISTRY OF *CASSIA FISTULA* LINN

Vaishnava *et al.* (1993), Vaishnav and Gupta (1996) reported the presence of Rhamnetin 3-O gentiobioside while Rastogi and Mehrotra (2004) and Anonymous (2007) reported 7-methylphyscion, betulinic acid and β -sitosterol in the roots. Mondal *et al.* (1998) characterized the detailed biochemical analysis of flowers pollen,

and reported the composition of protein 12 %, carbohydrate 11.75%, lipid 12% and free amino acid 1.42%, respectively. Rastogi and Mehrotra (2004) Anonymous (2007) reported that the stem bark of *Cassia fistula* contains two flavonol 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, 1, 8-dihydroxy-3, 7-dimethoxyxanthone-4-O- α -L-rhamnosyl (1 \rightarrow 2)-O- β -D-glucopyranoside. Singh and Singh (2010) studied preliminary phytochemicals analysis from the mucilage of defatted seeds of *Cassia fistula* and confirmed the presence of carbohydrates, flavonoids, resins and phenols. Barthakur *et al.* (1995) reported that the fruit of *Cassia 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 While, Misra TN *et al.* (1996) isolated 5-Nonatetracontanone, 2-hentriacontanone, triacontane, 16 hentriacontanone and beta-sitosterol from the hexane fraction of the fruits. Later Sartorelli *et al.* (2009) isolated the active isoflavone biochanin A from dichloromethane extract of *Cassia fistula* fruits. Rastogi and Mehrotra (2004); Agarwal and Paridhavi (2005) and Nadkarni (2009); reported that fruit pulp contains sugar, gum, astringent matter, gluten, coloring matter and water proteins (19.94%) and carbohydrates (26.30%); arginine, leucine, methionine, phenylalanine, tryptophan, aspartic and glutamic acids; a new dimeric

proanthocyanidin CFI isolated along with (–) epiafzelechin, (+) catechin, kaempferol, dihydrokaempferol and 1, 8-dihydroxy-3-methylanthraquinone. Abu Sayeed *et al.* (1999) reported that the seed oil of seeds of *Cassia 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 linoleic acid (42.42%), oleic acid (29.62%), stearic acid (14.33%) and palmitic acid (11.41%). In addition to the above, caprylic acid (0.76%) and myristic acid (1.44%) were also present in minor amounts. Yueh-Hsiung Kuo *et al.* (2002), identified four new compounds from the seeds of *Cassia fistula*, 5-(2-hydroxyphenoxyethyl)furfural, (22S)-7-hydroxy-5-hydroxymethyl-2-(22-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, (22S)-7-hydroxy-2-(22-hydroxypropyl)-5-methylchromone, and two oxyanthraquinones, chrysophanol and chrysophanein. While Ali *et al.* (2003) isolated three lectins CSL-1, CSL-2 and CSL-3 from the *Cassia fistula* seeds. The neutral sugar contents of were estimated to be 3.5, 3.1 and 2.0%, respectively. The sugar composition of the lectins was found to be galactose in CSL-1, galactose and glucose in CSL-2, and galactose and mannose in CSL-3. Yadav *et al.* (2003)

isolated a new bioactive flavone glycoside from defatted seeds of *Cassia fistula*, i.e., 5, 3', 4'-trihydroxy-6-methoxy-7-O- α -L-rhamnopyranosyl-(1 \rightarrow 2)-O- β -D-galactopyranoside by several colour reactions, spectral analysis and chemical degradations. Rastogi and Mehrotra (2004), Anonymous, (2007) reported that the seed oil contains cyclopropenoid fatty acids, viz., vernolic, malvalic and stercularic acids. Two new aliphatic compounds, viz.; cis-Heptacosanyl-5-Hydroxypentadec-2-enoate 1 and octacosan-5,8-diol 2 have been isolated from the leaves of *Cassia fistula* by Singh *et al.* (2005). The structures of these compounds were elucidated by chemical and spectral studies. Agrawal and Paridhavi (2005) and Khare (2007) reported that pulp of the pod of *Cassia fistula* contains anthraquinone glycosides, Sennosides A and B, rhein and its glucoside, barbaloin, aloin, formic acid, butyric acid and their ethyl esters and oxalic acid, pectins and tannins. Apolar compounds including 5-nonatetracontanone, 2-hentriacontanone, tricontane, 16-hentriacontanol and β -sitosterol showing antibacterial activity has been isolated in *Cassia fistula* pods by Mishra *et al.* (1996). Proanthocyanidins containing flavan-3-ol (epiafzelechin and epicatechin) units with an abnormal 2S configuration have been observed in the pods along with common flavan-3-ols and Proanthocyanidins like catechin, epicatechin, procyanidin B-2 and epiafzelechin has been reported by Kashiwada *et al.* (1996). Later Mishra *et al.* (1997) isolated a new diterpene, 3 β -hydroxy-17-norpimar-8(9)-en-15-one. Meena Rani (1998) characterized an anthraquinone derivative - 3-formyl-1-hydroxy-8-methoxyanthraquinone 1 and Anonymous, (2007) reported that the pods of *Cassia fistula* contain 5-nonatetracontanone, 2-hentriacontanone.

Rastogi and Mehrotra (2004); analyzed aurantiamide acetate (0.011), β sitosterol (0.006) and its α D glucoside (0.02%). While, Chopra *et al.* (2006) and Gupta (2010) reported presence of anthraquinone, tannin, oxyanthraquinone, rhein and volatile oils from the flowers of *Cassia fistula*. Khare, (2007) reported that the flowers contain ceryl alcohol, kaempferol, rhein and a bianthraquinone glycoside, fistulin. Srinivasan *et al.* (2011) isolated a compound called fistulic acid from the pods and also from flowers of *Cassia fistula* (Figure 8). The isolated fistulic acid was subjected to UV, FTIR, ^1H and ^{13}C NMR spectral characterization to determine its purity and nature of functional groups present in it. Lee *et al.* (2001) reported that the aril of *Cassia fistula* contains 27 compounds including eight long-chain hydrocarbons, 1-hexacosanol, 1-octacosanol, palmitic acid, stearic acid, oleic acid, linoleic acid, heptacosyleicosanate, glyceryl-1-tetraeicosanoate; three sterols, β - sitosterol, stigmasterol, beta-sitosteryl-3-O Dglucopyranoside; one triterpene, lupeol; eight anthraquinones, chrysophanol, emodin, physcion, citreorosein, rhein, rhein methyl ester, ziganein, 1,4,5-trihydroxyanthraquinone; two coumarins, isoscopoletin, scopoletin; two chromones, 2,5-dimethyl-7- hydroxychromone, 2,5-dimethyl-7-methoxychromone, and three aromatic compounds, isovanillic acid, vanillic acid and 2,4-dihydroxybenzaldehyde. Their structures were determined on the basis of spectral data. The chemical compositions of essential oil of the flower of *Cassia fistula* was examined by Tzakou *et al.* (2007) by GC and GC/MS. The main components of the flower oil were (E)-nerolidol (38.0%), and 2- hexadecanone (17.0%). Chopra *et al.* (2006), Khare (2007) and Gupta, (2010) reported that leaves contain anthraquinone, tannin,

oxyanthraquinone free rhein, its glycosides- Sennosides A and B and volatile oils. Rastogi and Mehrotra (2004) and Anonymous (2007) investigated the cuticular wax of leaves and examined the presence of hentriacontanoic, triacontanoic, nonacosanoic and heptacosanoic acids. The leaf essential oil was examined by Tzakou O *et al.* (2007), which revealed the presences of phytol mainly (16.1%). Luximon-Ramma *et al.* (2002) investigated and characterized the contents of total phenolics, proanthocyanidin and flavonoids in vegetative and reproductive organs of *C. fistula* and showed that among the vegetative organs, the young and old leaves showed the highest total phenolic, flavonoid and proanthocyanidin contents.

CASSIA NIGRICANS (VAHL)

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

Figure 2: Plant of *Cassia nigricans* Vahl



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) (Figure 2).

MEDICINAL USES

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.

PHYTOCHEMISTRY OF *CASSIA NIGRICANS* VAHL

Chidume *et al.* (2001), and Ayo *et al.* (2007) investigated the preliminary phytochemical screening of the extracts of the leaves of *C. nigricans* Vahl which revealed the presence of carbohydrates, reducing sugars, anthracene derivatives, flavanoids, steroids, tannins, saponins, cardiac glycosides and alkaloids. The methanolic extract of the leaves of *Cassia nigricans* (Vahl) was investigated by Ayo *et al.* (2009). They identified the presence of five compounds 4- hydroxyanthraquinone-2-carboxylic acid; heptadecanoic acid, 14-methyl-methyl ester; bis (2-ethylhexyl) phthalate; β -cholest-3-ene and β -sitosterol acetate by gas chromatography/mass spectrometric analysis.. While, Obodozie *et al.* (2004); Ayo *et al.* (2007); Georges *et al.* (2008) reported an active constituent 1, 6, 8 trihydroxy-3-methylantraquinone (emodin). Bioassay-guided leaf extract of *C. nigricans* Vahl yielded anthraquinones, emodic acid, citreorosein and a flavonoid, Luteolin (Georges *et al.*, 2008).

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 a 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 (Figure 3).

Figure 3: Plant of *Cassia angustifolia* Vahl



MEDICINAL USES

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). The infusion of the plant is used in treating bronchitis, dysentery, fevers and hemorrhoids.

PHYTOCHEMISTRY OF *CASSIA ANGUSTIFOLIA* (VAHL)

Rastogi and Mehoratra (1993) reported the plant contains β -sitosterol (0.33%), sennoside A, B, C, D and aloe-amine in free and compound form. Bala *et al.* (2001), Shrivastava *et al.* 2006 and Upadhyay *et al.* (2011) revealed the presence of Sennosides A and Sennosides B from the leaves of *Cassia angustifolia*. Wang *et al.* (2007) isolated two new naphthalene glycosides from the seeds of *C. angustifolia* recently. A novel oleanen type triterpenoid glycoside has been isolated from butanolic seed extracts of *Cassia angustifolia* by Noor Khan and Shrivastava (2009) (Figure 8). Its structure was elucidated as 3-O- $\{\beta$ -D-glucuronopyranosyl-(1 \rightarrow 4)- $[\beta$ -D-galactopyranosyl-(1 \rightarrow 2)]- β -D-xylopyranosyl-(1 \rightarrow 3)- β -D-glucopyranosyl}-2, 16 α -dihydroxy-4, 20-hydroxy methyl olean-12-ene-28-oic acid on the basis of spectral evidence (i.e., FTIR, 1 H NMR, 13 C NMR and FAB-MS data). Chaubey and Kapoor (2001) reported that the seeds of *Cassia angustifolia* are an alternative source of commercial gums. They determined the structural aspects of the galactomannans for a better understanding of their properties. Methylation analysis, periodate oxidation, Smith degradation and 13 C NMR studies confirm that the gum has the basic structure of legume galactomannans with a main chain of (1 \rightarrow 4)-linked beta-D-mannopyranosyl units to which single alpha-(1 \rightarrow 6)-D-linked galactopyranosyl units are attached through block pattern.

CASSIA TORA LINN

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,

almost an under shrub about 30-90 cm high with pinnate leaves. Leaflets are in three pairs, opposite, obovate and oblong. Flowers are in pairs in axile of leaves with five petals and yellow colored. Pods are somewhat flattened or four angled 10-15 cm long and sickle shaped. The seeds are 30-50 in a rhombohedral pod. (Vaidya, 1994) (Figure 4).

Figure 4: Plant of *Cassia tora* Linn



MEDICINAL USES

Due to its moist quality, sweet flavor and cold property, *Cassia tora* is used to cure blurring vision. (Kirtikar and Basu, 1998). 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)

PHYTOCHEMISTRY OF *CASSIA TORA* L

Jain and Patil (2010) investigated the roots, flowers and seeds of *Cassia tora*. Roots contains

1, 3, 5 trihydroxy - 6 - 7 dimethoxy - 2 - methyl anthroquinone and β - sitosterol. Flowers consists of kaempferol and leucopelargonidin, While, seeds yield sitosterol from petroleum ether extract, chrysophanol, physcion, emodin, rubrofusarin from CHCl_3 extract and glycoside II and I from ethanolic extract. Glycoside II was identified as nitrofurarin-6- β -gentiobioside. The seed oil also contains different percentage of mixed fatty acids composition as palmitic, 6.70; stearic, 7.56; lignoceric, 10.05; oleic, 39.55; and linoleic, 36.14. Mukherjee, 2002; Soumyanath, 2005 and Yun Choi, 1990 reported that the leaves of *Cassia tora* are rich in emodin, tricontan-1-ol, stigmasterol, β -sitosterol- β -D-glucoside, freindlen, palmitic, stearic, succinic and d-tartaric acid, uridine, quercitrin and iso - quercitrin. Trease and Evans (1996), Soumyanath Amala (2005), Mukherjee (2002) and Jain and Patil (2010) reported that the seeds of *Cassia tora* contain naphtho-a-pyrone toralactone, chrysophanol, physcion, emodin, rubrofusarin, chrysophonic acid-9-anthrone. Three naphthopyrone glucosides, cassiaside, rubrofusarin-6-O- β -D-gentiobioside and toralactone-9-O- β -D-gentiobioside isolated from the butanol soluble extract of the seeds. This extract was tested for *in vitro* bioassay evaluation based on inhibition of activity on advanced glycation end products formation (AGEs) by Lee *et al.* (2006). In another study by Jang *et al.* (2007) nine Anthraquinones, aurantio-obtusin (1), chryso-obtusin (2) obtusin (3), chryso-obtusin-2-O- β -D-glucoside (4), physcion (5), emodin (6), chrysophanol (7), obtusifolin (8) and obtusifolin-2-O- β -D-glucoside (9) isolated from an EtOAc-soluble extract of the seeds of *C. tora*

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 (Figure 5).

Figure 5: Plant of *Cassia auriculata* L



MEDICINAL USES

The plant has been widely used in traditional system of medicine as a cure for rheumatism (Kirtikar and Basu, 2006) and conjunctivitis (Pari and Lata, 2002). The various parts of the plant were reported to exert a beneficial effect to alleviate the symptoms of diabetes (Surana *et al.*, 2008) and serves as an 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). The flowers are used to treat urinary discharges, nocturnal emissions and throat irritation. (Vedavathy and Rao, 1991)

PHYTOCHEMISTRY OF *CASSIA AURICULATA*

Yesu Raj *et al.* (2011) found fatty acid esters, fatty acid amide, terpenoids, diterpene alcohols, phytols as major compound groups in the methanol fractions from the seed extract of *Cassia auriculata* by GC- MS analysis. The chemical composition of the leaves of *Cassia auriculata* was investigated by Anandan *et al.* (2011) and revealed the presence of 3-O-Methyl- β -D-glucose (48.50%), α - Tocopherol- β -D-mannoside (14.22%), Resorcinol (11.80%), n-Hexadecanoic acid (3.21%), 13-Octadecenal, (Z)- (2.18%) and 1,2,3,4-Tetrahydroisoquinolin-6-ol-1-carboxylic acid (1.98%) which were identified by GC – MS analysis. Senthilkumar and Reetha (2011) isolated an antibacterial compound - Oleanolic acid from the leaves of *Cassia auriculata* and identified by IR spectrum, ^1H NMR, ^{13}C NMR and Mass spectrum studies (Figure 8). Juvekar and Halade (2006) investigated the flowers of *Cassia auriculata* which revealed the presence of anthroquinones, aloe emodin and sitosterols.

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). 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 (Figure 6).

Figure 6: Plant of Plant of *Cassia occidentalis* L



MEDICINAL USES

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).

PHYTOCHEMISTRY OF *CASSIA OCCIDENTALIS*

Yadav *et al.* (2010) reported that the main plant constituents in *Cassia occidentalis* include: achrosin, aloe-emodin, emodin, anthraquinones, anthrones, apigenin, aurantiobtusin, campesterol, cassiollin, chrysophanol, chryso-obtusin, chrysophanic acid, chrysarobin chrysoeriol, physicon, quarcetin, rhamnosides, rhein, sitosterols, tannins, and xanthorine. Yadava and Satnami (2011) isolated and elucidated the structure of three new compounds 1, 2 and 3 from

the seeds of *Cassia occidentalis*. They were characterized as 5, 7-dihydroxyflavone-5-O- β -D xylopyranoyl-7-O- β -L-rhamnopyranosyl-(1 \rightarrow 3) (Figure 8) O- β -L-arabinopyranoside (1), 3, 5, 7, 3, 4'-pentahydroxyflavone-3-O-L-rhamnopyranosyl-7-O- β -D-glucopyranosyl-(1 \rightarrow 3) O- β -D xylopyranoside (2) (Figure 8) and 5, 7, 3, 4'-tetrahydroxy-6-methoxyflavone-5-O- β -L-arabinopyranosyl (1 \rightarrow 4)-O- α -L-rhamnopyranosyl-(1 \rightarrow 3)-O- β -D-galactopyranoside (3), respectively. Three new C-glycosidic flavonoids, *Cassiaoccidentalis* A, B and C, were isolated from aerial parts of *Cassia occidentalis* by Hatano *et al.* (1999) and their structures with a 3-keto sugar were established on the basis of spectroscopic and chemical evidence.

CASSIA SOPHERA LINN

Cassia sophera, Linn known as 'Kasondi' is an important drug of Islamic System of Medicine (Unani Medicine). The plant is found throughout India It is common in waste lands, on road sides and in the forests. It's a perennial, erect, bushy herb with evergreen foliage which grows about 0-5 m. The leaves are oblong, lanceolate and

Figure 7: Plant of *Cassia sophera*



pinnately compound. Flowers are yellow colored (Figure 7).

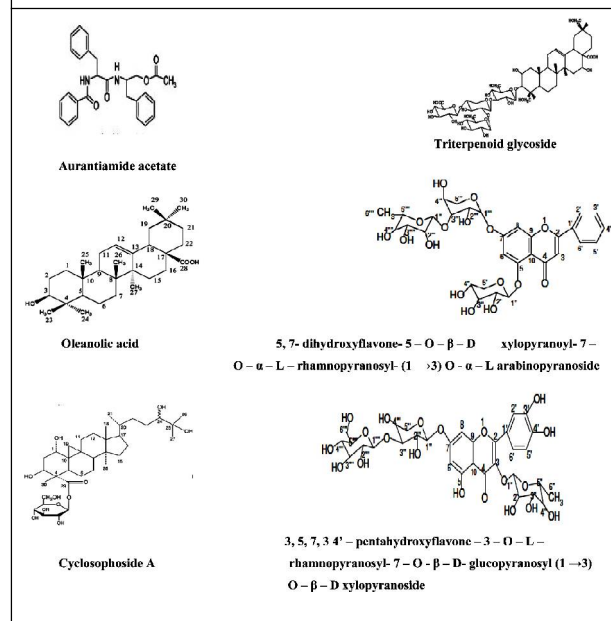
MEDICINAL USES

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)

PHYTOCHEMISTRY OF CASSIA SOPHERA

Cycloartane triterpene glycoside named Cyclosophoside A has been isolated by Yan *et al.* (2007) from the seeds of *Cassia sophera* (Figure 8). A new hydroanthracene derivative named presengulone named 9-(62-methoxy-32-methyl-32,82,92-trihydroxy-12-oxo-12,22,32,42-tetrahydro-anthracene-72-yl)-5,10-dihydroxy-2-methoxy-7-methyl-1,4-anthraquinone] was isolated, together with physcion, physcion bianthrone, xanthorin, floribundone-1,

Figure 8: Some Important Phytochemicals in *Cassia* Species



isosengulone, sengulone, and anhydrophlegmacin-9,10-quinones A2 and B2 has been isolated by Gizachew *et al* (1998).

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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