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## Pharmacological Potentials of *Cassia auriculata* and *Cassia fistula* Plants: A Review

<sup>1</sup>Sushma Kainsa, <sup>2</sup>Praveen Kumar and <sup>3</sup>Poonam Rani

<sup>1</sup>Maharishi Markandeshwar University, Mullana, Haryana, India

<sup>2</sup>Field Officer, Indian Farmers Fertilizers Cooperative Limited, Ambala City, Haryana, India

<sup>3</sup>Karnataka State Open University, Mysore, India

**Abstract:** People are using herbal medicines from centuries for safety, efficacy, cultural acceptability and lesser side effects. Plant and plant products have utilized with varying success to cure and prevent diseases throughout history. Therapeutically interesting and important drugs can be developed from plant sources which are used in traditional systems of medicines. Indian traditional system of medicine is based on empirical knowledge of observations and the experience over millennia and more than 5000 plants are used by different ethnic communities in India. *Cassia* is an indigenous medicinal plant genus, in which *Cassia auriculata* have large biodiversity in south India and *Cassia fistula* in north India. The present communication constitutes a review on the medicinal properties and pharmacological actions of *Cassia auriculata* and *Cassia fistula* used in Indian traditional medicine. These plants are known to contain various active principles of therapeutic value and to possess biological activity against a number of diseases.

**Key words:** *Cassia auriculata*, *Cassia fistula*, diabetes, pharmacology, traditional medicine, diasulin

### INTRODUCTION

The interest in medicinal plants has been shown all over the world because of safe and effective constituents of plant products and presence of active principles in medicinal plants (Ganesan *et al.*, 2009). From 2000 to 2005, annual sales for traditional medicines increased from US\$ 385 million to US\$ 1.29 billion. The prevalence and factors associated with its use is largely unknown, although the use is believed to be widespread. Patients and the public have been known to self prescribed herbal medicines for health maintenance for treatment or prevention of minor ailments and also for chronic illnesses (Aziz and Tey, 2009). Nowadays, the use of complementary alternative medicine and especially the consumption of botanicals has been increasing rapidly worldwide mostly because of the supposedly less frequent side effects when compare to modern western medicine (Hu *et al.*, 2003). India is a veritable emporium of medicinal and aromatic plants. It has been estimated that out of 15000 higher plants occurring in India, 9000 are commonly useful of which 7500 are medicinal, 3900 are edible, 700 are culturally important, 525 are used for fibre, 400 are fodder, 300 for pesticide and insecticide, 300 for gum, resin and dye and 100 for incense and perfumes (Rajendran *et al.*, 2008). The review informed about the traditional, pharmacological, chemical and toxicological profile of *Cassia fistula* and *Cassia auriculata* of genus *Cassia*.

### CASSIA AURICULATA

*Cassia auriculata* known as Tanner's *cassia* belongs to family Leguminosae. Its vernacular names as, Tanner's *cassia* (English), Tarwar (Hindi), Mataran Tea, Tanner's Tea (Malaysia), Avartaki, Pitapuspa, Pitakalika, Manojyna, Pitakala, Carmaranga (Sanskrit) and Tangedu (Telugu). Taxonomically it is classified as:

**Kingdom** : Plantae  
**Order** : Fabales  
**Family** : Leguminosae  
**Subfamily** : Caesalpinioideae  
**Genus** : *Cassia*

### TRADITIONAL USES

**Leaves and fruits:** The tea prepared from the leaves is used in chronic fever and fruits are used as antihelminthic (Joshi, 2000). Ratnam and Raju (2005) illustrated that the tribals of Eastern Ghats of Andhra Pradesh, make pills from ground leaves and fruits, which are given orally with limewater for 3 days for the treatment of leucorrhoea. It was observed that the Southern Indian tribals prepare paste from leaves in vinegar, which applied on skin for various skin diseases (Jeeva *et al.*, 2007; Kingston *et al.*, 2009). In Gundla Brahmeswaram Wild Life Sanctuary Andhra Pradesh, tribals dropped the juice of fresh

macerated leaves into ears in case of scorpion bite (Ratnam and Raju, 2008). It was also found that the tenders of leaves mixed with lime and is given once a day for treatment of stomachache (Nagnur *et al.*, 2009). Leaves and flowers are used for treatment of diabetes and for religious function in sacred grove of Pallapatty village (reserved forest), Madurai district, Tamil Nadu. (Ganesan *et al.*, 2009).

**Flowers:** Flowers are used for spermatorrhoea (Joshi, 2000). Dried powder of flowers mixed with goat milk and taken orally to prevent white discharge in Kancheepuram district of Tamil Nadu (Muthu *et al.*, 2006). The flowers are also used as food stuff by tribal people of Andhra Pradesh (Reddy *et al.*, 2007). Flowers are mixed with whole plant of *Enicostema axillare* and fruits of *Cuminum cyminum*, given to cattle along with grass for three days prevent heat diseases (Ganesan *et al.*, 2008).

**Other parts:** According to Ayurveda, the different parts of plant have been used for various ailments. Roots are useful in urinary discharges and cures tumours, skin diseases and asthma. Powder of bark is used for fixing teeth and decoction for chronic dysentery. Decorticated seeds in fine powder and paste are valued local applications to purulent ophthalmia and conjunctivitis (Joshi, 2000). The tribals of the Chittor district of Andhra Pradesh used various parts of the plant for the treatment of skin diseases, asthma, conjunctivitis and renal disorders (Vedavathy *et al.*, 1997). Tribals of Eastern Ghats of Andhra Pradesh uses whole plant and roots orally in form of pills with pinch of red soil for 3 days for Leucorrhoea (Ratnam and Raju, 2008). Valaiyan community of Piranmalai hills, Tamil Nadu flora tribal uses different part of *Cassia auriculata* in the treatment of body heat and cuts (Sandhya *et al.*, 2006). Tribal's mixed stem decoction, mixed with garlic and powdered pepper, given to cattle as purgative in Southern districts of Tamil Nadu (Rajendran *et al.*, 2008).

## PHARMACOLOGICAL PROFILE

**Antidiabetic activity:** The 50% ethanolic extract of flower and leaves was reported to have antiviral, antispasmodic and antilipidemic (Dhar *et al.*, 1968) and antipyretic activity (Vedavathy and Rao, 1991). The administrations of aqueous extract of the flowers for 30 days possess antihyperlipidemic effect in addition to antidiabetic activity at the doses of 0.15, 0.30 and 0.45 g kg<sup>-1</sup> b.wt. (p.o.). However, the extract dose of 0.45 g kg<sup>-1</sup> was found to be comparable to glibenclamide as an antidiabetic (Pari and Latha, 2002). Dose dependent reduction in serum

glucose level in normal and alloxan induced diabetic rats with aqueous leaf extract was reported by Sabu and Subburaju (2002) after 4 h duration. The extract was found to have no direct insulin like effect that can enhance the peripheral utilization of glucose.

Methanolic extract of flowers showed significant reduction of blood glucose response towards maltose ingestion and concurrently suppress insulin activity in sprague Dawley rats (Abesundara *et al.*, 2004). The safety evident and steady state serum level on concurrent administration of herbal tea prepared from flowers and aerial parts of *Cardiospermum halicacabum* and carbamazepine were investigated by Thabrew *et al.* (2004) in male albino Wistar rats. They demonstrated enhancement of bioavailability by 47.1%, when compared with the blood levels of animals receiving only carbamazepine, with no apparent changes in toxicity.

The comparative antidiabetic and hypolipidemic activity of aqueous extract of various parts (root, stem, leaves and flowers) were investigated in alloxan-induced diabetic rats. The results showed significant reduction in serum glucose, triglycerides, cholesterol and increases in plasma insulin levels with flowers and leave extracts at a dose of 250 mg kg<sup>-1</sup> b.wt. (p.o.) for 28 days (Devi *et al.*, 2006). The antidiabetic effect of aqueous extract of leaves at doses 150, 300, 500 mg kg<sup>-1</sup> b.wt., once daily for 30 days. They concluded dose dependent reduction in elevated glucose and lipid levels in diabetic rats. Anti-nociceptive activity in mice at 500 mg kg<sup>-1</sup> comparable was also observed (George *et al.*, 2007).

Hypoglycemic properties of ethanolic extract of *Cassia auriculata* leaves and flowers was reported in alloxan-induced diabetic rats at doses of 120 mg kg<sup>-1</sup> b.wt. for 15 days. The results of the experiment showed that both the extracts significantly reduced the blood glucose level, may be attributed to stimulated insulin secretion from the  $\beta$  cells or regenerate the  $\beta$  cells (Kalavani *et al.*, 2008).

Gupta *et al.* (2009a) administered the aqueous leaf extract at doses of 100, 200 and 400 mg kg<sup>-1</sup> b.wt. (p.o.) for 21 days, in mild and severe diabetic rats induced with streptozotocin. Reduction in blood glucose level in dose dependent fashion was observed. They revealed that extract at dose of 400 mg kg<sup>-1</sup> showed significant reduction in thiobarbituric reactive substances and oxidized low density lipid level in serum. The combined aqueous extract of *Cassia auriculata* and *Aegle marmelos* (1:1) at doses of 250, 350 and 450 mg kg<sup>-1</sup> b.wt. (p.o.) showed a significant reduction in glucose and lipid in serum on streptozotocin-induced diabetic rats in dose dependent manner. It also possessed increment in serum insulin and restoration of  $\beta$ -cells (Sivaraj *et al.*, 2009).

Hydromethanolic, butanolic and ethyl acetate fractions of flowers was effective in reducing blood glucose, lipids (especially triglycerides and cholesterol), protein level and restoring the body weight. However, n-butanolic fraction was highly effective and comparable with phenformin (Surana *et al.*, 2009). Aqueous extract of *Cassia auriculata* leaves showed dose dependent antihyperglycemic and hypolipidemic activity in streptozotocin-induced diabetes, at a dose of 100, 200 and 400 mg kg<sup>-1</sup> (Gupta *et al.*, 2009b).

**Hepatoprotective activity:** Aqueous extract of *Cassia auriculata* leaves was evaluated for hepatoprotective activity against alcohol intoxication at doses of 250 and 500 mg kg<sup>-1</sup> b.wt. orally once daily for 30 days. They reported tissue lipid lowering effect comparable to control group with a reversal of steatosis in the liver and spongiosis in the brain. The treatment with extract also showed significant improvement in body weight (Kumar *et al.*, 2002). At doses of 250 and 500 mg kg<sup>-1</sup> b.wt., p.o. aqueous extract showed hepatoprotective activity for 30 days against ethanol induced hepatotoxicity. They concluded that significant reduction in the level of hepatic marker enzymes along with elevated activities of super oxide dismutase and catalase enzymes in liver with restoration of serum vitamin A and C level (Rajagopal *et al.*, 2003).

**Antioxidant activity:** Aqueous extract of the flowers administered in diabetic rats (streptozotocin induced diabetes) showed antioxidant effect. After investigating antioxidants marker enzymes in the brain they observed significant increase, with decrease in thiobarbituric reactive substances and hydroperoxide formation comparable with glibenclamide (Latha and Pari, 2003). Agarwal (2007) reported that *Cassia auriculata* L. seedlings counteracted the induced oxidative stress with reduction in ascorbate, dehydroascorbate, glutathione/oxidized glutathione content at two doses assayed (7.5 and 15.0 kJ<sup>-2</sup>) if irradiated with ultraviolet B (UV-B).

Ethanollic and methanolic extracts of the flowers showed antioxidant activity which may due to presence of flavonoids and tannins. The aqueous and ethanolic extract of flowers at dose 0.25 and 0.5 g kg<sup>-1</sup> b.wt., p.o. for 30 days exhibited a significant (p<0.001) reduction in blood glucose, serum triglycerides, total serum cholesterol level and a remarkable increase in plasma insulin level. Normal restoration of liver marker enzymes with free radical scavenging activity at 50 µL aliquot of both extracts (Hakkim *et al.*, 2007; Kumaran and Karunakaran, 2007).

**Nephroprotective activity:** Nephroprotective activity of ethanolic extract of *Cassia auriculata* roots at doses of 300 and 600 mg kg<sup>-1</sup> b.wt. in cisplatin and gentamicin-induced renal injury in animals. Significant reduction in elevated blood urea, serum creatinine and normalization of histopathological changes in the curative regimen were observed (Annie *et al.*, 2005).

**Antibacterial activity:** Aqueous extract of the powered whole plant material showed significant antibacterial activity against *Bacillus subtilis*, *Staphylococcus aureus*, *Enterococcus faecalis* and *Escherichia coli*, *Staphylococcus epidermidis*, *Enterococcus faecalis* and *Escherichia coli* (Duraipandiyani *et al.*, 2006; Samy and Ignacimuthu, 2000). Girish and Satish (2008) analysed the antibacterial activities of aqueous and methanolic extracts of leaves of *Boerhaavia diffusa*, *Cassia auriculata*, *Cassia lantana*, *Eclipta alba* and *Tinospora cordifolia* against few bacterial species. The methanolic extract showed wider range of better antibacterial activity as compared with aqueous extract at same doses (50 µL). *Cassia auriculata* and *Cassia lantana* showed lesser zone of inhibition in all tested pathogenic bacteria when compared with other plant extracts.

**Anthelmintic activity:** The anthelmintic activity of aqueous extract of *Cassia auriculata* leaves (Awali), *Erythrina variegata* leaves (Pangora) and *Dioscorea bulbifera* bulbs (Kand) against earthworms (*Eisenia fetida*), tapeworms (*Raillietina spiralis*) and roundworms (*Ascaridia galli*) at 10-50 mg mL<sup>-1</sup> dose of each plant extract. They concluded that plant extract exhibited significant anthelmintic activity at highest concentration of 50 mg mL<sup>-1</sup> (Kosalge and Fursule, 2009).

**Anticancer activity:** *In vitro* anti-cancer activity of *Cassia auriculata* leaf extract was carried in human breast adenocarcinoma (MCF-7) and human larynx carcinoma (Hep-2) cell lines. Extract produced a dose dependent manner inhibition with IC<sub>50</sub> 400 and 500 µg for MCF-7 and Hep-2 cells, respectively and it may be through induction of apoptosis (Prasanna *et al.*, 2009).

**Immunomodulatory activity:** The immunomodulatory activity of methanolic extract in rats was evaluated by administered doses of 100 and 200 mg kg<sup>-1</sup> orally. The extract showed a significant stimulation of the cell mediated immunity in immune responses with the antigenic challenge by sheep RBCs, a significant increase in neutrophil adhesion and delayed type hypersensitivity response and no effects on the humoral immunity.

*Cassia auriculata* significantly potentiated the cellular immunity by facilitating the foot pad thickness responses to the sheep RBCs in sensitized rats with a dose of 50 and 100 mg kg<sup>-1</sup> the DTH response (Chakraborty, 2009).

**Herbal formulations:** The antihyperglycaemic effect of Diamed, a herbal formulation (aqueous extracts of *Azadirachta indica*, *Cassia auriculata* and *Momordica charantia*) were investigated in alloxan-induced diabetic rats at doses of 1.39 (0.25 g), 1.67 (0.30 g) or 1.94 (0.35 g) mL kg<sup>-1</sup>, p.o. for 30 days resulted in a significant reduction in blood glucose, glycosylated haemoglobin with an increase in plasma insulin and total haemoglobin. At dose of the 1.94 mL, formulation showed comparable antihyperglycemic effect as with 600 µg kg<sup>-1</sup> glibenclamide (Pari *et al.*, 2001).

Another polyherbal formulation Hyponidd, prepared from the mixture of the extracts of *Cassia auriculata* in combination with other nine plants such as *Eugenia jambolana*, *Momordica charantia*, *Melia azedarach*, *Pterocarpus marsupium*, *Tinospora cordifolia*, *Gymnema sylvestre*, *Enicostemma littorale*, *Embllica officinalis* and *Curcuma longa* exhibited antihyperglycemic and antioxidant activity against streptozotocin induced diabetic rats (Subash Babu and Prince, 2004).

Diasulin, a polyherbal prepared from *Cassia auriculata*, *Coccinia indica*, *Curcuma longa*, *Embllica officinalis*, *Gymnema sylvestre*, *Momordica charantia*, *Scoparia dulcis*, *Syzygium cumini*, *Tinospora cordifolia* and *Trigonella foenum* were evaluated for antihyperlipidemic and antiperoxidative effect. It showed significant (p<0.05) reduction in blood glucose, cholesterol, triglycerides, free fatty acids, phospholipids and increment in plasma insulin level at dose 200 mg kg<sup>-1</sup> b.wt., p.o. in alloxan-induced diabetic rats when administered for 30 days and found to be comparable with glibenclamide (Pari and Ramalingam, 2006).

Dinex, a polyherbal formulation prepared from the mixture of the aqueous extracts of *Cassia auriculata* in combination with *Eugenia jambolana*, *Gymnema sylvestre*, *Momordica charantia*, *Azadirachta indica*, *Aegle marmelos*, *Withania somnifera* and *curcuma longa*. It exhibited significant (p<0.05) hypoglycaemic activity in both normal and diabetic animal (Mutalik *et al.*, 2005).

Diakur, a polyherbal formulation composed of standardized aqueous extract of *Cassia auriculata*, *Salacia reticulata*, *Gymnema sylvestre*, *Mucuna pruriens*, *Syzygium jambolanum* and *Terminalia arjuna* have hypoglycaemic and anti-lipid peroxidative effect at

dose of 1600 mg kg<sup>-1</sup>, p.o. when administrated for 28 days in alloxan induced diabetic rats and rabbits (Joshi *et al.*, 2007).

Guruvayoorappan and Sudha (2008) evaluated the antidiabetic efficacy of Byesukar ethanol extract with reduction in serum and tissue lipid profile (cholesterol, triglycerides, phospholipids and free fatty acids), blood glucose, tissue glucose-6-phosphatase and fructose 1, 6-bisphosphatase activity at dose of 500 mg kg<sup>-1</sup> b.wt., p.o., when administered for 30 consecutive days.

The Garlip, a polyherbal drug showed antihyperlipidemic and antiperoxidative effect along with antidiabetic effect at dose of 200 mg kg<sup>-1</sup> b.wt., p.o. for 30 days, with significant reduction of blood glucose, lipid peroxides (TBARS and hydroperoxide) and tissue lipids (cholesterol, triglyceride, phospholipids and free fatty acids) in streptozotocin induced diabetic rats. Treatment with garlip and tolbutamide resulted in a significant reduction of blood glucose and increase in plasma insulin (Banu *et al.*, 2009).

**Toxicity profile:** Sabu and Subburaju (2002) carried out an acute toxicity studies of aqueous leafy extract of *Cassia auriculata* on normal healthy Albino Wistar male rats, at different doses (500, 1000, 2000 and 5000 mg kg<sup>-1</sup> b.wt., p.o.). They showed that the extract did not produce, any mortality up to the highest dose tested i.e., 5000 mg kg<sup>-1</sup>. In addition, animals did not exhibit any toxic signs like restlessness, respiratory distress, convulsions and coma.

In an acute toxicity study on adult albino Wistar male rats using ethanol extract of *Cassia auriculata* root suspended in acacia (2% w/v) up to a dose 3000 mg kg<sup>-1</sup> b.wt., p.o., observed that the alcoholic extract of *Cassia auriculata* root, did not produce any significant changes in the autonomic or behavioral responses, including death during the observation period (Annie *et al.*, 2005).

Acute toxicity studies of ethanol and aqueous extract of *Cassia auriculata* flowers on healthy adult male albino rats at a dose level of 100, 500, 1000 and 3000 mg kg<sup>-1</sup> b.wt., p.o. Acute toxicity studies revealed the non-toxic nature of the ethanol and aqueous extract of *Cassia auriculata* flowers in terms of mortality (Hakkim *et al.*, 2007).

Gupta *et al.* (2009a) studied the toxicity of aqueous extract of *Cassia auriculata* leaves at doses of 1000 and 2000 mg kg<sup>-1</sup> b.wt., p.o. once daily for a period of 3 weeks. The rats treated with 1000 and 2000 mg kg<sup>-1</sup> doses of extract did not show any drug-induced

physical signs of toxicity during the complete experimental period and no deaths were registered.

#### POLYHERBAL MARKETED FORMULATION OF *CASSIA AURICULATA*

**Hyponidd:** A polyherbal formulation hyponidd, prepared from the mixture of the extracts of *Cassia auriculata* in combination with other nine plants such as *Eugenia jambolana*, *Momordica charantia*, *Melia azedarach*, *Pterocarpus marsupium*, *Tinospora cordifolia*, *Gymnema sylvestre*, *Enicostemma littorale*, *Emblica officinalis* and *Curcuma longa* exhibited antihyperglycemic and antioxidant activity in Streptozotocin-induced diabetic rats (Subash Babu and Prince, 2004).

**Mersina capsule:** *Cassia auriculata*, *Gymnema sylvestre*, *Momordica charantia*, *Syzygium cumini*, *Phyllanthus emblica*, *Melia azadirachta*, *Trigonella foenum-graecum*, *Coccinia indica*, *Tinospora cordifolia*, Potassium carbonates, used as antidiabetic agent (Jarald *et al.*, 2008; Sateesh and Veeranjaneyulu, 2009).

**Dianex:** *Cassia auriculata*, *Gymnema sylvestre*, *Eugenia jambolana*, *Momordica charantia*, *Azadirachta indica*, *Aegle marmelos*, *Withania somnifera* and *Curcuma longa*. It is a polyherbal formulation, having hypoglycaemic activity in both normal and diabetic animals. It may be useful in the treatment of diabetes mellitus (Mutalik *et al.*, 2005).

**Diamed:** *Cassia auriculata*, *Azadirachta indica* and *Momordica charantia* (Jarald *et al.*, 2008). Diamed an herbal formulation, composed of the aqueous extract of *Cassia auriculata* showed significant reduction in blood glucose, glycosylated haemoglobin and increase in plasma insulin and total haemoglobin of rats with alloxan-induced experimental diabetes (Pari *et al.*, 2001).

**Aavirai kudineer:** *Cassia auriculata*, *Cassia fistula*, *Salacia prinooides*, *Cyperus rotundus*, *Saussurea lappa*, *Eugenia jambolana* and *Terminalia arjuna*.

**Madhumeha churna:** *Cassia auriculata*, *Azadirachta indica*, *Gymnema sylvestre*, *Eugenia jambolana*, *Ziziphus mauritiana*, *Curculigo orchiooides*, *Melochia corchorifolia*, *Michelia champaca*, *Cynodon dactylon*, *Murraya koenigii*, *Acacia catechu*, *Cassia fistula*, *Salacia oblonga* and *Momordica charantia* (Jarald *et al.*, 2008).

**Diasulin:** *Cassia auriculata*, *Coccinia indica*, *Curcuma longa*, *Momordica charantia*, *Scoparia dulcis*, *Gymnema sylvestre*, *Emblica officinalis*, *Syzygium cumini*, *Tinospora cordifolia*, *Trigonella foenum-graecum* (Jarald *et al.*, 2008). According to a study, diasulin a polyherbal drug decrease blood glucose level in alloxan induced rats. Diasulin, have flowers of *Cassia auriculata* in its formulation (Pari and Ramalingam, 2006).

#### *CASSIA FISTULA*

*Cassia fistula* is a fast-growing, medium-sized, deciduous tree which is now widely cultivated worldwide as an ornamental tree for its beautiful showy yellow flowers. *Cassia fistula* also known as golden shower belongs to the family Leguminosae (Joshi, 2000; API, 2000). Its vernacular names as, Kotamjla, Vyidhighjta, áampjka, Nopadruma (Sanskrit), Sonaroo (Assamese), Sondala (Bengali), Indian Laburnum, Purging *cassia* (English), Garamala, Garamalo (Gujrati), Amaltas (Hindi), Aragvadhya, Kakke, Kakke-gida, Kakkernara, Kakkedai (Kannada), Kriyangal Phali (Kashmiri), Konna, Kritamalam (Malayalam), Bahava, Garamala, Amaltas (Marathi), Sunari (Oriya), Amaltas (Punjabi), Sarakonrai, Sarak konnai, Sarak kondi, Sharakkonrai (Tamil) and Rela (Telugu). Taxonomically it is classified as:

**Kingdom :** Plantae  
**Order :** Fabales  
**Family :** Leguminosae  
**Subfamily :** Caesalpinioideae  
**Genus :** *Cassia*

#### TRADITIONAL USE

**Bark:** Decoction of *Cassia fistula* bark is used in treatment of leprosy and various skin disease and wound washing (Silja *et al.*, 2008). Paste of bark is used along with rose water and misri for painless delivery (Verma and Chauhan, 2007).

**Leaf:** Leaf of *Cassia fistula* used for the treatment of ringworm. Mulu Kurma tribe used *Cassia fistula* leaf paste is as poultice in leprosy and skin disease. Khampits people use leaves extract during indigestion (Sen *et al.*, 2008).

**Seeds:** People used *Cassia fistula* seed powder for the preparation of fermented food product by selective inhibition of spoilage bacteria in coconut toddy, which permitting the ongoing fermentation toddy into wine (Sekar and Marriapan, 2007). The sun dried seed mixed in

200-250 mL water or a cup of tea and administered internally twice a day for 3 days, for the treatment of diarrhoea (Tetali *et al.*, 2009).

**Pods:** Tribles of Rajasthan used decoction of *Cassia fistula* pods thrice a day for three days for the treatment of typhoid. During treatment excess intake of hen egg is prescribed to get rapidly relief from disease. Pods ash given along with honey for the treatment of cough in the children (Tetali *et al.*, 2009).

**Roots:** In Traditional Medicine, roots are used in the treatment of hematemesis, pruritus, intestinal disorders, leucoderma, diabetes, antipyretic, analgesic and laxative (Ansarullah *et al.*, 2009). The root of *Cassia fistula* is used by the Malamalsar tribes to revive the nervous system, which is paralysed by alcoholic intoxication (Yesodharan and Sujana, 2007).

**Pharmacological profile:** According to British Pharmacopoeia, *Cassia fistula* is widely used for its medicinal properties, its main property being that of a mild laxative suitable for children and pregnant women (Mukhopadhyay *et al.*, 1998).

Aqueous fraction produced a significant decrease in the glycemia ( $p < 0.001$ ) at 4 and 24 h with doses of 300 and 500 mg kg<sup>-1</sup> and at 1 and 4 h after the dose of 1000 mg kg<sup>-1</sup> ( $p < 0.001$ ). In the glucose tolerance test, the aqueous fraction of *Cassia fistula* produced a significant decrease ( $p < 0.05$ ) with the dose of 500 mg kg<sup>-1</sup> at 0.25 and 0.5 h. The 1000 mg kg<sup>-1</sup> dose produced a significant increase ( $p < 0.001$ ) at 0.25 and 2 h (Esposito Avella *et al.*, 1991). The hypocholesterolemic and hypoglycemic effects of the hexane extract of stem bark of *Cassia fistula* were investigated at doses 0.15, 0.30, 0.45 g kg<sup>-1</sup> b.wt. p.o. for 30 days that suppressed the elevated blood glucose levels in diabetic rats. As well as the extract at 0.45 g kg<sup>-1</sup> was found to be comparable with glibenclamide (Nirmala *et al.*, 2008).

Bhakta *et al.* (1999) reported n-hexane extract of *Cassia fistula* leaves produced hepatoprotective effect against carbon tetrachloride: liquid paraffin (1:1) induced toxicity at doses of 400 mg kg<sup>-1</sup> in rats. Methanol extract of 90% of stem bark was considered more potent as compare to leaves (90% ethanol extract), flowers and pulp as antioxidant (Siddhuraju *et al.*, 2002). The alcohol extract of *Cassia fistula* leaves were analysed for antibacterial effect against *Staphylococcus aureus* and *Pseudomonas aeruginosa*. A 10% (w/w) plant extract ointment was topically applied on the infected wound. *Cassia fistula* treated rats showed, better wound closure, improved tissue regeneration at the wound site and supporting histopathological parameters pertaining to wound healing (Kumar *et al.*, 2006).

Methanolic and aqueous extracts of *Cassia fistula* bark having significant ( $p < 0.01$ ) anti-inflammatory effect against carrageenan and cotton pellet induced inflammation at the doses of 250 and 500 mg kg<sup>-1</sup> b.wt. (p.o.). Aqueous extract shows comparable activity to diclofenac and more potent as compare to methanol extract (Ilavarasana *et al.*, 2005). Different extracts (i.e., hexane, chloroform, ethyl acetate, methanol and water) of the flower of *Cassia fistula* exhibited antibacterial activity against gram-positive organisms with MIC between 0.078 and 2.5 mg mL<sup>-1</sup>. Fraction of ethyl acetate extract also exhibited antifungal activity against *Trichophyton mentagrophytes* (MIC-0.5 mg mL<sup>-1</sup>) and *Epidermophyton floccosum* (Duraipandiyar and Ignacimuthu, 2007). Isoflavone isolated from dichloromethane extract of *Cassia fistula* fruits and evaluated for antileishmanial activity with EC50% of 18.96 µg mL<sup>-1</sup> against promastigotes of *Leishmania chagasi*. The cytotoxicity of this substance against peritoneal macrophages was evaluated with EC50% of 42.58 µg mL<sup>-1</sup> (Sartorelli *et al.*, 2009).

Possible modulatory influence of aqueous extract of *Cassia fistula* seeds was analysed on biochemical constituents of uterus. Post-coital administration of contragestive doses (100, 200 and 500 mg kg<sup>-1</sup> b.wt./day) of aqueous extract of seeds of *Cassia fistula* from day 1-5 post coitum resulted in a statistically significant decline ( $p < 0.001$ ) in the acid phosphatase activity and glycogen content ( $p < 0.01$ ) when compared with control pregnant rats. While the activity of alkaline phosphatase, cholesterol and sialic acid concentration remained significantly unchanged, as compared to the controls on day 15 post coitum (Yadav and Jain, 2009).

**Toxicological profile:** As per OECD-423 guidelines acute oral toxicity was studied using Albino Wistar rats up to the doses of 2000 mg kg<sup>-1</sup> of aqueous and methanol extract of *Cassia fistula* bark and concluded that up to these dosage levels extract did not show any mortality (Ilavarasana *et al.*, 2005).

#### POLYHERBAL MARKETED FORMULATION OF *CASSIA FISTULA*

**Purim ingredients (per tablet):** *Cassia fistula*: 36 mg, *Curcuma longa*: 36 mg, *Psoralea corylifolia*: 36 mg, *Saussurea lappa*: 36 mg, *Picrorhiza kurroa*: 36 mg, *Azadirachta indica*: 32 mg, *Tinospora cordifolia*: 32 mg, *Crataeva magna*: 32 mg, *Emblica officinalis*, *Terminalia chebula* and *Terminalia bellerica*: 31 mg, *Embelia ribes*: 31 mg, *Eclipta alba*: 31 mg *Andrographis paniculata*: 31 mg.

Table 1: Chemical constituent of *Cassia auriculata* and *Cassia fistula*

Plant name	Plant part	Name of constituent	References
<i>Cassia auriculata</i>	Leaves	Polysaccharides, flavonoids, anthracene derivatives, dimeric procyanidins, myristyl alcohol, $\beta$ -sitosterol $\beta$ -D-glucoside, quercetin 3-o-glucoside, rutin, di-(2-ethyl)-hexyl phthalate, ketoalcohols, emodin, goratensidine, auriculacacidin, Alkane-nonacosane-6-one, saponins, steroids, alkaloids, tannins, phenolic substances and tannins	Joshi (2000), Rao <i>et al.</i> (2000) Kalavani <i>et al.</i> (2008) and Chakraborty (2009)
	Bark	Tannins	Joshi (2000)
	Flowers	$\beta$ -sitosterol, kaempferol, rhein, glucoside, Flavonoids, phenolic acids, steroids/ terpenoids, tannins and anthocyanins	Joshi (2000), Hakkim <i>et al.</i> (2007), Kumaran and Karunakaran (2007) and Surana <i>et al.</i> (2009)
	Plant	Goratensidine, (-) auriculacacidin, emodin, rubiadin, nonacosane and fisetinidols	Sastry (2004)
<i>Cassia fistula</i>	Roots	Flavonoids, polysaccharides, tannins and saponins	Rao <i>et al.</i> (2000) and Rao <i>et al.</i> (2001)
	Bark	lupeol, $\beta$ -sitosterol, hexacosanol, oxy-anthraquinone and their derivative, flavonoids, dihydroxyanthraquinone	Abu <i>et al.</i> (1999) and Rani and Kalidhar (1998)
	Flowers	4-hydroxy benzoic acid hydrate	Rani and Kalidhar (1998) and Duraipandivan and Ignacimuthu (2007)

**Pilex ingredients (per tablet):** *Cassia fistula*: 32 mg, Balsamodendron mukul: 0.26 mg, Shilajeet: 32 mg, *Azadirachta indica*: 14 mg, *Berberis aristata*: 64 mg, *Embllica officinalis*: 32 mg, *Terminalia chebula*: 32 mg, *Terminalia bellirica*: 32 mg, *Bauhinia variegata*: 32 mg, *Mesua ferrea*: 6 mg.

**Orthoease capsules:** Orthoease is a poly herbal supplement for joint care. Formulation is manufactured using standardized herbal extracts. Each capsule contains: *Cassia fistula*, *Abutilon indicum*, *Acorus calamus*, *Adhatoda vasica*, *Alpinia galanga*, *Asparagus racemosus*, *Boerhaavia diffusa*, *Boswellia serrata*, *Cedrus deodara*, *Commiphora mukul*, *Coriandrum sativum*, *Cyperus rotundus*, *Ipomoea turpethum*, *Kaempferia galanga*, *Peucedanum graveolens*, *Piper longum*, *Sida cordifolia*, *Solanum melongena*, *Strobilanthes ciliatus*, *Tinospora cordifolia*, *Tragia involucrata*, *Tribulus terrestris*, *Withania somnifera*, Yogaraj guggulu Choornam and *Zingiber officinale*.

**Hadensa capsule:** *Cassia fistula*, *Argyrea speciosa*, *Plumbago zeylanica*, *Terminalia chebula*, *Embllica officinalis*, *Terminalia belerica*, *Embelia ribes*, *Zingiber officinalis*, *Piper nigrum*, *Piper longum*, *Abies webbiana*, *Azadirachta indica*, *Curcuma aromatica*, *Withania somnifera*, *Vitex negundo* and *Ipomea turpethum*.

**Xpiles tablet:** *Cassia fistula*, Pure guggul, *Azadirachta indica*, *Mimosa pudica*, *Aegle marmelos*, *Mukta shukti*, Bhasma shilajeet (Shudh), *Embllica officinalis*, *Terminalia chebula*, *Terminalia belerica*, *Berberis aristata*, *Mesua ferrea* and *Bauhinia variegata*.

**Gudlax:** Five gram powder contains Aragvadh majja (*Cassia fistula*) Sonamukhi (*Cassia angustifolia*) and Haritaki (*Terminalia chebula*): 1.39 g, Yashtimadhu (*Glycyrrhiza glabra*) and Shatapushpa (*Foeniculum vulgare*): 0.70 g each and Saindhav lavan (Rock salt): 0.12 g (Data obtained from market survey).

## CHEMICAL CONSTITUENTS

Various chemical constituents present in the different parts of *Cassia auriculata* and *Cassia fistula* are summarised in Table 1.

## CONCLUSION

Thus, the review ascertains the value of plants used in tribal medicine, which could be of considerable interest in the development of new drugs. The genus *Cassia* definitely holds promise of providing potent drug for both chronic and acute diseases like diabetes mellitus and others. *Cassia auriculata* and *Cassia fistula* subjected to antidiabetic investigations; in animal models, have reported favorable results. *Cassia*, single and in combination with other herbs, has shown potent pharmacological activities. Considering in account, the drug-resistance and cost-effectiveness, the genus *Cassia* can be exploited for clinical studies for justifying their pharmacological effect. It is also clear that much needs to be discovered, both as to the active ingredients and their biological effects. The information summarized here is intended to serve as a reference tool to researchers in the fields of ethanopharmacology.

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