



BIOACTIVE CONSTITUENTS, ETHNOBOTANY AND PHARMACOLOGICAL PROSPECTIVES OF CASSIA TORA LINN.

Satish A Bhalerao^{1*}, Deepa R Verma², Nikhil C Teli², Rohan V Gavankar², Ashwin A Trikannad² and Parinita P Salvi²

¹Environmental Sciences Research Laboratory, Department of Botany, Wilson College, Mumbai-400 007, University of Mumbai, India

²Department of Biological Sciences, VIVA College, Virar (w)-401 303, University of Mumbai, India

Received for publication: August 11, 2013; Revised: September 23, 2013; Accepted: September 27, 2013

Abstract: *Cassia tora* Linn. (Family: Leguminosae) is one of the well-known herb as well as a common weed in most of the Asian countries. In India, Different parts of these plants are known for its medicative value as an antioxidant, antimutagenic, antidiuretic etc. In Ayurveda this plant constitutes as “Dadrughan- vati” which helps in treatment of skin diseases like ring worm, leucoderma, eczema etc. It is an anthroquinone containing plant which also has a certain bioactive compounds such as emodin, rhein, palmatic, isostearic, etc. The present review deals with bioactive compounds, traditional uses, and pharmacological perspectives of *Cassia tora* Linn.

Keywords: Anthroquinone, *Cassia tora* Linn., Eczema, Medicative, Pharmacological

INTRODUCTION

Cassia tora Linn. (Caesalpinaceae) is a small annual, erect, shrub like herb which grows in warm moist soil throughout the tropical parts of Asian and African countries; with a height of 30 to 90 cm. It grows as a wild shrub mostly in the tropical regions and is considered as a weed in most places. Its native range is not well known but it is mostly found in South Asia¹. It is often confused with Chinese Senna or Sicklepod, *S. obtusifolia*. It is mainly found in the states of Uttar Pradesh and Madhya Pradesh, in India. In Himachal Pradesh it mostly grows as a weed in waste disposal sites, roadsides, field border etc². It occurs frequently in hot, wet and tropical climates^{3,4}.

The trunk of *Cassia tora* Linn., is straight, woody, profusely branched however hairy stem end regions are rare. It has pinnate leaves, which are about 10 cm long. Each leaf has three pairs of leaflets that are opposite, ovate, oblong and oblique at the base⁵. The yellow colored flowers are bearded in the axel of the leaves. The flowers comprises of five petals, each about half inch in diameter. The seeds of *Cassia tora* are rhombohedral and brown in color, about 30 to 50 in number. The plant bears flowers in the rainy season and fruits in the winter.

This plant popularly known as Foetid Cassia, Tora, Sickle Senna, Wild Senna, Sickle Pod, Coffee Pod, Tovar, Chakvad and Ringworm Plant. The *Cassia tora* is also known as Charota and Chakvad in Hindi, Chakunda in Bengali and Oriya, Kawaria in Gujarati, Chakramandrakam in Malayalam, Takala in Marathi, Chakramarda & Dadmari in Sanskrit, Tagarai in Tamil and Chinnakasinda in Telugu^{6,7}.

Herbals which form a vital part of our nutrition and provide an supplementary therapeutic effect which is in demand and *Cassia tora* is one such plant. It is a medicinal plant whose properties are². Traditionally, it is used as a tonic, carminative and stimulant. Its leaves, seeds, and roots are used medicinally, primarily in Asia^{8,9,10}. Plant is widely used to treat vitiated tridosha, skin diseases, dandruff, constipation, cough, hepatitis, fever, and hemorrhoids. The seed of *C. tora* has tremendous potential in the field of pharmaceuticals as it processes antioxidant activity and contain many active substances including chrysophenol, emodin, rhein etc¹¹. Many medicinal properties such as antimicrobial, antihepatotoxic and antimutagenic activities have been known to this plant^{12,13,14}. *C. tora* leaves, seeds and roots are also utilized as food ingredients⁸. *Cassia tora* Linn. (Sans: Chakramardha) is already mentioned in the ancient Ayurvedic Literature. A literature survey indicated its use against various skin diseases such as ringworm, eczema, and scabies^{15,16}.

Table.1: Botanical classification of *Cassia tora* Linn.

Family Name	Caesalpinaceae
Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Rosidae
Order	Fabales
Family	Fabaceae
Subfamily	Caesalpinioideae
Tribe	Cassieae
Sub-tribe	Cassinae
Genus	<i>Cassia</i>
Species	<i>Tora</i>
Botanical Name	<i>Cassia tora</i> Linn.

*Corresponding Author:

Dr. Satish A Bhalerao,
Environmental Sciences Research Laboratory,
Department of Botany, Wilson College,
Mumbai-400 007, India





Figure.1: *Cassia tora* Linn.

(Source: ayurvedicmedicinalplants.com)

Bioactive Constituents

Phytochemical analyses of the plant extracts along with callus extracts are found to contain anthrone, flavonoids, glycoside and anthracene derivatives. Its formulation includes 1-2% volatile cassia oil, which is largely accountable for the spicy aroma and taste. The leaves have approximately 72 percent water, 10 percent petroleum ether extract, 0.90 percent ether extract, 1.60 percent absolute alcohol extract and 20 percent watery extract. The chief chemical constituents of *Cassia tora* include cinnamaldehyde, gum, tannis, mannitol, coumarins, and essential oils it also contains sugars, resins, and mucilage, among other constituents¹⁷.

Leaves:

Preliminary phytochemical tests of leaf showed the presence of polyphenols which driven researchers to estimate its antioxidant and antiproliferative potential¹⁸. Leaves principally contains, myricyl alcohol, anthraquinone glycosides, d-mannitol beta-sitosterol, and Flavonoids. Emodin, tricontan-1-ol, stigmasterol, β -sitosterol- β -D-glucoside, freindlen, palmitic, stearic, succinic and d-tartaric acids uridine, quercitrin and isoquercitrin were also detected in *Cassia tora* L. Leaves also contain Kaempferol-3-diglucoside^{19,20}. A prospective hepatoprotective constituent, Ononitol monohydrate, was isolated from *C. tora* leaves²¹.

Seeds:

Seeds contained, emodin, subrofusarin, chrysophanic acid, 1, 8-dihydroxy anthroquinone, beta-sitosterol rein like aglycones, cassiaside, rubro-fusarin, torosachryson, quercetin and its analog²². Various phenolic glycoside including novel compounds were isolated from seeds of *Cassia tora* (Leguminosae) which are torachryson tetraglucoside, nor-rubrofusarin gentiobioside, demethylflavasperone gentiobioside, torachryson gentiobioside, rubrofusarin triglucoside and torachryson apioglucoside, were identified on the basis of spectroscopic and chemical data²³. Two new naphtha-pyrone glycosides, 9(β -D-glucopyranosyl-1(6)-O- β -D-glucopyranosyl)oxy]-10-hydroxy-7-

methoxy-3-mehtyl-1H naphtho [2,3-c]pyran-1-one and 6-O- β -D-glucopyranosyl)oxy]-rubrofusarin, jointly with cassiaside and rubrofusarin-6- β -gentiobioside were also identified from the seeds of *Cassia tora* L²⁴.

Roots:

Roots have anthraquinones, beta- sitosterol and it also includes some amount of Choline, 1, 3, 5-trihydroxy-6, 7-dimethoxy-2-methyle anthraquinone²⁵, chrysophanic acid, Myricyl alcohol, 9-anthrone, Naphtho- α -pyrone, Phycion, Rubrofusarin, toralactone, Leucopelargonidin-3-O- α -L-rhamnopyranoside and 6- β -gentiobioside²⁶.

Other parts:

Pods are rich in sennosides. Flowers are reported to contain leucopelargonidine and Kaemferol. The roots of *C. tora* showed the occurrence of 1,3,5-trihydroxy, 6,7-dimethoxy-2-methyle anthraquinone, leucopelargonidine and β -Sitosterol^{27, 28}. The Stem bark of this plant contains behenic acid, arachidic acid, isostearic acid, palmitic acid, marginic acid, linoleic acid, phenolics like emodine, Hexahydroxy flavones, rhein, and a Hydroxycoumarin²⁷.

Ethnobotany

In Ayurveda, *Cassia tora* is broadly used in 'Pamari Taila' as well as 'Dadrughani Vati'²⁸. Conventionally it is used as a carminative, tonic, and stimulant. Its leaves, seeds, and roots are used medicinally²⁹. Sennosides, which are well acknowledged for their medicinal significance, have been detected in the leaves of the plant²⁰. According to Ayurveda the leaves and seeds are laxative, acrid, liver tonic, antiperiodic, anthelmintic, cardiotoxic, ophthalmic and expectorant. The leaves of *C. tora* are reported to have antirheumatic activity in traditional practice. Chakramardha tailamu it is a compound ayurvedic oil of this herb which is valuable in treatment of eczema, ringworm and other skin diseases¹⁶. The seeds of *C. tora* have been extensively utilized in Chinese medicine as antiasthnic aperients, and as a diuretic agent. It is also set to improve visual activity and to take care of liver disorders³⁰. In Korea, the hot extract of seeds is taken orally for protection of liver³¹. As a folk remedy, the seeds are often roasted, then boiled in water to produce a tea and used as a substitute for coffee³².

The leaves and seeds are of use in cardiac disorders, dyspepsia, leprosy, ringworm, colic, constipation, flatulence, cough and bronchitis. Pods are used in dysentery as well as to treat eye diseases. Root is known to be bitter, tonic, stomachic and is antidote against snake bite^{34,35}.

In Andhra pradesh, the tribal people had been using the leaves of this plant grounded along with peppers and water into a paste, for the treatment of

Jaundice³⁶. The leaves are alterative, aperient, antiperiodic and given to children suffering from intestinal disorders³⁷. The leaves, roots, and even the whole plant are engaged in cure of ulcers, helmenthiasis, impetigo and as a purgative³⁸. The pounded leaves are useful as poultice on cuts and wounds similar to tincture-iodine and for ulcers to hasten suppuration³⁹. Decoction of leaves is a mild laxative in doses of 5 to 15 ml, especially for children suffering from fever while teething. Poultice of the leaves is applied locally in gout, sciatica and pains in the joints.

Cassia tora powder made from *Cassia tora* seeds and *Cassia tora* splits are some ancient natural herb products. In India, *Cassia tora* is used as a natural pesticide in organic farms. The seeds yield yellow, blue and red coloured dyes used in dyeing and tanning therefore *Cassia tora* powder is most popularly used in the pet-food industry. It is mix with guar gum for use in mining and other industrial application⁴⁰.

According to Chinese Material Medica, it enhances blood circulation, and its cold nature makes it efficient in the treatment of heat syndromes. Seed tarts ailments due heat such as blindness, conjunctivitis, hyperdacryosis, and others. Conventionally Chinese healers use this herb to treat conjunctivitis, blindness, and xerophthalmia. The seeds are reputed in Chinese medicine as vision improving, antiasthenic, aperient, diuretic and an effective agent in lowering cholesterol and reducing blood pressure⁴¹.

Young and tender leaves and stems are eaten as a vegetable and in soups. The unripe fruits are also cooked and eaten. The seeds can be introduced as a protein rich food for livestock. Other applications of *Cassia tora* Linn. are in abnormal child birth, vermicide, cold, epilepsy, night blindness, scabies, scorpion bite, stomachache and in bone fracture⁴².

Pharmacological Prospective:

Cassia tora Linn., has been found to display varied pharmacological activities. Several research workers have reported diverse biological activities of *C. tora* in various in vitro and in vivo experimental models. It is a medicinal plant traditionally used as laxative, for the treatment of leprosy and various skin disorders. The phytochemical analysis of leaf showed the presence of polyphenols. The occurrence of phenolic compound prompted us to evaluate its antioxidant and antiproliferative potential. There are a variety of pharmacological applications, which have been described in detailed in following headings:

- I. **Anti-Oxidant Activity:** Anti-oxidants can work as free lipid peroxidation inhibitor, radical scavengers and savior to other free radical mediated processes, protecting the human organs against numerous pathologies such as, Alzheimer's disease, atherosclerosis Parkinson's disease and cancer⁴³ was recommended that polyphenols may protect cell ingredients against oxidative damage and, by that mean they limit the risk of different degenerative diseases linked with oxidative stress. The polyphenolic content of *C. tora* is high (3.7 g kg⁻¹) in dried leaves. Observing the fact of rich polyphenolic content in dried leaves of *C. tora*, in mind, Rejiya et al.(2009) evaluated the nitric oxide scavenging activity of methanolic leaves extract of *C. tora* and reducing power assays using Rutin and BHT(butyl hydroxytoluene) as standards. The extract was also well thought-out for its lipid peroxidation inhibition assay using rat liver and brain. The methanolic extract of seeds of *C. tora* (MECT) shows stronger antioxidant activity. It was established that MECT shows stronger antioxidant activity as compared to Alpha-tocopherol. Emodin was demonstrated as antioxidant component of MECT 30. The phenolic active component, alaternin and nor-rubrofusarin glucoside separated from extract of *C. tora* also effectively showed a free radical scavenging activity⁴⁴.
- II. **Anti-Microbial Activity:** Antimicrobial Activity was observed in the chloroform, methanol and aqueous extracts of leaves of *C. tora* L. Methanolic extracts also showed antifungal activity. In-vitro study by Das et al. (2010) four strains of *Staphylococcus aureus*, five strains of *Shigella dysenteriae*, and three strains of *Escherichia coli*, have shown sensitivity against in vitro treatment of the methanol extracts. The consequence of phenolics glycoside, their aglycones and numerous other compounds structurally related to them on *Pseudomonas aeruginosa* PA 01, *E. coli* K12, and some strains of *Staphylococcus aureus* were observed. Among them, torolactone, torochryson, rhein, aloe-emodin and emodin exhibited clear antibacterial effect on four strains of methicillin resistant *Staphylococcus aureus* with minimum inhibitory concentration of 264µg/ml^{45,46}. The leaf extract has expressed considerable antifungal activity to inhibit the growth of *Aspergillus niger*, *Candida albicans*, *Sachharomyces cerevisiae* and *Trichophyton mentagrophyte*⁴⁷. It also expresses antifungal activity owing to the presence of chrysophenol and chrysophanic acid- 9-anthrone and other anthraquinones such as physcion, emodin, and rhein^{48,49}.
- III. **Anti-Diabetic Activity:** Nam and Choi (2008) studied the activities of *C. tora* L. seed butanol

fraction (CATO) on postprandial glucose control and insulin secretion from the pancreas of the normal and streptozotocin induced diabetic rats. They examined that in normal rats fed with CATO have lower postprandial glucose levels. In diabetic rats, the levels in the CATO fed group have lower postprandial glucose during the 30–180 min. It was prescribed orally to the diabetic rats for 5 days, the 12 hr fasting serum glucose level was exhausted in the diabetic rats⁵⁰. The reduction in 12 hr fasting serum insulin level was less in the diabetic CATO rats than diabetic control rats. The results of this study indicated that components of *C. tora* L. seeds have favorable effect on postprandial blood glucose control which may be partly mediated by stimulated insulin secretion from the pancreas of the diabetic rats⁵¹.

- IV. **Anti-Inflammatory Activity:** The Methanolic extract of the leaves of *C. tora* exhibited good activity against serotonin, histamine, carageenin and dextran induced rat hind paw oedema in a dose dependent manner⁵². It exhibited significant anti-inflammatory activity in opposition to these agents.
- V. **Immunostimulatory Activities:** *Cassia tora* Linn. is an non poisonous wild plant. In a study by Cherng et al. (2008) the immunostimulatory activities of four anthraquinones of *C. tora* (rhein, chrysophanol, aloe-emodin and emodin) on human Peripheral Blood Mononuclear Cells (PBMC) were evaluated. The results mentioned that at non-cytotoxic concentrations, the anthraquinones were competent in increasing the proliferation of resting human PBMC and/or secretion of interferon- γ (IFN- γ). However, at the concentration of 10 ng mL⁻¹, rhein significantly stimulated⁵⁰ proliferation of resting human PBMC, but inhibited IFN- γ secretion⁵³.
- VI. **Hepatoprotective Activity:** The various extracts of seeds of *Cassia tora* have been examined for cytoprotection against galactosamine toxicity in primary cultured hepatocytes. Significant hepatoprotective effect against toxicity of galactosamine in primary cultured rat hepatocytes have been showed by Methanolic extract of seeds. Methanolic extract at a dose of 400mg/ml orally have shown significant protective effect by lowering the serum level of transaminases in rats. The % Cytoprotection of different isolates observed from the methanol extract of seeds of *C. tora* were also studied against galactosamine toxicity in primary cultured hepatocytes. The naphtha-pyrone glycosides were found to have significant hepatoprotective effect against galactosamine damage²¹. Rajan et al. (2009) found that (*in-vivo* model of rat) *C. tora* leaves methanol extract had a positive effect in protecting liver against Carbon tetrachloride (CCl₄) induced liver damage. It has also been reported that Ononitol monohydrate lowered the levels of serum transaminase, lipid peroxidation and TNF- α but amplified the levels of antioxidant and hepatic glutathione enzyme activities. However when compared with reference drug silymarin ononitol monohydrate had high hepatoprotective activity. Histo pathological results also recommended the hepatoprotective activity of ononitol monohydrate with no adverse effect. Hence that ononitol monohydrate is a potent hepatoprotective agent⁵⁴.
- VII. **Antifertility Activity:** *C. tora* leaves extract (200mg/100mg/Kg body weight) showed maximum antifertility activity in Female rats. The antifertility activity of the drug has been observed to be related to oestrogenic activity⁵⁵.
- VIII. **Anti-Proliferative Activity:** Rejiya et al. (2009) found the anti-proliferative potential of *C. tora* methanolic extract of leaves with Cisplatin, anticancer drug in human cervical cancer cells (HeLa). This study confirmed that *C. tora* methanolic extract strongly inhibited the growth of human cervical cancer cells⁵⁶.
- IX. **Antigenotoxic Properties:** The water extracts from *C. tora* (unroasted), noticeably decreased the mutagenicity of 2-amino-6-methylpyrido imidazole (Glu-P-1) and 3-amino-1, 4-dimethyl-5H-pyrido (4, 3- β) indole (Trp-P-1). While the roasted *C. tora* have less antigenotoxic potency than the unroasted one and it may be due to the reduction in their anthraquinones during roasting⁵⁷.
- X. **Purgative Effect:** The methanolic extract of *C. tora* leaves was observed to possess purgative action. Seeds have been used as a purgative, mostly due to the presence of aloe-emodin, emodin and anthraquinone glycosides^{58,59,60}.
- XI. **Spasmogenic and Antinociceptive Activity:** The methanolic extract of leaves was examined in guinea pig ileum, rabbit jejunum and mice intestinal transit for antinociceptive and spasmogenic effect. The extract contracted smooth muscles of guinea pig ileum and rabbit jejunum in a concentration dependent manner which is reversibly blocked by Atropine. The extract augmented intestinal transit in mice. The extract also notably reduced the number of acetic acid induced abdominal constrictions in mice and the effect was equal to that of Aspirin. The extract also significantly condensed the nociceptive response of mice to increases force, which is dose

dependent. Thus the use of *C. tora* conventionally as purgative and in treatment of other ailments is adequate.

- XII. **Hypolipidemic Activity:** Ethanolic extract and its ether soluble and water soluble fractions were examined for their hypolipidemic activity against triton induced hyperlipidemic profile. It reduced serum and triglyceride level of total LDL cholesterol but amplified HDL cholesterol level by different percentages. Soluble fibers isolated from the seeds expressed the hypolipidemic level due to their phenomenal rheological behavior and lipid metabolism. The soluble fibers increases fecal lipid excretion and showed significant hypolipidemic effect due to noticeable reduction in serum concentration of total cholesterol and triglyceride level^{62,63}.
- XIII. **Antimutagenic Activity:** The antimutagenic activity of a methanolic extract of roasted *C. tora* seeds against Aflatoxin-B₁ (AFB₁) was established with *Salmonella typhimurium* assay. The number of relevant per plate decreased significantly when the extract was added to assay system using *Salmonella typhimurium* TA100 and or TA98. Alaternin and isorubrafusarin gentiobioside found to acquire antimutagenic activity⁶⁴.
- XIV. **Antitumor Activity:** Emodine, an anthraquinone, present in root and bark of *C. tora* possess anti-tumor activity. It exhibits inhibitory effect on angiogenic and metasis regulatory process. Because of its quinine like structure, emodin may hamper with electron transport process and in changing cellular redox status, which may affect its cytotoxic property⁶⁵.
- XV. **Oxytocic Activity:** The seeds of *C. tora* include oxytocic principle. It was found to be effective in producing the contraction of isolated uterus of guinea pig. The claim for oxytocic principle from the seeds lacks reliability due to lack of experimental data⁶⁶.
- XVI. **Antihelmintic Activity:** Alcohol and aqueous extracts of *C. tora* seeds demonstrated antihelmintic activity against *Ascaridia galli* and *Pheretima posthuma* due to the presence of flavonoids. Both the extract showed antihelmintic activity at maximum concentration of 100mg/ml⁶⁷.

CONCLUSION

Cassia tora Linn., is one of the wild herbs which is well known for its medicinal attributes. Various bioactive compounds present in stem, roots, seeds, leaves as well as its pods this particular plant. Hence *Cassia tora* Linn., has shown tremendous applications in

both traditional and modern medical practices. It contains some of the useful bioactive compounds like anthraquinone glycosides, phenolic compounds, myricyl alcohol, steroids, flavonoids etc. The pharmacological profile reveals it to be for its good anti-oxidant activity, anti-microbial activity, anti-diabetic activity, anti-inflammatory activity, immunostimulatory activities, hepatoprotective activity, antitumor activity, oxytocic activity, antihelmintic activity etc. In future the standardization and stabilization studies on *Cassia tora* leaves extract can be carried out which can help in proving it to be a promising source in pharmaceutical as well as nutraceutical industry.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to: Dr. V.J. Sirwaiya, Principal, Wilson College; Management, VIVA Trust, Virar (W) Maharashtra. K.P.N. Kutty, Co-Ordinator, VIVA Trust, Virar (W) Maharashtra; Dr. R.D. Bhagat, Principal, VIVA College, Virar (W) Maharashtra; Non-Teaching Staff, Dept. Biological sciences, VIVA College Virar (W) Maharashtra.

REFERENCES

- Nadkarni RM, Indian Materia Medica, 1954, 1, 291.
- Jain SK, Medicinal Plants, 1968, 37.
- Acharya TK, Chatterjee IB, Isolation of chrysophanic acid-9-anthrone, the major antifungal principle of *Cassia tora*, Lloydia, 38, 1975, 218-220.
- Hatano T, Uebayashi H, Ito H, Shiota S, Tsuchiya T, Yoshida T, Phenolic constituents of *Cassia tora* seeds and antibacterial effect of some naphtholones and anthraquinones on methicillin-resistant staphylococcus aureus, Chemical and Pharmaceutical Bulletin, 1991, 47, 121-127.
- Sharma PC, Yelne MB, Dennis TJ, Database of Medicinal Plants used in Ayurveda, 2005, 144-148.
- Nadkarni KM, Indian Materia Medica, 2009, 1, 291-292.
- Singh VK, Khan AM, Medicinal Plants and Folklores - A Strategy towards Conquest of Human Ailments, 1990, 9, 67.
- Ingle A, Ranaware P, Ladke A, Damle M, *Cassia tora*: Phytochemical and pharmacological activity, Int Imperial J Pharmacognosy Natural Products, 2012 2, 14-23.
- Kirtiker KR, Basu BD, Indian Medicinal Plants, 1975, 2, 30-45.
- The Ayurvedic Pharmacopoeia of India part-I volume-III First edition pp.153.
- Huang KC, Anti hypercholesterolemic herbs, The Pharmacology of Chinese Herbs, 1993, 103.
- Wong SM, Wong MM, Seligmann O, Wagner H, New antihepatotoxic naphthopyrone glycosides from seeds of *Cassia tora*, Planta Medica, 1989, 55, 276-280.

13. Choi JS, Lee HJ, Park KY, Ha JO, Kang SS, In vitro antimutagenic effects of anthraquinone aglycones and naphthopyrone glycosides from *Cassia tora*, *Planta Medica*, 1997, 63, 11–14.
14. Yen GC, Chung DY, Antioxidant effects of extracts from *Cassia tora* L. prepared under different degrees of roasting on the oxidative damage to biomolecules, *Journal of Agricultural Food Chemistry*, 1999, 47, 1326–1332.
15. Quality Standards of Indian Medicinal plants volume VI page no.76-85.
16. The wealth of India a raw material, volume-3:(ca – ci) CSIR New Delhi Revised edition 1992:368-370.
17. Singh VK, Khan AM, Medicinal Plants and Folklores - A Strategy towards Conquest of Human Ailments. Vol. 9. Today & Tomorrow Printers & Publishers, 1990:67.
18. Rejiya CS, Cibir TR, Abraham A. Leaves of *Cassia tora* as a novel cancer therapeutic-An in vitro study. *Toxicology in vitro*, 2009, 23, 1034-1038.
19. Shibata S, Morishita E, Kaheda M, Kimura Y, Takido M, Takashashi S, *Chem Pharm Bull*, 1969, 17, 454.
20. Raghunathan K, Hariharan V, Rangaswami S, Chrysophanol-1- β -gentiobioside, a new anthraquinone glycoside from *Cassia tora* Linn., *Indian J Chem*, 1974, 12, 1251-1253.
21. Ignacimuthu S, Dhanasekaran M, Agastian P, Potential hepatoprotective activity of ononitol monohydrate isolated from *Cassia tora* L. on carbon tetra chloride induced hepatotoxicity in wistar rats, *Phytomedicine* 16, 2009, 891–895.
22. Yen GC, Chen HW, Duh PD, *J Agric Food Chem*, 1998, 46, 820–824.
23. Patil UK, Saraf S, Dixit VK, *J. Ethnopharmacol*, 2004, 90, 249–252.
24. Hatani T, Hiroshi U, Hidey KI, Sumico S, Tomofusa T, Takashi Y, Phenolic constituents of *Cassia* seeds and Antibacterial effect of some naphthalenes and anthraquinones on methicillin resistant *Staphylococcus aureus*, *Chem Pharm Bull*, 1999, 47, 1121-1127.
25. Anonymous. The Wealth of India: A Dictionary of Indian Raw Materials & Industrial Products, Publications & Information Directorate, C.S.I.R., Vol.3:368-370.
26. Chatterjee A, Pakrashi SC, The Treatise on Indian Medicinal Plants. Vol. 2(Revised). CSIR, 1992:45.
27. Tiwari RD, Behari JR, Chemical examination of roots of *Cassia tora*, *Planta Med.*, 1972, 21,395.
28. Thakur RS, Puri HS, Husain A, Major Medicinal Plants of India, 1st edition, 1989, 143.
29. Chatterjee A, Pakrashi SC, The Treatise on Indian Medicinal Plants. Vol. 2(Revised). CSIR, 1992:45.
30. Nikado T, Ohmoto T, Sankawa U, Kitanaka S, and Takido M, *Chem Pharm Bull*, 1984, 32, 3075.
31. Yun HS, Chang IM, *Korean J Pharmacognosy*, 1977,8, 125.
32. Jain SK, Dictionary of Indian Folk Medicines and Ethnobotany, 1991, 2, 14.
33. Kirtikar KR, Basu BD, *Indian Medicinal Plants with Illustration*, 2003, 4, 1227-1229.
34. Kapoor LD, *CRC Handbook of Ayurvedic Medicinal Plants*, CRC Press, 108-109.
35. Hemadri K, Rao SS, Jaundice: Tribal Medicine. *Ancient Sci Life*, 1984, 3, 209-212.
36. Dastur JF, *Medicinal Plants of India and Pakistan*, D.B. Taraporevala sons & Co. Pvt. Ltd. Bombay, 1962, 52.
37. Manojlovic I, Bogdanovic-Dusanovic G, Gritsanapan W, Manojlovic N. Isolation and identification of anthraquinones of *Caloplaça cerina* and *Cassia tora*. *Chem Pap* 2006, 60, 466-468.
38. Deore SL, Khadabadi SS, Kamdi KS, Ingle VP, Kawalkar NG, Sawarkar PS, Patil UA and Vyas AJ, *In-vitro* antihelmintic activity of *Cassia tora*, *Chem Tech*, 2009, 1(2), 177-179.
39. Wallis TE, *Text book of pharmacognosy*. fifth edition T.A. Churchill; London, 1967, 571-582.
40. Soni PL, Singh SV, Naithani S, Modification of *Cassia tora* seed gum and its application as beater additive in paper making. *Inpaper International*, 2000, 5, 14–17.
41. Foster S, Chongxi Y, Major Chinese medicinal herbs-weeds, In: *Herbal Emissaries, Bringing Chinese herbal to the west*. Healing Arts Press, Vermont, 1992, 311-317.
42. Jain SK, *Dictionary of Indian Folk Medicines and Ethnobotany*, 2nd ed. Deep Publications, New Delhi, 1991:14.
43. Mates JM, Perez-Gomez C, Castro IND, 1999, Antioxidant enzymes and human diseases. *Clin Biochem*, 32, 595-603, 9120-9199.
44. Chakrabarty K, Chawla H, Terpenoids and phenolics from *Cassia tora* stem bark, *Indian J Chem*, 1983, 22, 1165-1166.
45. Hatani T, Hiroshi U, Hidey KI, Sumico S, Tomofusa T, Takashi Yoshida, Phenolic constituents of *Cassia* seeds and Antibacterial effect of some naphthalenes and anthraquinones on methicillin resistant *Staphylococcus aureus*, *Chem. Pharm. Bull.*, 1999, 47(8), 1121-1127.
46. Sinha M, Tiwari PV, Screening of antifertility activity of certain indigenous drugs, South East Asian Seminar on Herbs and Herbal Medicine Patha, 1999, 55-62.
47. Lemli J, Cuveela, J *Chromatography of anthrone glycosides of purgative drug*, *Planta Med*, 1974, 26, 193.
48. Mukharjee PK, Saha K, Das J, Saha BP, Pal M, Antifungal activity of the leaf extract of *Cassia tora* linn, *Phytother Res*, 1996, 10, 521-522.
49. Acharya TK, Chatterjee IB, Isolation of chrysophanic acid –9-anthrone, a fungicidal compound from *Cassia tora*, *Sci Cult*, 1974, 40, 376.
50. Santosh Kumar Shukla et al., *On Line Journal of Biological Sciences*, 2013, 13, 13-17.
51. Nam J, Choi H,. Effect of butanol fraction from *Cassia tora* L. seeds on glycemic control and insulin secretion in diabetic rats. *Nutr Res Pract*, 2008, 2, 240-246.
52. Maity TK, Mandal SC, Mukharjee PK, Saha K, Das J et al, 1998, Studies on anti-inflammatory effect of *Cassia tora* leaf extract (fam. Leguminosae), *Phytother Res*, 12 221-223.
53. Chergn, JM, Chiang W, Wang JH, Lin CM, Shin CM et al., 2008, Anthraquinones of edible wild vegetable *Cassia tora* stimulate

- proliferation of human CD4+ T lymphocytes and secretion of interferon-gamma or interleukin 10, Food Chem, 107, 1576-1580.
54. Ignacimuthu S, Dhanasekaran M, Agastian P, Potential hepatoprotective activity of ononitol monohydrate isolated from *Cassia tora* L. on carbon tetra chloride induced hepatotoxicity in wistar rats, Phytomedicine, 2009, 16 , 891–895.
 55. Cho IJ, Lee C, Ha TY, Hypolipidemic effect of soluble fiber isolated from seeds of *Cassia tora* Linn, in rats fed a high cholesterol diet, J Agric Food chem, 2007, 55, 1592-1596.
 56. Rejiya CS, Cibir TR, Abraham A, 2009. Leaves of *Cassia tora* as a novel cancer therapeutic-An invitro study, Toxicol Vitro, 23, 1034-1038.
 57. Wu CH, Yen GC,. Antigenotoxic properties of *Cassia tea* (*Cassia tora* L.): Mechanism of action and the influence of roasting process, Life Sci, 2004, 76, 85-101.
 58. Chidume FC, Kwanashie HO, Adekeye JO, Wambebe C, Gamaniel KS, Antinociceptive and smooth muscle contracting activities of the Methanolic extract of *Cassia tora* leaf, J Ethnopharmacology, 2002, 81, 205-209.
 59. Pal M, Roy DK, and Pal PR, Emodine from the leaves of *Cassia tora* Linn, Indian J Pharm, 1977, 39, 116-117.
 60. Maitya TK, Winda SC, Purgative activity of *Cassia tora* leaf extract and isolated *Aloe emodin*, Indian J Pharm Sci, 2003, 93-95.
 61. Wu CH, Hsieh CL, Song TY and Yen GC, Inhibitory affects of *Cassia tora* L. on Benzo[a]pyrene-mediated DNA damage toward HepG2 cells, J Agric Food Chem, 2001, 49, 2579-2586.
 62. Grow-Chin Y, Horn-wen C, Pin-der D, Extraction and Identification of an antioxidative component from *Cassia tora* Linn, J Agri Food Chem, 1998, 46, 820-824.
 63. Patil UK, Saraf S, Dixit VK, Hypolipidemic activity of seeds of *Cassia tora* Linn, J Ethnopharmacol, 2004, 90, 249-252.
 64. Roopshree TS, Raman D, Shobha Rani RH, Narendra C, Antibacterial activity of antipsoriatic herbs: *Cassia tora*, *Momordica charantia* and *Calendula officinalis*, Int J Appl Res Nat Prod, 2008, 1, 20-28.
 65. Choi JS, Lee H, Park KY, *In vitro* antimutagenic effect of alateranin and rubrofusarin gentiobioside from roasted *Cassia tora*, Natural Product Sciences, 4, 1998, 100 -104.
 66. Acharya TK, Chatterjee IB, Isolation of chrysophanic acid –9-anthrone, The major antifungal Principle of *Cassia tora*, Lloydia, 1975, 38, 213.
 67. Yogindernath, Chopra IC, Rao PR, Oxytocic principle from the seeds of *Cassia tora*, Current Sciences, 1962, 31, 285.

Source of support: Nil

Conflict of interest: None Declared