Review Article

Phytochemical And Pharmacological Potential of Cassia Tora Linn

Vipul V. Dhasade[1]*, Ravindra Y. Patil[2], Krunal G. Kanase[3], Vivek B. Ingale[4]
[1,3,4]Assistant Professor, Professor[2] , [1,2,3,4]Department of Pharmacognosy
[1,2,3,4]PDEA"s SU College of Pharmaceutical Sciences and Research Centre, Kharadi, Pune Maharashtra, India.

Corresponding Author:
Mr. Vipul V. Dhasade
E-mail: vipuldhasade2009@gmail.com

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Abstract:

Cassia tora Linn (Leguminosae) is a shrub, has been widely used for a management of human as well as pet"s abnormalities in folk medicine. *C. tora* commonly found in waste grounds and secondary forest. Many novel aromatic components discovered after systematic investigation of pimenta leaves and its unripe berries, mostly terpenoids, glycosides, steroids, alkaloids, tannins, saponins, polyphenols etc. The chemical constituents reported from this plant belong to different classes such as glycosides, tannins, flavonoids, steroids, resins and sugars. *C. tora* has number of medicinal uses, many of which have been verified by scientific methods. The chemistry and pharmacological profile of *C. tora* has been summarized in present review article.

Key Words:*Cassia tora,* ethnopharmacology, phytochemicals, anthraquinone glycoside, aromatic components.

Introduction:

Cassia tora Linn. Belongs to family Leguminosae is a sessional shrub. This is very common weed throught India, Ceylon and tropics generally. It is commonly known as takala (Marathi), ayudham (Sanskrit), fetid cassia (English). The pinnate leaves bearing three pairs of ovate oblong leaflets (two pair of leaflets have glands at their bases) bright yellow flowers in pairs and stout long pods containing 25-30 green seeds. Decoctions of parts of *Cassia tora* are uses as an analgesic, anticonvulsant, antifungal, anthelmintic, diuretic, expectorant, antipyretic, laxative, purgative, and antimicrobial, ant hepatotoxic and anti-mutagenic activities.[1-2]

Fig 1: Aerial parts of *Cassia tora* Linn.

Fig 2: Flowers of *Cassia tora* Linn.

Vernacular names of *C. tora* Linn.

Table No. 1: Vernacular names

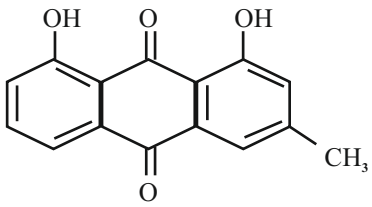
Language	Vernacular names
Bengali	Chakunda, Panevar
English	Foetid Cassia
Guajarati	Kawario, Konariya
Hindi	Chakavat, Chakund, Panevar
Malaya	Chowkeat
Malayalam	Chakramandrakam, Takara
Marathi	Takala, Tarota
Punjabi	Chakunda, Pawar
Rajasthan	Chakuada, Pumaria
Sanskrit	Ayudham, Chakramardaka
Tamil	Senavu, Tagarai
Telugu	Tagirise, Tellakasinda
Oriya	Chakunda

Phytochemistry of *C. tora* Linn.

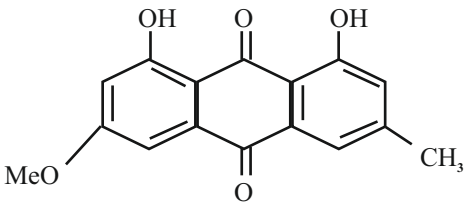
Table No. 2: Phytocomponents

Sr. No	Parts.	Chemical Constituents
1	Seeds	Cinnamaldehyde, gum, tannins, mannitol, coumarins, and essential oils (aldehydes, eugenol, and pinene), sugars, resins, and mucilage, among other constituents.[1] Cassia contains 1-2 % volatile cassia oil, which is mainly responsible for the spicy aroma and taste.[1] Naptho-alpha-pyrone-toralactune, chrysophenol (I), physcion (II), rubrofusarin. Emodin, alaternin, gluco-obtusifolin, cassiaside, gluco-aurantio-obtusin, cassitoroside, toralactone gentiobioside, chrysophanol triglucoside, quercetin, 2- hydroxyemodin 1-methylether and anthraquinone glycoside torachrysone 8-O-[beta-D-glucopyranosyl(1-->3)-O-beta-D-glucopyranosyl (1–-- >6)-O-beta-D-glucopyranoside] (1) and toralactone 9-O-[beta-D-glucopyranosyl - (1-->3)-O-beta-D-glucopyranosyl-(1-->6)-O-beta-D-glucopyranoside].[2-4] Three naphthopyrone glucosides, cassiaside, rubrofusarin-6-O-β-D-gentiobioside (III), toralactone-9-O-β-D-gentiobioside (IV), β-sitosteral-β -D-glucoside, freindlen, palmitic, stearic, succinic, d-tartaric acids, quercitrin (V) and isoquercitrin (VI) Alaternin 2-O-β-d-glucopyranoside (VII) and uridine (VIII).[4] Chrysophonic acid-9-anthrone (IX
2	Roots	1,3,5-trihydroxy-6-7-dimethoxy-2-methylanthroquinone (X) and β –sitosterol.[1-2]
3	Leaves	Emodin, tricontan-1-0l, stigmasterol, β -sitosteral- β -D-glucoside, freindlen, palmitic, stearic, succinic and d-tartaric acids uridine, quercitrin and isoquercitrin.[1-2]
4	Stem	Chrysophanol, emodine, β-sitosterol, 1-hydroxy-5-methoxy-2- methylan- thraqunone and its glycoside, Tigonelline, choline, rhein and 3,5,8,3'4',5'- hexahydroxyflavone.
5	**Other parts**	Pods are rich in sennosides. Flowers contain Kaemferol and leucopelargonidine. Roots showed the presence of 1, 3, 5 trihydroxy 6, 7 dimethoxy-2-methyle an- thraquinone, leucopelargonidine and β-Sitosterol.[1-2]

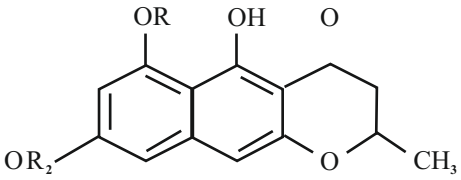
Chemical structures of some important Phytoconstituents present in *C. tora* Linn



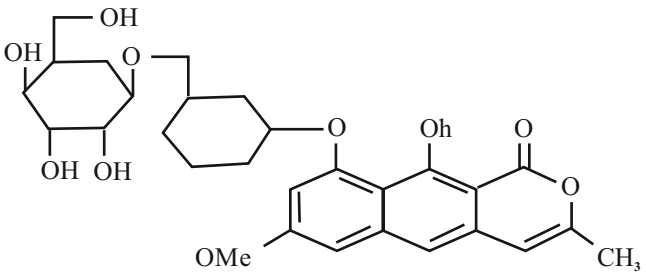
I. Chrysophenol



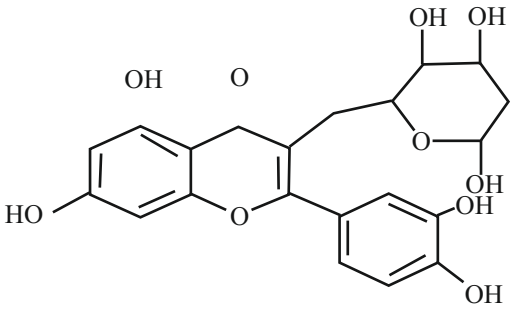
II. Physcion



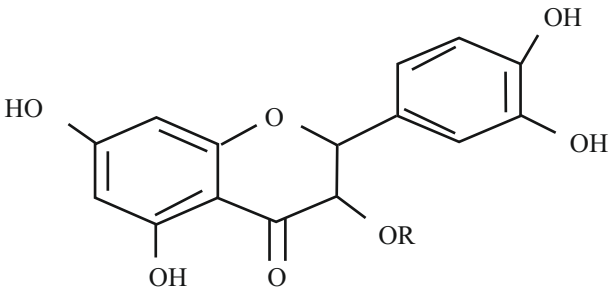
III. 1. R_1 = glucosyl R_2 = H Cassiaride
2. R_1 = gentiobiosyl, R_2 = Ch_3 Ruibrofusarin$_6$O D gentiobioside



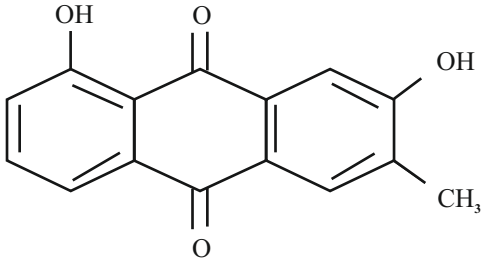
IV. Toralactone - 9 - 0 - D - gentiobioride



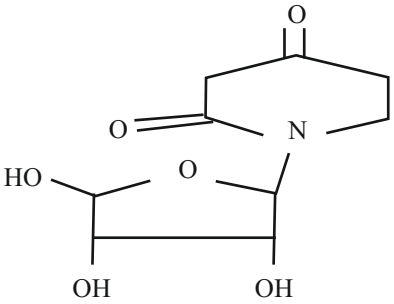
V. Quircetin



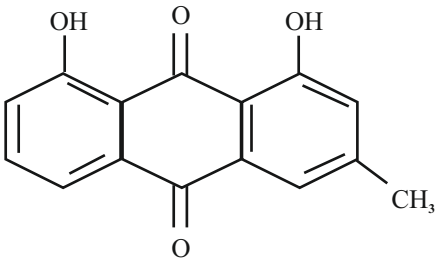
Vi. Isoquircetin



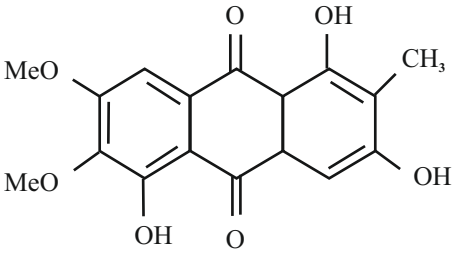
VII - Alaterinin



VIII. Ridines



IX - Chrysophonic acid



X - 1, 3, 5, Trihydroxy 6,7 dimethoxy 2 methy anthraquinone

Traditional Medicinal Uses:

According to Ayurveda the leaves and seeds are useful in the treatment of leprosy, ringworm, flatulence, colic, dyspepsia, constipation, cough, bronchitis and cardiac disorders.[5-7]

Pharmacological Activity:

Fungicidal activity

The *C. tora* ethanol soluble components of have potent antifungal activities against *Microsporum canis* and *Candida albicans* and low potency against *Aspergillus fumigatus*. Fugicidal activity of chrysophanic acid-9- anthrone from *C. tora* have been reported.[8-11]

Antibacterial activity

The aqueous extract of *C. tora* exhibited good antibacterial activity in terms of zone of inhibition as compared to other extracts against both gram positive and gram negative organisms except *Bacillus subtillus. Staphylococcus aureus* was the most susceptible to the aqueous extrac.[12-15]

Used for conjunctival congestion and blurred vision:

Being so bitter and cold as to purge heat and so sweet and salty as to replenish yin (body fluids), this herb can not only clear and purge fire from the liver, but also nourish the liver and the kidneys. As the liver has its orifices open on the eyes and the pupils correspond to the kidneys, this herb is excellent for the improvement of eyesight and can be used for eye ailments of both the excess and deficiency types. It is often used together with self-heal spica (*Spica Prunellae*), cape jasmine fruit (*Fructus Gardeniae*), etc., for conjunctivitis (inflammation of the conjunctiva, the mucous membrane that lines the inner surface of the eyelids and is continued over the forepart of the eyeball) and photophobia, or intolerance to light, due to fire of excess types in the liver channel. It is also often used together with chrysanthemum, mulberry leaves, etc., for headache with conjunctival congestion due to upward attacks of pathogenic wind-heat. It is frequently used together with milk vetch seed (*Semen Astragali Complanati*),

etc., for blurred vision due to yin deficiency of the liver and kidneys.[12-15]

Hypolipidemic activity

Ethanol extract of seeds of *C. tora* L. and its fractions were investigated for hypolipidemic activity on triton induced hyperlipidemic profile. Ethanolic extract and its ether soluble and water soluble fraction decreased serum level of total cholesterol by 42.07, 40.77 and 71.25%, respectively. On the other hand ethanolic extract, ether soluble fraction and water soluble fraction increased the serum HDL- cholesterol level by 6.72, 17.20 and 19.18%, respectively. Ethanolic extract, ether fraction and water fraction decreased triglyceride level by 26.84, 35.74 and 38.46%, respectively. The reduction in LDL-cholesterol level by ethanolic extract, ether soluble fraction and water soluble fraction were 69.25, 72.06 and 76.12%, respectively.[16]

Antioxidant and Cytotoxic activity

Preliminary phytochemical analysis of leaf showed the presence of polyphenols (3.7 mg gallic acid equivalent per gram dried leaves). Phenolic compounds are responsible for its antioxidant and anti proliferative potential. *C. tora* methanol leaf extract (CTME) was evaluated for its nitric oxide scavenging activity and reducing power assays using Rutin and BHT as standards. The extract was studied for its lipid per oxidation inhibition assay using rat liver and brain. In all assays, a correlation existed between concentration of extract and percentage inhibition of free radical, reducing power and inhibition of lipid per oxidation. The anti proliferative activity of CTME with Cisplatin, anticancer drug was studied using human cervical cancer cells (HeLa). Proliferation of HeLa was measured by MTT assay, cell DNA content by modified diphenylamine method and apoptosis by Caspase 3 activity. The plant extract induced a marked concentration dependent inhibition on proliferation, reduced DNA content and apoptosis in HeLa. These results clearly indi- cate that *C. tora* is effective against free radical mediated disease.[17]

Antipsoriatic activity

Aqueous extracts of *C. tora* have been reported to be used as decoctions and infusions for treating skin infections and other skin diseases such as psoriasis. According to American association of Dermatology, antibacterial therapy is included in treating psoriasis and many of the antibacterial agents, including those obtained from the herbal source are used for treating different skin diseases like psoriasis.[18-27]

Estrogenic and anti-estrogenic activities of Cassia *tora* phenolic constituents.

The estrogenic activity of the fractions and the isolated compounds were investigated using the estrogen-dependent proliferation of MCF-7 cells. In addition, the yeast two hybrid assay expressing estrogen receptor alpha (ERalpha) and beta (ERbeta) and the ERalpha competitor screening assay (ligand binding screen) were used to verify the binding affinities of the isolated compounds to ER. Furthermore, a naringinase pre-treatment of the 70% alcoholic extract of *C. tora* seeds resulted in a significant increase in its estrogenic activity. From the naringinase pre-treated extract six compounds were isolated, among which 6-hydroxymusizin and aurantio-obtusin showed the most potent estrogenic activity, while torachrysone, rubrofusarin and toralactone showed a significant anti-estrogenic activity.[28-29]

Inhibitory activity on advanced glycation end products (ages) formation

The ethanol-soluble extract of the seeds of *C. tora* as active constituents, using an in vitro bioassay based on the inhibition of advanced glycation end products (ages) to monitor chromatographic fractionation.[30]

In vitro Anthelmintic activity

Alcohol and aqueous extracts from the seeds of *C. tora* were investigated for their anthelmintic activity against *Pheretima posthuma* and *Ascardia galli*.[31-33]

Used for constipation due to intestinal dryness

With its cool and moistening properties, this herb can clear heat from the bowels and loosen them to relieve constipation. It is often used with hemp seed, Mongolian snake gourd seed (*Semen Trichosanthis*), etc., for constipation due to interior heat and intestinal dryness. In addition, Ju Ming Jiang Ya Pian made from this herb in combination with chrysanthemum has a certain curative effect on high blood pressure, and sickle senna seed decoction, syrup and tablets are effective for hyperlipemia, the presence of excess fat or lipids in the blood.[34]

Inhibitory Activities on Angiotensin- Converting Enzyme

The mathanol extracts from the raw and roasted *C. Tora* exhibited significant inhibitory properties against ACE, demonstrating more than 50% inhibition at a concentration of 163.93µg/ml. Only anthraquinone glycoside demonstrated marked inhibitory activity against ACE, with an IC_{50} value of 30.24 ± 0.20 µm. Conversely, aurantio obtusin, obtained from the acid hydrolysis of gluco-aurantioobtusin, showed no activity. Further inhibitory kinetics analyzed from Line weaver-Burk plots showed 7 to be a competitive inhibitor with a Ki value of 8.3×10^{-5} M. Moreover, compound gluco-aurantio obtusin showed marked inhibitory and scavenging activities with an IC_{50} value of 49.64 ± 0.37 µm (positive control; trolox: 26.07 ± 1.05 µm) for total reactive oxygen species generation, and 4.60 ± 1.12 µm (positive control; penicillamine: 0.24 ± 0.04 µm) for $ONOO^-$.[35]

Antidiabetic activity

C. tora L. seeds have previously been reported to reduce blood glucose level in human and animals with diabetes. In the present study, the effects of *C. tora L.* seed butanol fraction (CATO) were studied on postprandial glucose control and insulin secretion from the pancreas of the normal and diabetic rats.[36-39]

Antiproliferative Activity

The *Cassia tora* methanolic leaf extract showed potential in human cervical cancer cells with reference to Cisplatin.[40]

Nitric Oxide Scavenging Activity

The methanolic leaf extract of *Cassia tora* was evaluated for its nitric oxide scavenging activity and reducing power assays using Rutin and BHT as standards. The extract was studied for its lipid peroxidation inhibition assay using rat liver and brain.[40]

Hypolipidemic Activity

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Spasmogenic and Antinociceptive Activity

The methanol extract of leaves of Cassia tora Linn. Evaluated for spasmogenic effects on guinea pig ileum, rabbit jejunum and mice in- testinal transit. The antinociceptive activity of the methanol extract was also evaluated in the mice. The extract contracted smooth muscles of guinea pig ileum and rabbit jejunum in a con- centration-dependent manner. The extract in- creased intestinal transit in mice dose depen- dently. *C. tora* extract significantly reduced the number of acetic acid induced abdominal con- strictions in mice and the effect was compara- ble to that of aspirin. The extract also signifi- cantly reduced the nociceptive response of mice to increased force.[42]

Immunostimulatory Activities

Inpresent study evaluated the immunostimulatory activities of four anthraquinones of *C. tora* (aloeemodin, emodin, chrysophanol, and rhein) on human peripheral blood mononuclear cells (PBMC). The results showed that at non-cytotoxic concentrations, the tested anthraquinones were effective in stimulating the proliferation of resting human PBMC and/or secretion of IFN-?. The concentration of 10 lg/ml (35 lM), rhein significantly stimulated proliferation of resting human PBMC (stimulation index (SI) = 1.53), but inhibited IFN-? Secretion (74.5% of control). The augmentation of lymphocyte proliferation was correlated to the increase in number of CD4+ T cells, while the elevated secretion of IFN-? and IL-10 might have been due to the activated CD4 + T cells.[43]

Neuro protective effects

The present study was to determine whether *Cassia tora* extracts could reverse the oxidative stress-induced neurodegeneration in a Parkinson's disease in vitro model. The ethyl acetate extracts were tested for their neuro protective effects in human SK-N-SH neuroblastoma cells. As result extract reduced the paraquat-induced apoptosis. Moreover, there was a significant reduction of paraquat-induced DNA damage in SK-N-SH cells pre-treated with CtEA or CtME. The ethyl acetate extracts significantly inhibited paraquat-dependent lipid peroxidation, so these in vitro data establish *C. tora* as a possible anti-Parkinson natural remedy.[44]

Larvicidal activity

In the present study, rotenoids viz., sumatrol, rotenone, tephrosin, rotenol, deguelin, and elliptone were identified from the plant parts and callus culture of Cassia tora L. and evaluated for larvicidal potential. Significant potential showed in insecticidal property of rotenoids from *C. tora.*[45]

Conclusion:

The updated scientific studies and research on plant species *C. tora* revels that an enormous biological potential of this plant. Clinical and pharmacological studies with standardized extracts and isolated components need to be performed to investigate any unexploited potential of this plant. In future wide scope for research on plant *C. tora.* As current review paper summaries the plant having varying chemical compounds which are more useful to serve as a drugs. So, current information as presented in this review on pharmacognosy, phytochemistry and biopotential of *C. tora* may provide strong scientific evidence for the use of this plant in different form of advance natural medicines.

Source of Support: Nil

Conflict of Interest: Nil

References:

1. Kirtikar KR, Basu BD. Indian medicinal plants, Shri sadguru publication New Delhi, 2000.
2. The wealth of India a raw material, Vol-3: (ca – ci) CSIR New Delhi Revised edition 1992.
3. Sastry MS. Chemical investigation on Cassia tora Linn. Curr.Sci.1965; 34:481.JungLee
4. H, J, HyungJung J, SikKang S. Alaternin glucoside isomer from Cassia tora. Phytochemistry. 1998; 49(5):1403-1404.
5. Dighe NS, Pattan SR, Nirmal SA. A Review on Phytochemical and Pharmacological Profile of Cassia tora Linn. Res. J. Pharmacog and Phytochem. 2009, 1(3):173-176.
6. Yun-Choi HS. Potential inhibitors of platelet aggregation from plant sources, V. An- thraquinones from seeds of Cassia obtusifolia and related compounds. J. Nat. Prod 1990; 53:630-633.
7. Uniyal RG, Sandhav S, Chandhok JK. The Ayuveda Encyclopedia Natural Secrets To Healing, Prevention and Longevity, Shri sadguru publication,Vol II , p. 132-135.
8. Hatano T, Uebayashi H, Ito H, et al. Pheno- lic constituents of Cassia seeds and antibac- terial effect of some naphthalenes and an- thraquinones on methicillin-resistant Staphylococcus aureus. Chem Pharm Bull. 1999; 47(8):1121-27.
9. Kim Ym, Lee Ch, Kim Hg, Lee Hs. An- thraquinones isolated from Cassia tora (Leguminosae) seed show an antifungal property against phytopathogenic fungi. J Agric Food Chem. 2004; 52(20):6096-100.
10. PODOLSKY, DANIEL K, INVENTORS.Methods and composition for treating der- mal lesions. 2003, US Patent 20030148949.
11. Acharya TK, Chatterjee IB. Isolation of chrysophanic acid-9-anthrone, the major antifungal principle of Cassia tora. Lloydia. 1975; 38(3):218-20.
12. Patel RP, Patel KC. Antibacterial activity of Cassia tora and Cassia obovata, Indian J Pharm, 1957; 19:70-75.
13. Tomi NS, Kranke B, Aberer E. Staphylo- coccal toxins in patients with psoriasis, atopic dermatitis, and erythroderma, and in healthy control subjects, AAD. 2005; 53 (1):67-72.
14. Bastert J. Current and future approaches to antimycotic treatment in the era of resistant fungi and immunocompromised hosts. Int. J of Antimicrobial Agents. 2001; 17: 81–91.
15. Cruickshank R. A guide to diagnosis and control of infection. In: Medical microbiol- ogy. 11th ed. Ediburg, London: E and S Livingston Ltd.; 1965.
16. Patil UK, Saraf S, Dixit VK, Ethnopharma- col. 2004 ; 90(2-3):249-52.
17. Rejiya CS, Cibin TR, Abraham A, Toxicol In Vitro. 2009; 23(6):1034-8.
18. Daniel AC, Mark L, Suhail H, et al., Retro- spective analysis of the treatment of psoria- sis of the palms and soles. AAD. 2004; 50 (3):176-179.
19. Ellen JB and Sydney MF. Baily & Scott‟s diagnostic microbiology. 8th ed. USA, Missouri; 1990.
20. Evans WC. Trease and Evans‟ Pharmacognosy. 14th ed. London, England:W.B.Sounders company ltd.; 1996. p. 545-46.
21. Grover JK, Yadav SP. Pharmacological ac- tions and potential used of Momordica cha- rantia a review.J. Ethanopharmacol, 2004; 93:123-32.
22 Guidelines of care for Psoriasis. American association of Dermatology, Bulletin 9, 1991.p10.
23. Harrison and Dorothy, Inventors. Natural therapeutic composition for the treatment of wounds and sores. CIPO 2003. Patent 2392544 Apr 17.
24. Horvath, Ferenc, inventors. Therapeutical compositions against psoriasis. “US Patent 5165932” 1992. Nov 24.
25. Kennet GL, Gerald D, Weinstein. Psoriasis: Current perspectives with an emphasis on treatment. The American J of Medicine. 1999; 107: 595-605.
26. Le GA. Anti-infective phytotherapies of the tree-savannah, Senegal (occidental Africa). III: A review of phytochemical substances and the antimicrobial activity of 43 species. J Ethanopharmacol 1989; 25(3):315-38.
27. May G, Willuhn G. Antiviral activity of aqueous extracts from medicinal plants in tissue cultures. Arzneim- Forsch, 1978; 28:1-7.
28. Chemical & Pharmaceutical bulletin (Chem. Pharm. Bull (Tokyo), Japan. 2007;55 (10): 1476-1482
29. El-Halawany AM, Chung MH, Nakamura N, Ma CM, Nishihara T and Hattori M. Es- trogenic and antiestrogenic activities of Cassia tora phenolic constituents. Chem Pharm Bull. (Tokyo) 2007; 55(10):1476-82.
30. Ga Young Lee, Dae Sik Jang, Yun Mi Lee, Jet al., Anthelmintic activity of latex of Calotropis procera . Pharma Biol. 2003; 41:263-5.

31. Kaushik RK, Katiyar JC, Sen AB. Studies on the mode of the action of anthelmintic with Ascardia galli as a test parasite. Indian J Med Res. 1974; 62:1367-75.
32. Deore SL, Khadabadi SS, Kamdi KS, et al., In vitro Anthelmintic activity of Cassia tora Int. J of Chem Tech Research. 2009; 1 (2): 177-179.
33. Tandon V, Pal P, Roy HS, et al., In vitro anthelmintic activity of root-tuber extract of Flemingia vestita, an indigenous plant in Shillong, India. Parasitol Res. 1997; 83:492-8.
34. Maity TK, Dinda SC, Purgative activity of cassia tora leaf extract and isolated aloe- emodin. Indian Journal of Pharmaceutical Science. 2003;65: 93-95.
35. Hyun, Lee H, Kang SS, et al., Inhibitory activities of Cassia tora and its an- thraquinone constituents on angiotensin- converting enzyme. Phytotherapy research. 2009;23(2):178-84.
36. Adisakwattana S, Moonsan P, Yibchok- anun S. Insulin-releasing properties of a series of cinnamic acid derivative vitro and in vivo. J Agric Food Chem. 2008; 56:7838-7844.
37. Ahn DK. Illustrated book of Korean me- dicinal herbs, Kyo-Hak Publishing Co. Ltd, Seoul. Republic of Korea. 1998. p. 636.
38. Ahren B, Taborsky GJ. The mechanism of vagal nerve stimulation of glucagon and insulin secretion in the dog. Endocrinol- ogy. 1986; 118:1551-1556.
39. Ahren B, Veith RC, Taborshy GJ. Sympa- thetic nerve stimulation versus pancreatic norepinephrine infusion in the dog: effects on basal release of insulin and glucagon. Endocrinology 2007; 55 (10):1476-82
40. Abraham A, Rejiya CS, Cibin TR. Leaves of Cassia tora as a novel cancer therapeutic – An in vitro study, Toxicology in vitro, 2009, 23: 1034–1038.
41. Patil UK, Saraf S, Dixit VK. Hypolipi- demic activity of seeds of Cassia tora Linn, Journal of Ethnopharmacology, 90 (2-3), 2004, 249–252.
42. Chidume FC, Kwanashie HO, Adekeye JO, et al., Antinociceptive and smooth muscle contracting activities of the methanolic ex- tract of Cassia tora leaf, Journal of Ethno- pharmacology, 2002, 81, 205-209.
43. Chiang LC, Cherng JM, Chiang W. An- thraquinones of edible wild vegetable Cas- sia tora stimulate proliferation of human CD4 + T lymphocytes and secretion of in- terferon-gamma or interleukin 10, Food Chemistry, 2008,107:1576–1580.
44. Ravi SK, Narasingappa RB, Joshi CG, Girish TK. Bruno Vincent Neuropro- tective effects of Cassia tora against paraquat-induced neurodegeneration: relevance for Parkinson's disease, Nat Prod Res. 2018, 32(12):1476-1480.
45. Sharad V. Larvicidal activity and in vitro regulation of rotenoids from Cassia tora L. Biotech. 2018, 8(1):13.