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AMULTHUS A IMPORTANT MEDICINAL HERBS: A REVIEW OF ITS TRADITIONAL USE, PHYTOPHARMACOLOGICAL PROPERTIES

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ABSTRACT
Amulthus is most widespread deciduous or semi-evergreen tree of Indian subcontinent. It is widely planted in gardens and societies due to its ornamental and medicinal properties.Amulthus has therapeutic importance in health care from ancient time. Almost all parts of this tree are having pharmacological actions. Cassia fistula is used against various diseases from primeval time. This article aims to provide a comprehensive review on the phytochemical and pharmacological aspects of Cassia fistula. It is obtained from deciduous and mixed-monsoon forests throughout greater parts of India. Laboratory work has been done on this plant and many chemical constituents have been isolated are useful against several diseases. It is widely used in traditional medicinal system of India has been reported to possess hepatoprotective, anti-inflammatory, antitussive, antifungal and also used to check wounds healing and antibacterial. It is known as a rich source of tannins, flavanoids and glycosides. The innumerable medicinal properties and therapeutic uses of Cassia Fistula as well as its phytochemical investigations prove its importance as a valuable medicinal plant.

KEYWORDS: Amulthus, *Cassia fistula*, Pharmacological, Phytochemical constituents etc.

INTRODUCTION
The drug consists of ripe fruits and fruit pulp of *Cassia fistula* Linn. family Caesalpiniaceae.[1] The tree of *Cassia fistula* is decorated with thick clusters of showy yellow blooms in summer season, which look like shower so it is commonly known as 'golden shower'. It is a well-known plant in the Ayurvedic system of medicine. The plant is found throughout India in all deciduous forests and hilly tracts. It is cultivated as an ornamental plant for its beautiful yellow flowers.[2] *Cassia fistula* has traditionally been used to treat leprosy, tuberculosis, syphilis, rheumatism, skin disease.[3] The Ayurvedic pharmacopoeia of India indicated the fruit pulp for constipation, colic, chlorosis and urinary disorders.[4] The fruit of *Cassia fistula* is used to treat diabetes.[5] *Cassia fistula* plant is rarely ever wholly leafless, but in some localities it is almost bare between March and May and new leaves appear during April-July. The flowers appear along with the leaves, in dry areas the flowers however appear till October.[6] The various chemical constituents isolated from the plant are fistucacidin, leucocyanidin, leucopelargonidin, hexacosanol, lupeol and β-sitosterol.[7]

Current research on *Cassia fistula* has focused on its hepatoprotective, antioxidant, anticancer, anti-inflammatory and other reported activities.[8] This review on *Cassia fistula* presents the chemical and pharmacological investigations so far reported.

Pharmacological investigations
Hepatoprotective activity
Hepatoprotective activity of the n-heptane extract of *Cassia fistula* leaves was investigated in rats by inducing hepatotoxicity with carbon tetrachloride: liquid paraffin (1:1). The extract has been shown to possess significant protective effect by lowering the serum levels of transaminase (SGOT and SGPT), bilirubin and alkaline phosphatase (ALP). The extract of *Cassia fistula* at a dose of 400 mg/kg showed significant hepatoprotective activity which was comparable to that of a standard hepatoprotective agent.[9-11]

Antitumor activity
Effects of methanolic extract (ME) of *Cassia fistula* seed on the growth of Ehrlich ascites carcinoma (EAC) and on the life span of tumor bearing mice were studied. ME treatment showed an increase of life span and a decrease in the tumor volume and viable tumor cell count in the EAC tumor hosts. Cytological studies have revealed a reduction in the mitotic activity and the appearance of membrane blebbing and intracytoplasmic vacuoles in the treated tumor cells. Improvement in the hematological parameters following ME treatment, like hemoglobin

content, red blood cells count and bone marrow cell count of the tumor bearing mice have also been observed. The results of the study suggest that ME of *Cassia fistula* seed has an antitumor activity.[12]

Laxative activity

The *in-vitro* effect of *Cassia fistula* infusion on isolated guinea-pig ileum was examined. The acute and sub chronic toxicity of the infusion of *Cassia fistula* and *Cassia acutifolia* pods taking senokot tablet as the reference drug were also determined. The results obtained for *Cassia fistula* infusion when compared with senokot tablet showed that the infusion of *Cassia fistula* pods possessed very low levels of toxicity, having the LD_{50} of 660 mg/kg and also without any pathological effects on the organs examined microscopically. It is therefore concluded from the study that *Cassia fistula* pods infusion could be safely utilized as laxative drugs and as a substitute for the official senna.[13-14]

Antioxidant activity

Aqueous extract of *Cassia fistula* flowers (ACF) was screened for its antioxidant effect in alloxan induced diabetic rats. An appreciable decrease in per oxidation products viz thiobarbituric acid reactive substances, conjugated dienes, hydro peroxides was observed in heart tissues of ACF treated diabetic rats. The decreased activities of key antioxidants enzymes such as super oxides dismutase, catalase, glutathione peroxides, glutathione reductase and glutathione in diabetic rats were brought back to near normal range upon ACF treatment. These results suggest that ACF has got promising anti oxidative activity in alloxan diabetic rats.[15-17]

Anti-inflammatory activity

Anti–inflammatory activities of the aqueous and methanolic extract of the *Cassia fistula* were assayed in the wistar albino rats. The extracts were found to possess significant anti-inflammatory effect in both acute and chronic models.[18]

Antibacterial activity

Various fractions of *Cassia fistula* fruit pulp have been studied for *in vitro* antibacterial activity against urinary pathogens i.e. *E. coli, P. mirabilis, P. aeruginosa,* and *K. pneumoniae.* All fractions showed inhibitory activity against all test pathogens but maximum inhibition was seen with ethanol fraction. *K. pneumoniae* and *P. aeruginosa* were more sensitive as compared to *E. coli* and *P. mirabilis.*[19-22]

Antifungal activity

Hexane, chloroform, ethyl acetate, methanol and water extracts from the flower of *Cassia fistula* were tested against bacteria and fungi .All the extract exhibited antibacterial activity against Gram-positive organism with minimum inhibitory concentration (MIC) between 0.078 and 2.5 mg/ml. Among the Gram-negative bacteria, only *Pseudomonas aeruginosa* was susceptible to the extracts. Ethyl acetate crude extract was fractionated using chromatographic technique. A crystal was isolated, which was confirmed as 4-hydroxy benzoic acid hydrate using X-ray crystallography. It exhibited antifungal activity against *Trichophyton mentagrophytes* (MIC 0.5 mg/ml) and *Epidermophyton floccosum* (MIC 0.5 mg/ml).[23-24]

Antileishmanial activity

Crude extracts and fractions from the fruits of *Cassia fistula* were tested against the most dramatic and fatal disease form of leishmaniasis, the visceral form (VL). Hexane extract from the fruits showed significant antileishmanial activity against the promastigote form of leismania *L. Chagasi*. The bioguided fractionation resulted in the isolation of a sterol, clerosterol, promastigotes presented an inhibitory concentration 50% (IC_{50}) of 10.03 µg/ml and intracellular amastigotes demonstrated high susceptibility, with an IC_{50} of 18.10 µg/ml. Mammalian cytotoxicity was evaluated and it was demonstrated that clerosterol was 3.6 fold less toxic than the standard drug pentamidine.[25]

Antiviral activity

It was possible to infect the callus culture of *C. fistula* by Ranikhet disease virus (RDV) and an animal virus under certain well defined conditions. The high concentration of RDV would induce in these callus cultures the production of an interferon like antiviral factor which appears to be heat stable, more resistant to trypsin and possessed better protective and therapeutic values than chick interferon.[26]

Wound healing activity

Methanol extract of *Cassia fistula* leaves were examined for its wound healing property in the form of an ointment in two types of wound models in rats, Excision wound model and Incision wound model.

The ointment of the leaf extract of two different concentrations (5% and 10% w/w ointment of leaves extract in simple ointment base) responded significantly in both models of wounds tested. The results were comparable to standard drug nitrofurazone in terms of wound contraction ability, epithelisation period, tensile strength and regeneration of tissue at wound area.[27]

Larvicidal and ovicidal activity

Methanolic leaf extract of *Cassia fistula* was tested for larvicidal and ovicidal activity against *Culex quinquefasciatus* and *Anophelas stephensi*. The extract was found to be more lethal to the larvae of *A. stephensi* than *C. quinquefasciatus* with LC_{50} values of 17.97 and 20.57 mg/l respectively. Mean percentage hatchability of the ovicidal activity was observed 120 hours after treatment. The percentage hatchability was inversely proportional to the concentration of extract and directly proportional to the eggs. The egg raft of *C. quinquefasciatus* was found to be more hatchable than *A. stephensi.*[28]

Antitussive activity

T. Bhakta et al. (1998) reported that the methanol extract of leaves of C. fistula (collected from India in 1995) was investigated for its effect on a cough model induced by sulfur dioxide gas in mice. The extract exhibited significant, dose-dependent antitussive activity compared with the control. The antitussive activity was comparable with that of codeine phosphate, a prototypes antitussive agent. C. fistula extract (400 and 600 mg/kg, p.o.) inhibited coughing by 44.44 and 51.85%, respectively, with respect to the control group.[29]

CNS activities

Methanol extract of seeds of C. fistula was tested for different pharmacological actions in mice. The extract significantly potentiated the sedative actions of sodium pentobarbitone, diazepam, meprobamate and chlorpromazine. It also potentiated analgesia induced by morphine and pethidine in a dose-dependent manner. The extract also influenced behaviour in mice.[30]

Leukotriene inhibition activity

Extract of fruits of C.fistula inhibited the 5lipoxygenase catalysed formation of leukotriene B4 in bovine polymorphonuclear leukocytes (IC50 value of 38 micro g/ml). Lipid peroxidation in bovine brain phospholipid liposomes Scholar Research Library induced with 2,2'-azo-bis-(2-amidinopropane) dihydrochloride (AAPH) was inhibited (IC50 of 40 micro g/ml). A linear correlation was obtained between the effects of the extract in the 2 assays suggesting a redox-based mechanism for the inhibition of the 5-lipoxygenase enzyme.[31]

Clastogenic effect

Anthraquinone glycosides of Cassia fistula were investigated for their ability to induce a clastogenic effect on the bone marrow cells of Swiss albino mice. The endpoints screened were chromosomal aberrations and frequency of aberrant cells. Oral exposure to doses of these anthraquinones and their equivalent amount in leaf and pod extracts did not induce significant numbers of chromosomal aberrations or aberrant cells. The results indicate that anthraquinone sennoside B and rhein are weakly genotoxic. Pure sennoside B and rhein were weakly clastogenic. Crude extracts of C. fistula (leaves and pods) each containing sennoside B and rhein were also weak clastogens. The CA/cell and % DC were lower than those induced by an equivalent amount of pure sennoside B. Therefore, these phytolaxatives do not behave as potent clastogens and pods or leaves of C. fistula can be used as an alternative source of sennosides.[32]

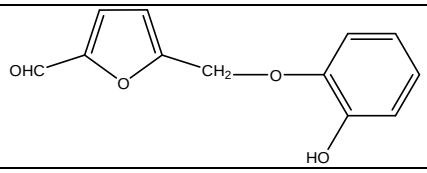
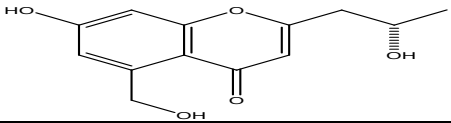
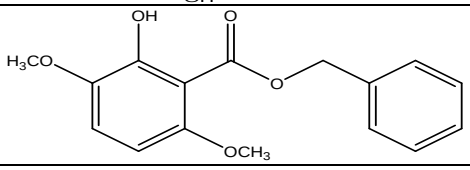
Anti-leishmaniatic activity

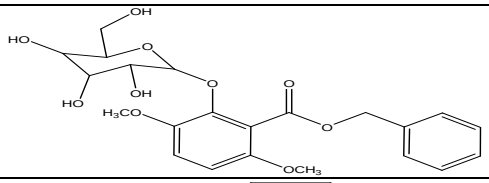
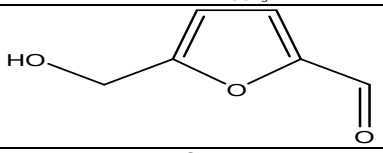
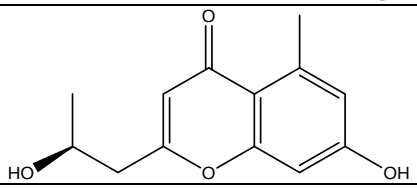
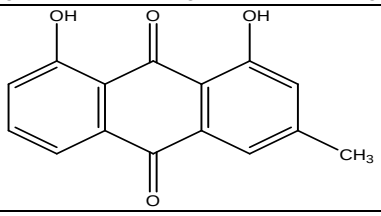
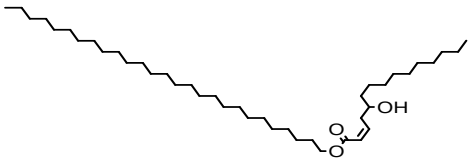
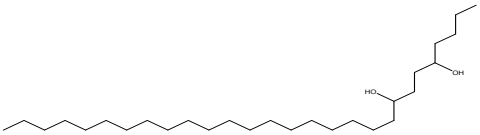
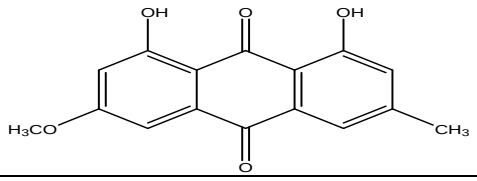
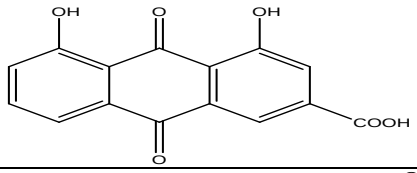
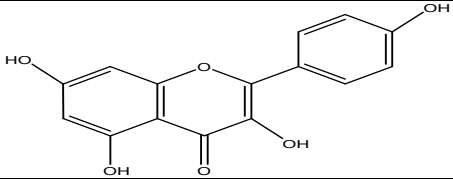
P. Sartorelli et al. (2007) examined that the hexane extract from the fruits showed significant antileishmanial activity against the promastigote form of Leishmania L. chagasi. The bioguided fractionation resulted in the isolation of a sterol, clerosterol, which was further analysed in different models. Promastigotes presented an inhibitory concentration 50% (IC50) of 10.03 micro g/mL and intracellular amastigotes demonstrated high susceptibility, with an IC50 of 18.10 micro g/mL. Mammalian cytotoxicity was evaluated and it was demonstrated that clerosterol was 3.6fold less toxic than the standard drug pentamidine.[33]

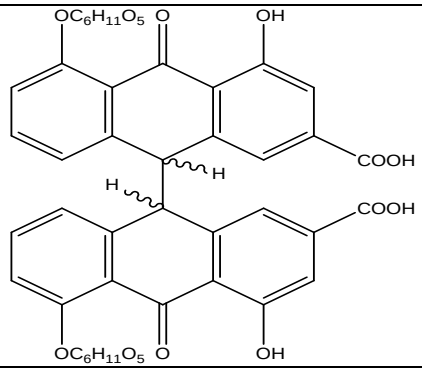
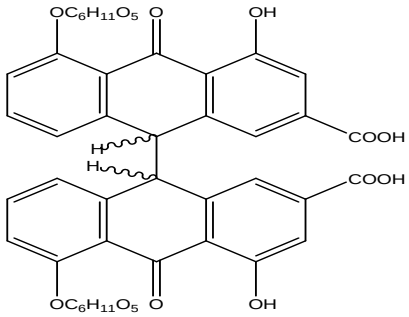
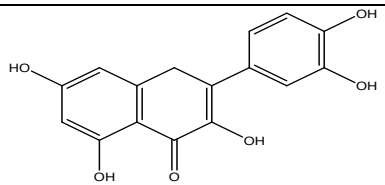
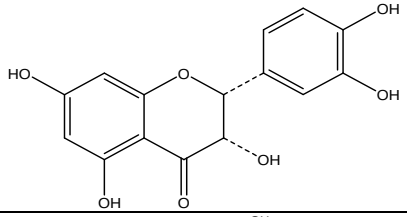
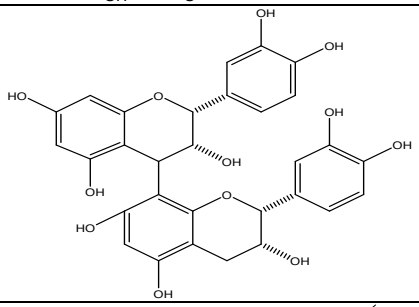
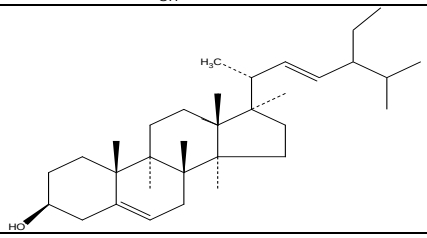
Phytochemical Investigations

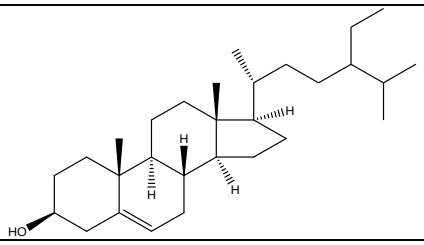
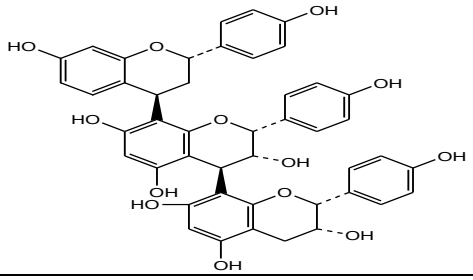
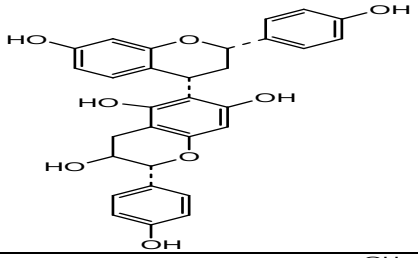
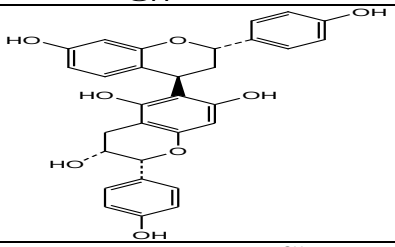
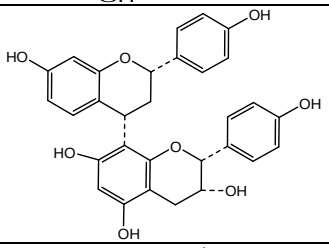
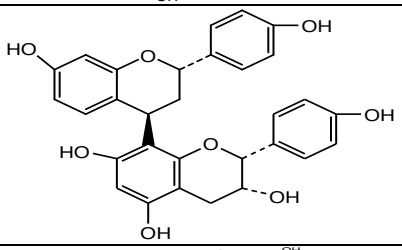
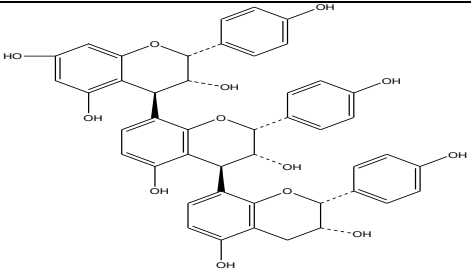
Extensive studies have been carried out on *Cassia fistula*. Various chemical constituents of biological importance isolated from root, seed, leaf, bark, flower and pod have been presented in Table 1.

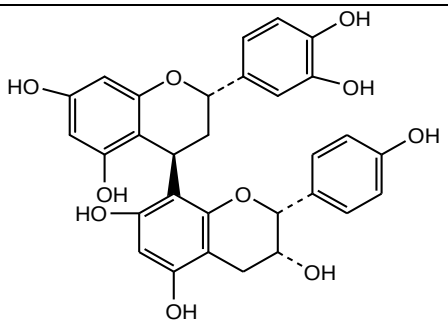
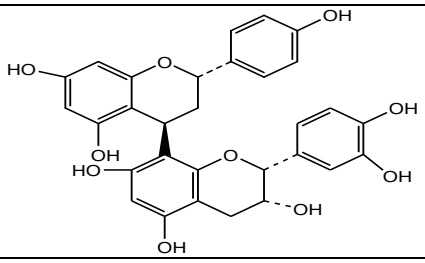
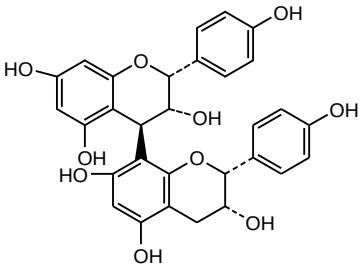
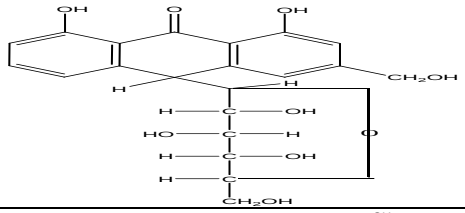
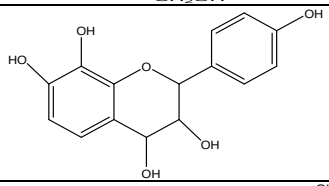
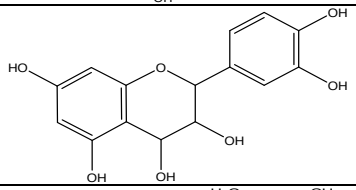
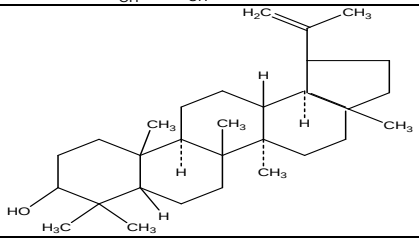
Table 1: Chemical constituents of C*assia fistula* found in various plant parts

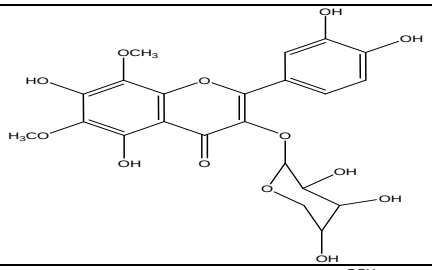
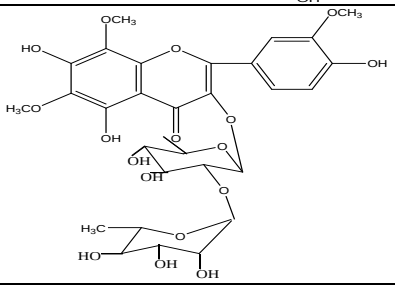
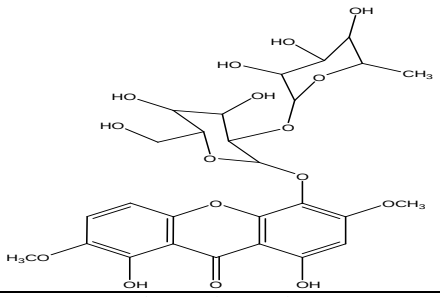
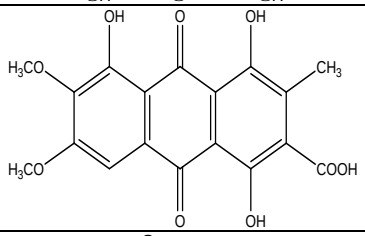
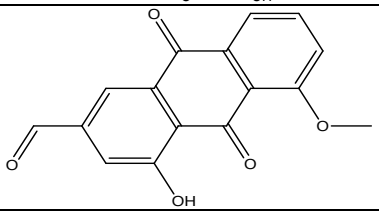
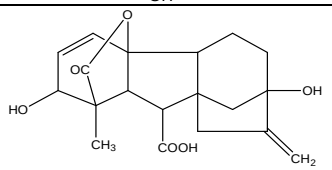
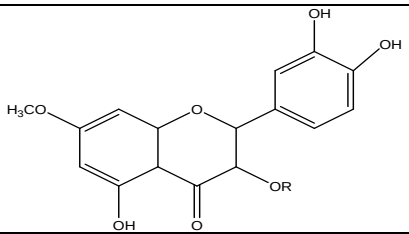
S/ No	Constituents isolated	Parts	Reference	Chemical structure
1.	5-(2-hydroxyphenoxymethyl)furfural	Seeds	[29]	
2.	(2S)-7-hydroxy-5-hydroxymethyl-2-(2′-hydroxypropyl)chromone	Seeds	[29]	
3.	Benzyl-2-hydroxy-3,6-dimethoxybenzoate	Seeds	[29]	
4.	Benzyl-2β-O-D-glucopyranosyl-3,6-dimethoxybenzoate	Seeds	[29]	

				
5.	5-hydroxymethylfurfural	Seeds	[29]	
6.	(2′S)-7-hydroxy-2-(2′-hydroxypropyl)-5-methylchromone	Seeds	[29]	
7.	Chrysophanol	Seeds	[29]	
8.	Cis-heptacosanyl-5-hydroxypentadec-2-enoate	Leaves	[30]	
9.	Octacosan-5,8-diol	Leaves	[30]	
10.	Physcion	Leaves	[31]	
11.	Rhein glycoside	Leaves	[32]	
12.	Kaempferol	Leaves	[33]	
13.	Sennoside A	Leaves	[33]	

				
14.	Sennoside B	Leaves	[33]	
15.	Quercetin	Leaves	[34]	
16.	Epicatechin	Leaves	[34]	
17.	Procyanidin B2	Leaves	[35]	
18.	Stigmasterol	Leaves	[36]	

19.	β-Sitosterol	Leaves	[36]	
20.	(2S)-7,4′-dihydroxyflavan-(4β→8)-epiafzelechin-(4β→8)-epiafzelechin	Leaves	[37]	
21.	(2S)-7,4′-dihydroxyflavan-(4α→6)-epiafzelechin	Leaves	[38]	
22.	(2S)-7,4′-dihydroxyflavan-(4β→6)-epiafzelechin	Leaves	[39]	
23.	(2S)-7,4′-dihydroxyflavan-(4α→8)-epiafzelechin	Leaves	[40]	
24.	(2S)-7,4′-dihydroxyflavan-(4β→8)-epiafzelechin	Leaves	[41]	
25.	Epiafzelechin-(4β→8)-epiafzelechin-(4β→8)-epiafzelechin	Leaves	[42]	

26.	Epicatechin-(4β→8)-epiafzelechin	Leaves	[43]	
27.	Epiafzelechin-(4β→8)-epicatechin	Leaves	[44]	
28.	Epiafzelechin-(4β→8)-epiafzelechin	Leaves	[45]	
29.	Barbaloin	Pulp	[46]	
30.	Fistucacidin(3,4,7,8,4′-pentahydroxyflavon)	Bark	[47]	
31.	Leucocyanidin	Bark	[47]	
32.	Lupeol	Bark	[47]	

33.	5,7,3,4′-tetrahydroxy6,8-dimethoxyflavone-3-o-α-arabinopyranoside	Bark	[48]	
34.	5,7,4′-trihydroxy-6,8,3′-trimethoxyflavone-3-o-α-L-rhamno-pyranosyl-(1→2)-o-β-D-galactopyranoside	Bark	[48]	
35.	1,8-dihydroxy-3,7-dimethoxyxanthone-4-o-α-L-rhamno-pyranosyl-(1→2)-o-β-D-galactopyranoside	Bark	[48]	
36.	Fistulic acid	Pods	[49]	
37.	3-formyl-1-hydroxy-8-methoxyanthraquinone	Pods	[50]	
38.	Gibberellic acid	Flower	[51]	
39.	Rhamnetin-3-o-Gentiobioside	Roots	[52]	

CONCLUSION

Before the introduction of modern medicines, disease treatment was entirely managed by herbal remedies. It is estimated that about 80% of the world population residing in the vast rural areas of the developing and under developed countries still rely mainly on medicinal plants. It is quite obvious that the plant is widely used in traditional medicinal system of India and has been

reported to possess hepatoprotective, anti-inflammatory, antitussive, antifungal and also used to check wounds healing and antibacterial properties. It is known as a rich source of tannins, flavanoids and glycosides present in Cassia fistula might be medicinally important and/or nutritionally valuable. The plant is rich in carbohydrates, Linoleic, Oleic and Stearic. Leaf of Cassia fistula mainly contains Oxalic Acids, Tannins, Oxyanthraquinones, Anthraquinones Derivatives. Fruit of Cassia fistula contains Rhein Glycosides Fistulic Acids, Sennosides A B, Anthraquinones, Flavanoid-3-ol-derivatives. Ceryl Alcohol, Kaempferol, Bianthraquinone Glycosides, Fistulin, Essential Oils, Volatile Components , Phytol (16.1%), 2-Hexadecanone (12%), Crystals, 4-Hydroxy Benzoic Acids Hydrate have been reported from the plant. The present review summarizes some important pharmacological studies on Cassia fistula and phytochemical investigations and isolated principles from them, which can be investigated further to achieve lead molecules in the search of novel herbal drugs.

REFERENCES

1. Sarin YK. Illustrated manual of herbal drugs used in Ayurveda. CSIR and ICMR. New Delhi. 1996; 200.
2. Indian Herbal Pharmacopoeia. Indian Drug Manufacturer's Association. Mumbai. 2002; 106.
3. Kirtikar KR and Basu BD, Indian Medicinal Plants. LM Basu publications Allahabad. 1935; 2: 857.
4. Khare CP. Indian medicinal plants: An Illustrated Dictionary. Springer-Verlag Heidelberg publication. 2007; 128.
5. Khan IA and Khanum A. Antidiabetic plants of India. Ukaaz publications. 2005; 240.
6. Krishnamurthy A. The Wealth of India. Publication and Information Directorate. CSIR. New Delhi. 2000; 1: 223.
7. Rastogi RP and Mehrotra BN, Compendium of Indian medicinal Plant. Central drug research Institute Lucknow. National Institute of Science. New Delhi. 1999; 1: 82.
8. Khan IA and Khanum A. Medicinal and aromatic plants of India Ukaaz publication. 2005; 142.
9. Karthikeyan S. Pradeep K. Mohan CVR and Gobianand K. Effect of *Cassia fistula* Linn. leaf extract on diethylnitrosamine induced hepatic injury in rats. Chem Biol Int. 2007; 167: 12.
10. Saha BP, Bhakta T, Mukharjee K, Banerjee S, and Mukherjee PK, Evaluation of hepatoprotective activity of *Cassia fistula* leaf extract. J. Ethnopharmacol. 1999; 66: 277.
11. Karthikeyan S, Pradeep K, Mohan CVR and Gobianand K. Pretreatment of ethanolic leaf extract of *Cassia fistula* Linn against CCl_4 induced heaptotoxicity. Indian J. Exp. Biol. 2005; 43: 526.
12. Gupta M, Mazumder UK, Rath N and Mukhopadhyay DK. Antitumor activity of methanolic extract of *Cassia fistula* L. seed against Ehrlich Ascites Carcinoma. J. Ethanopharmacol. 2000; 72: 151.
13. Elujoba AA, Ajulo OO and Iweibo GO, Chemical and biological analyses of Nigerian *Cassia* species for laxative activity. J. Pharm. and Biomed. Anal. 1989; 7: 1453.
14. Iwalewa EO, Akanmu MA and Elujoba AA. Toxicity potentials of *Cassia fistula* fruits as laxative with reference to senna. Afr. J. Biomed. Research. 2004; 7: 23.
15. Aruoma OI, Bahorum T, Soobrattee MA and Ramma LA. Antioxidant activities of phenolic, proanthocyanidin and flavonoid compontents in extracts of *Cassia fistula*. J. Argic. Food Chem. 2002; 50: 5042.
16. Manonmani G, Bhavapriya V, Kalpana S, Govindasamy S and Apparanantham T. Antioxidant activity of *Cassia fistula* (Linn.) flowers in alloxan induced diabetic rats. J. Ethanopharmacol. 2005; 97: 39.
17. Prakash D, Suri S and Singh BN. Total phenol, antioxidant and free radical scavenging activities of some medicinal plants. Int. J. Food Sci. Ntr. 2007; 58: 18.
18. Ilavarasan R, Mallika M and Venkataraman S. Anti-inflammatory and antioxidant activities of *Cassia fistula* linn bark extracts. Afr. Trad. Cam. 2005; 2: 70.
19. Ignacimuthu S and Sen A. Screening of thirty four Indian medicinal plants from Western Ghats. J. Ethnopharmacol. 1998; 62: 173.
20. Rajani M, Kumar VP, Chauhan NS and Padh H. Search for antibacterial and antifungal agents from selected Indian medicinal plants. J. Ethnopharmacol. 2006; 107: 182.
21. Sharma K, Sharma R, Agarwal A and Dak G. Inhibitory activity of various fractions of *Cassia fistula* fruit pulp extract against urinary pathogens. Indian drugs. 2007; 44: 716.
22. Ahmad I, Mehmood Z and Mohammad F. Screening of some Indian medicinal plants for their antimicrobial properties. J. Ethanopharmacol. 1998; 62: 183.
23. Ignacimuthu S and Duraipandiyan V. Antibacterial and antifungal activity of *Cassia fistula*. J. Ethanopharmacol. 2007; 112: 590.
24. Sayeed MA, Bhuiyan MSA and Yeasmin S. Antibacterial and antifungal activity of *Cassia fistula* L.: An ethnomedicinal plant. J. Med. Sci. 2004; 4: 24.
25. Sartarelli P, Andrade SP, Melhem MSC, Prado FO and Tempone AG. Antibacterial and antifungal activity of *Cassia fistula* L.: An ethnomedicinal plant. Phytoether Res. 2007; 21: 644.
26. Madan R and Babbar OP. Studies on the possibilities to infect the cells of callus of *Cassia fistula* by an animal virus & induce production of interferon-like antiviral factor(s). Indian J. Exp. Biol. 1981; 19: 349.
27. Saha BP, Bhakta T, Mukherjee PK and Mukherjee K. Hepatoprotective activity of *Cassia fistula* leaf extract. Nat. Prod. Sci. 1998; 4: 84.

28. Govindarajan M, Jebanesan A and Pushpanathan T, Bioefficacy of *Cassia fistula* Linn. (Leguminosae) leaf extract against chikungunya vector, Aedes aegypti (Diptera: Culicidae). Parasitol Res. 2008; 102: 289.
29. T. Bhakta, P. K. Mukherjee, K. Saha, M. Pal, B. P. Saha, Pharmaceutical Biology, 1998, 36(2): 140-143.
30. U. K. Mazumder, Malaya Gupta, Nandita Rath, Phytotherapy Research, 1998; 12(7): 520522.
31. K. C. S. Kumar, K. Muller, Phytotherapy Research, 1998; 12(7): 526-528.
32. M. J. Mukhopadhyay, A. Saha, A. Dutta, A. Mukherjee, Food and Chemical Toxicology, 1998; 36: 937-940.
33. P. Sartorelli, C. S. Carvalho, J. Q. Reimao, M. J. P. Ferreira, A. G. Tempone, Phytotherapy Research, 2007; 21(7): 644-647.
34. Kuo Y, Lee P and Wein Y. Four New Compounds from the Seeds of *Cassia fistula.* J. Nat. Prod. 2002; 65: 1165.
35. Singh RS, Singh H, Pandey HS, Pandey RP and Singh S. Two new aliphatic compounds from *Cassia fistula* L. Indian J. Chem, 2005; 44B: 2372.
36. Ahuja A, Parshad R, Kaushik JP, Phytochemical constituents of *Cassia fistula*. Fitoter. 1988; 49: 496.
37. Sanghavi MM, Kaji NN and Khorana ML, Antioxidant Activities of Phenolic, Proanthocyanidin, and Flavonoid Components in Extracts of *Cassia fistula.* Indian J. Pharm. 1968; 30: 8.
38. Bahoran T, Neergheen VS, Aruoma OI, Phytochemical constituents of *Cassia fistula.* Afr. J. Biotech. 2005; 4: 1530.
39. Koakte CK, Purohit AP and Gokhale SB. 'Pharmacognosy', CBS Publishers and distributors. 2005; 169.
40. Deshpande VH and Patil AD. A new dimeric proanthocyanidin from *Cassia fistula* leaf extract. Indian J. Chem. 1982; 21: 626.
41. Sen AB and Shukia YN. Phytochemical constituents of *Cassia fistula*. J. Indian Chem. Soc. 1968; 45: 744.
42. Morimoto S, Nonaka G and Nishioka I. Isolation and charechterization of proanthocynidins with a double linked unit from Vaccinnium vitisidaca L. Chem. Pharm. Bull. 1988; 36: 33.
43. Young DA, Ferreira D, Roux DG and Hull WE. Structure of natural 'angular' tetraflavanoids asymmetric induction during oligomeric synthesis. J. Chem. Soc. 1985; 2529.
44. Sethi VK, Taneja SC, Dhar KL and Atal CK. (-)-Epiafzelechin-5-0-α-D-glucoside from Craeteva religiosa. Phytochemistry. 1984; 23: 2402.
45. Morimoto S, Nonaka G and Nishioka I. Isolation and Structures of Novel Biflavonoids and Triflavonoids from the Leaves of *Cassia fistula* L. Chem. Pharm. Bull. 1986; 34: 633.
46. Fletcher AC, Porter LJ, Haslam E and Gupta RK. Conformational and configurational studies of natural procynadins J. Chem. Soc. 1977; 1628.
47. Thomson RS, Jaques D, Haslam E and Tanner RJN. Plant proanthocyanidins. J. Chem. Soc. 1972; 1387.
48. Sen AB and Shukia YN, Chemical examination of *Cassia fistula*. J. Indian Chem. Soc. 1968; 45: 744.
49. Nonaka G, Hsu FL and Nishioka I, Structures of dimeric, trimeric and tetrameric procynidins from areca catechu. J. Chem. Soc. 1981; 781.
50. Botha JJ, Young DA, Ferreira D and Roux DG. Stereoselective and stereo-specific synthesis of optically pure 4-arylflavan-3-ols and assessment of their absolute stereochemistry at C-4 by means of circular dichroism., J. Chem. Soc. 1981; 1213.
51. Singh GK and Bhandari A. Text book of Pharmacognosy. CBS Publishers New Delhi. 2000; 65.
52. Lohar DR, Chawan DD, Garg SP. Phytochemical studies on *Cassia* species of Indian Arid Zone. Curr. Sci. 1975; 44: 67.
53. Singh J, Agrawal A, Gupta V, Singh KN and Bharadwaj UR. Hypoglycaemic activity of Albizzia stipulata, Albizzia moluccana and *Cassia fistula* leguminous seed diets on normal young rats. Indian J. Chem. 1989; 28B: 282.
54. Agrawal GD, Rizvi SAI, Gupta PC and Tewari JD. Structure of Fistulic acid, a new colouring matter from the pods of *Cassia fistula*, Planta Med. 1972; 2: 150.
55. Rani M and Kalidhar SB. A new anthraquinone derivative from *Cassia fistula* Linn. Pods. Indian J. Chem. 1998; 37B: 1314.
56. Sinkar PK, Sanyal T, Ganguly SN and Sinkar SM, Gibberellic acid in the floral parts of *Cassia fistula*. Phytochemistry. 1970; 9: 735.
57. Vaishnav MM and Gupta KR, Rhamnetin-3-O-gentiobioside from *Cassia fistula* roots. Fitoter. 1996; 16: 78.