Research Article

Review on Nutraceutical Potential of *Cassia occidentalis* L. – An Indian Traditional Medicinal and Food Plant

S. Manikandaselvi[1], V. Vadivel[2], P. Brindha[2,*]

[1]PG and Research Department of Biochemistry, Sengamala Thayaar Educational Trust Women's College, Mannargudi, Tamilnadu, India.

[2]Centre for Advanced Research in Indian System of Medicine, SASTRA University, Thanjavur, Tamilnadu, India.

***Corresponding author's E-mail:** brindha@carism.sastra.edu

Accepted on: 01-03-2016; **Finalized on:** 31-03-2016.

ABSTRACT

Cassia occidentalis L. is an important member of plant family Fabaceae. *C. occidentalis* is known as 'kasamarda' and it has been mentioned in various nighandus viz. Rajnighantu, Dhanwantari, Bhavaprakasa, Rajballaba. It has active ingredients such as anthraquinones derivatives and their glycosides. *C. occidentalis* extract is used to cure eye inflammations in Ayurveda. It is also used in Jamaican folk medicines for curing diarrhoea, dysentery, constipation, fever, cancer, eczema and venereal diseases. Seeds of *C. occidentalis* are good source of alternative plant proteins, rich in vitamin B3 and also abundant in Ca, K, P, Na, Mg, Fe, Zn, Cu but low in Mo, Co, Se, S and F. The amino acid profile revealed a high concentration of leucine, histidine, proline and glycine. It is a main ingredient of Liv. 52. Herbolax, a polyherbal formulation that is commonly used in treating constipation. A new indigenous metabolic corrective for newborns and infants called 'Bonnisan' is also made up of *C. occidentalis* (0.5 mg/5 ml), which helps to bring immediate relief from discomfort caused by gastric wind. Pharmacological investigations have revealed several biological activities such as antioxidant, analgesic, antipyretic, anti-inflammatory, hepatoprotective, anti-malarial, anti-diabetic, anti-cancer and antidepressant activities of *C. occidentalis*. Detoxification of the seeds is essential through processing before its use in human/animal diet. This review article is an attempt to present the overview of pharmacognostical, phytochemical, nutraceutical and biological studies reported on *C. occidentalis*.

Keywords: *C. occidentalis,* Nutritional value, Pharmaceutical use, Nutraceutical, Biological properties.

INTRODUCTION

Cassia occidentalis L. is an annual or perennial plant which is used in several traditional medicines to cure various diseases. *C. occidentalis* is a spiny herb grows all over in India in shade as well as under open condition (Figure 1). Generally found up to an altitude of 1,000 m in Himalaya and wild throughout the plains on waste lands or in the coastal areas. It is also found in deltaic region of western, eastern and southern India[1]. Found particularly in the seacoast throughout the hotter parts of India, Burma and Sri Lanka. It is also grown as an ornamental plant[2]. This plant is called in different regional/vernacular languages like Hindi (Badikasondi, Chakunda, Kasonda), English (Coffee senna, Negro coffee, Rubbish cassia, Stinking weed, Foetid cassia), Sanskrit (Kasamarda), Urdu (Kasonji), Tamil (Nattamtakarari, Ponthagarai, Paeravirai, Ponnavirai, Paeravirai, Attutakarai), Bengali (Kalkashunda), Gujarati (Kasodari, Kasundari, Kasuvayee, Hikal), Kanada (Doddatagase, Anecogate, Doddatagache), Malayalam (Natramtakara, Ponnaviram, Natrum-takara, Ponnaveeram) and Telugu (Kasinda, Peddakasinda). Botanical synonyms of this species are *Senna occidentalis* Roxb., *Senna occidentalis* (L.) and *Cassia foetida* Pers.

In this review, an attempt was made to collect all possible ethnobotanical and nutraceutical potential of *C. occidentalis* with reference to its food and medicinal applications. A baseline survey was conducted during 2011-2015 and information's about *C. occidentalis* were collected through semi-structured interviews and discussion with the local healers, elderly and experienced people. Additionally, all available literature on *C. occidentalis* was reviewed and studied through online search engine Scopus and Google Scholar. Literature collection was done from 1965 to 2015 and all the information were compiled and presented in this review work.

Figure 1: Morphology of *Cassia occidentalis* L.

Taxonomic position

Kingdom: Plantae

Division : Magnoliophyta

Sub Division : Spermatophyta

Class : Magnoliopsida

Order : Fabales

Family : Fabaceae

Genus : *Cassia*

Species : *occidentalis*

Distribution

C. occidentalis is a spiny herb grows all over in India in shade as well as under open condition. Generally found up to an altitude of 1,000 m in Himalaya and wild throughout the plains on waste lands or in the coastal areas. It is also found in deltaic region of western, eastern and southern India. Found particularly in the seacoast throughout the hotter parts of India, Burma and Sri Lanka and it is also grown as an ornamental plant.

Botanical description

Leaves are evergreen, lanceolate, compound, glossy leaf surface, deep tap root system, stem is hard and woody, Dicot seed type with characteristic odour and bitter taste. Flowers are yellow in colour with 1 to 2 cm diameter arranged in raceme type inflorescence, axillary and also forming terminal, bracts are caduceus. Fruits are flat pods, 10-12 cm long with 10-30 seeds. Areolate seeds are pointed at end and blunt at the other.

Pharmacognostic details

Foliage : Evergreen

Roots : Deep roots, tap roots

Type of stem : Hard woody

Leaf type : Lanceolate or ovate-lanceolate

Leaf arrangement : Compound

Leaf colour : Green

Leaf surface : Glossy

Seed type : Dicot

Odour : Characteristic

Taste : Bitter

Flower : Yellow with 1 to 2 cm diameter, inflorescence Racemes few-flowered, axillary, and also forming terminal panicle; bracts caduceus.

Fruit : Flat pods, 10-12 cm long with 10-30 seeds. Areolate seeds are pointed at end and blunt at the other. Flowering in sharad and fruition in Hemantaritu.

Major chemical constituents

The main plant chemicals in *C. occidentalis* include: achrosin, aloe-emodin, emodin[3], anthraquinones, anthrones, apigenin, aurantiobtusin, campesterol, cassiollin, chryso obtusin, chrysophanic acid, chrysarobin, chrysophanol[4], chrysoeriol, emodin, essential oils, funiculosin, galactopyranosyl, helminthosporine[5], islandicine, kaempferol, lignoceric acid, linoleic acid, linolenic acid, mannitol, mannopyranosyl, matteucinol, obtusifolin, obtusin, oleic acid, physcion[3], quercetin, rhamnosides, rhein, rubrofusarin, sitosterols, tannins, and xanthorine[6]. The study of phytochemicals of *C. occidentalis* reveals that the nature and amount of phytochemicals vary according to climate. For example stems, leaves and the root bark of the plant from Ivory Coast, Africa contain small amount of saponins, no alkaloids, sterols, triterpenes, quinines, tannins and flavonoids. However, a large amount of alkaloids were found in the stem, leaves and fruits from Ethiopia[7]. Presence of various chemical constituent in different parts of *C. occidentalis* was reported (Table 1 and Figure 2).

Traditional uses

C. occidentalis is regarded as 'Edible weeds of Agriculture or 'Famine food'. Its infusion is given against the white discharge. In Mali, *C. occidentalis* is used as ingredient in a malarial formulation based on a traditional recipe comprising leaf of *C. occidentalis* leaves of *Lippia chevalieri* and flower heads of *Spilanthes oleraces*[16]. Decoction of *C. occidentalis* roots with black pepper is useful in filaria[17]. In the Malyagiri hills, a decoction is made from 15 leaves each of *C. occidentalis, Glycosmis pentaphylla* and *Vitex negundo* and used for bathing the new born baby to make the baby immune to skin diseases[18]. According to 'Bhavaprakasa', Kasamarda (*C. occidentalis*) is used in constipation, and is stated that leaves, roots and seeds are useful as purgative[19]. In folklore medicine, seed powder (half a tea spoon) is used to cure fever while two table spoons of leaf juice mixed with honey cures cough. For intestinal gas half a cup of leaf decoction is taken twice daily and paste of leaf is applied for skin diseases.

Uses in modern medicine

Various biological activities and medicinal properties of *C. occidentalis* were shown in Table 2. *C. occidentalis* is widely consumed by the local people as a substitute for coffee. It is an ingredient in Himoliv, a polyherbal Ayurvedic formulation.

It is also proved that it prevents the carbontetrachloride-induced hepatotoxicity in rats[20]. Based on the observation they suggested that Himoliv increases the protective enzymes superoxide dismutase (SOD) and catalase in liver homogenate of rats[21]. It is also present in other polyherbal formulation Liv.52 tablet and syrup which are extensively used for Hepatitis A[22]. *C. occidentalis*is also used in Senkot[23], Bonnisan, Geriforte, Herbolax, Liv.52 drops, Digyton, Geriforte Aqua, Geriforte Vet, Liv.52 Vet (Companion) , Liv.52 Vet and Liv.52 DS[24, 25].

Table 1: Major chemical constituents reported in *Cassia occidentalis*

S. No.	Parts studied	Chemical constituents identified	Reference
1	Flower	Cassiaoccidentalin A, Physcion, Emodine, Physcion1β-D-Glucopyranoside and β-Sitosterol	Niranjan and Gupta[8]
2	Leaf	Chrysophenol, Emodin and their Glycosides, Physcion, Metteucinol-7-rhamnoside; Jaceidin-7-rhamnoside and 4, 4, 5, 5-tetrahydroxy-2,2-dimethyl-1,1-bianthraquinone 4 and Flavonoid Glycosides	Tiwar and Singh[9], Ogunkunle and Ladejobi[10]
3	Root	Pinselin (cassialoin), Rhein, Aloe emodin and their glycosides; Chrysophanol, Physcion, Emodin, Islandicin, Helminthosporin, Xanthorin, Sitosterol, Campesterol, Stigmasterol, 1,8-dihydroxyanthraquinone; 1,7-dihydroxy-3-methoxyxanthone; α-hydroxyanthraquinone and Quercetin, Questin, Germichrysone, Methyl germitorosone, Singueanol-I, Pinselin; Bis(tetra hydro) anthracene derivatives; Occidentalol-1 and Occidentalol-II, C-glycosidic flavonoids, and Cassia occidentalins A, B and C flavonoids.	Rai and Shok[11], Kitanaka[12]
4	Seeds	Anthraquinones, 1,8-dihydroxy-2-methylanthraquinone; 1,4,5-trihydroxy-7-methoxy-3-methylanthraquinone; Physcion& its glucoside, Rhein, Aloeemodin, Chrysophanol& its glycoside, N-methyl-morpholine; α-glucosides of Campesterol& β-sitosterol; and a Galactomannan	Ryan et al.[13], Bruere[14]
5	Pods	3,5,3,4-tetrahydroxy-7-methoxyflavone-3-O-(2-rhamnosyl glucoside); 5,7,4-trihydroxy-3,6,3-trimethoxyflavone-7-O-(2”-rhamnosylglucoside)	Purwar et al.[15]

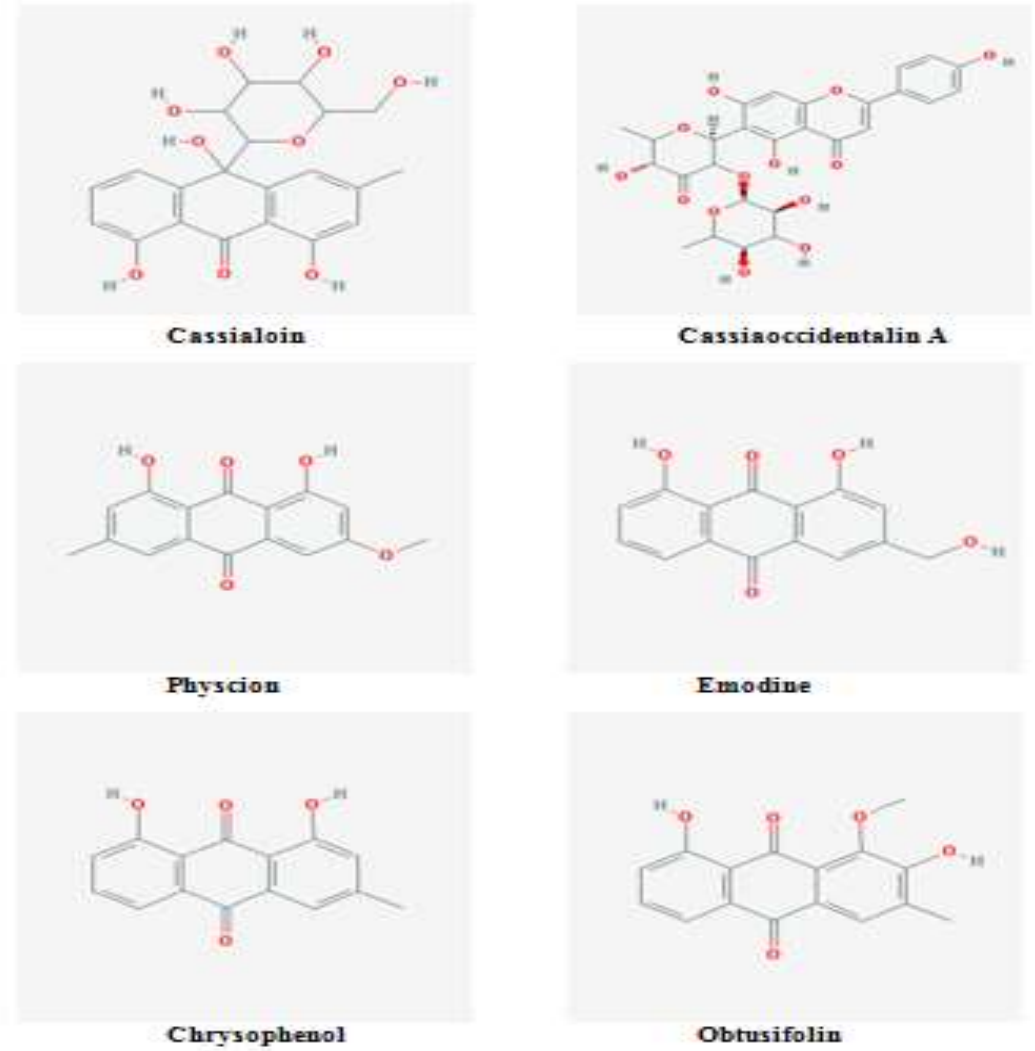

Figure 2: Phytochemicals identified in *Cassia occidentalis*

Table 2: Biological activity reported on *Cassia occidentalis*

S. No.	Parts studied	Biological activity	References
1	Methanol, aqueous, benzene, petroleum ether and chloroform extracts	Antimicrobial activity	Arya[27]
	Ethanol and water extract of leaf		Sadiq[28]
	Ethanol and water extract of flower		Daniyan[29]
	Anthraquinones fraction of leaf, pods, flowers and callus		Jain[30]
	Leaf extract		Mohammed[31], Basri and Fan[32]
2	Methanolic extract of seeds of whole plant	Antioxidant activity	Mehta[33]
	Ethanolic extract of seeds of whole plant		Sreejith[34]
	Chrysophanol and methanolic fraction of leaf		Rani[35]
3	Aqueous and ethanolic extracts of leaf	Hepatoprotective activity	Jafri[36]
4	Ethanolic, dichloromethane and lyophilized aqueous extracts of root bark	Antimalarial activity	Tona[37]
5	Leaf	Anti-inflammatory activity	Sadique[38]
6	Ethanolic extract of Senkot tablets (*Cassia occidentalis* concentrate)	Anti-mutagenic/anti-carcinogenic activity	Sharma[39]
	Aqueous and hydro-alcoholic extracts of whole plant		Bhagat and Saxena[40]
7	Ethanolic extract of whole plant	Anti-allergic activity	Ajagbonna[41]
8	Aqueous extract of the leaf	Muscle relaxant effect	Emmanuel[42]
9	Chrysophanol extracted from the leaf	Wound healing activity	Sheeba[43]
10	A quarternary base picrate isolated from the leaf	Cholinergic effect	Bhattacharya[44]
11	Ethanolic and aqueous extracts of the leaf	Antidepressant activity	Shafeen[45]
12	Ethanol extract of *Cassia occidentalis*	Larvicidal activity	Dhandapani and Kadarkarai[46]
	Cassia occidentalis seed oil		Lienard[47]
13	Whole plant extract	Immuno-suppression activity	Bin-Hafeez[48]
14	Ethanolic and aqueous extracts of leaf	Anti-anxiety and Anti-depressant activity	Shafeen[45]
15	Ethanolic and aqueous extracts of leaf	Analgesic and anti-pyretic activity	Sini[49]
16	Aqueous, petroleum ether and chloroform extracts of leaf	Anti-diabetic activity	Verma[50]
	Methanolic and aqueous extracts of leaf		Emmanuel[42]
	Butanolic and aqueous extracts of the leaf		Singh[51]

In Brazil, hydroalcoholic extract of *C. occidentalis* stem and leaf has been marketed by Pharmaceutical Laboratory (LAPERLI) with commercial name of Cassia Virgínica® and has been indicated for the treatment of flu, fever, erysipelas, febrifuge and as analgesic, hepatoprotective and diuretic[26].

Ayurvedic description

Charaka omitted it among the *Ganas, Sushruta* and *Vagbhata* have included it under *Sursadigana*. *Vagbhata* denoted it with a synonym *kasaghna*. The drug Kasamarda is used in the indigenous system of medicine since long time. Charak mentioned its use for curing cough. It has been mentioned in various nighantus viz. Rajnighantu, Dhanwantari, Bhavaprakasha and Rajballabha. Rasa (taste) is tikta (bitter), madhura, veerya (potency) is ushna (hot), vipaka-Katu guna (properties) is laghu (light), ruksha (dry), tikshna (sharp). Doshakarma - Vata, Pitta and Kapha (Vata is the impulse principle necessary to mobilize the function of the nervous system; Pitta is the energy principle which uses bile to direct digestion and hence metabolism into the venous system; Kapha is the body fluid principle which relates to mucous, lubrication and the carrier of nutrients into the arterial system). It has the properties of rogaghnata (Kasa, Swasa, Ajeerna,Visha, Raktavikara, Twakvikar), karma (Vrishya, Rochana, Pachana, Grahi, Kantyasodhana, Krimighna), karm (Kasaghna, Mutrala, Kusthaghna, Rechana), rog (Kasa, Swasa, Hikka, Kukkurakasa, Agnimandya, Udararroga, Pittavikaravibandha, Apasmara, Apatantraka,

Akshepaka, Kustha, Visharpa, Shlipada, Vrana, Dadru, Charmavikara, Mutrakrchra and Ikshumeha).

Nutraceutical values

Seeds of *C. occidentalis* are good source for alternative plant proteins. Proximate composition results showed high dry matter (92.50%), crude protein (29.54%) and crude fiber (10.18%), but low ether extract, nitrogen free extract, ash and calorific values[52]. The vitamin content data revealed poor vitamins B_2, B_1, C and A but the seeds were rich in vitamin B_3 (1.85 mg/100 g) values compared to other seeds. The seeds were also abundant in calcium (960 mg/100 g), potassium (1,200 mg/100 g), phosphorus (810 mg/100 g), sodium (600 mg/100 g), magnesium (640 mg/100 g), iron (234.60 mg/100 g), zinc (53.12 mg/100 g) and copper (10.48 mg/100 g) but low in molybdenum, cobalt, chromium, selenium, sulphur and fluorine. The amino acid profile revealed a high concentration of leucine (7.60 g/100 g protein), histidine (2.11 g/100 g protein), proline (2.33 g/100 g protein) and glycine (4.11 g/100 g protein) while the rest of the amino acids were of low concentration in the raw seed[53]. Detoxification of the seeds is essential through processing before its use in food/feed.

CONCLUSION

The scientific research on *C. occidentalis* suggests a huge nutraceutical potential of this plant. It is strongly believed that detailed information as presented in this review on the phytochemical, nutritional and various biological properties of this plant. Raw seeds might have some toxicological side effects. After proper processing, identification and removal of the harmful properties of seeds, they may be utilized to prepare a good, nourishing and Ayurvedic coffee. At the same time, *C. occidentalis* could be further exploited in the future as a source of useful phytochemicals and nutritional compounds for the nutraceutical industry.

Acknowledgement: Authors extend a deep sense of gratitude to the Management and Administrative authorities of SASTRA University, Thanjavur for their encouragement and also one of the Authors (SM) thank the Management, Sengamala Thayaar Educational Trust Women's College, Mannargudi for their motivation and support.

REFERENCES

1. Kapoor LD. Hand of Ayurvedic Medicinal Plants, CRC Press, 2010, 88.
2. Shankar DK, Ved A. Balanced perspective for management of Indian medicinal plants, *Indian Forest*., 129, 2003, 275-288.
3. Alves AC. Pharmacological study of the root of *Cassia occidentalis*. *Anal. Fac. Farm. Porto*., 24, 1965, 65-119.
4. Anton R, Duqenois P. L'emplois des Cassia dans les pays tropicaux etsubtropicaux examine d'apres quelquesunsdes constutiants chimiquesde ces plantes medicinales. *Plant. Med. Phytother*., 2, 1968, 255-268.
5. Kudav NA, Kulkarni AB. Chemical investigation on *C. occidentalis* II. Isolation of islandicin, helminthosporin, xanthorin and NMR spectral studies of cassiollin and its derivatives. *Indian J. Chem*., 12, 1974, 1042-1044.
6. Chukwujekwu JC, Coombes PH, Mulholland DA, Staden J. Emodin, anantibacterial anthraquinone from the roots of *C. occidentalis*. *S. Afr. J. Bot*., 72, 2006, 295-297.
7. Smolenski IJ, Silinis H, Farnsworth NR. Alkaloid screening. VI. Lloydia., 38, 1975, 225-256.
8. Niranjan GS, Gupta PC. Chemical constituents of the flowers of *Cassia occidentalis*. *Plant Med*., 23, 1973, 298-300.
9. Tiwar RD, Singh J. Flavonoids from the leaves of *C. occidentalis*. *Phytochem*., 16, 1977, 1107-1108.
10. Ogunkunle ATJ, Ladejobi TA. Ethnobotanical and phytochemical studies on some species of Senna in Nigeria. *Afr. J. Biotechnol*., 5, 2006, 2020-2023.
11. Rai PM, Shok M. Anthracene derivatives in tissue cultures of *Cassia species* indigenous to Nigeria. *Phytochem*., 5, 1982, 227-278.
12. Kitanaka S, Igarashi H, Takido M. Two new bitetrahydroanthracene from root of *Cassia occidentalis. Chem. Pharm. Bull*., 37, 1989, 511-512.
13. Ryan KJ, Ray CG, Kefha BJ. Sherrie's Medical Microbiology, 4th Edn, 2004, 119-125.
14. Bruere P. Bemerkungen uber ein in ungebranntem Zustand giftiges kaffessurrogat *Cassia occidentalis*. *Chem. Zentralblatt*., 1943, 1728.
15. Purwar C, Rai R, Srivastava N, Singh J. New flavonoid glycosides from *Cassia occidentalis. Indian J. Chem*., 43, 2003, 44-46.
16. Willcox M, Sanogo R, Diakite C, Giani S, Pharm D, Paulsen BS, Diallo D. Improved traditional medicines in Mali. *J. Alt. Comp. Med*., 18, 2012, 212-220.
17. Arvind K, Shamshun N. Environmental protection. New Delhi: Daya Publishing House. 2007, 157.
18. Yadav JP, Arya V, Yadav S, Panghal M, Kumar S, Dhankhar S. *Cassia occidentalis* L.: A review on its ethnobotany, phytochemical and pharmacological profile. *Fitoterapia*., 81, 2010, 223-230.
19. Warrier PK, Nambiar VPK. Indian Medicinal Plants: A Compendium of 500 Species, Orient BlackSwan/Universities Press, Vol. 2, 1994, 21.
20. Bhattacharyya D, Mukherjee R, Pandit S, Das N, Sur TK. Prevention of carbon tetrachloride induced hepatotoxicity in rats by Himoliv - A polyherbal formulation. *Indian J. Pharmacol*., 35, 2003, 183-185.
21. Kolhapure SA, Mitra WS. Meta-analysis of 50 Phase III clinical trials in evaluation of efficacy and safety of Liv. 52 in infective hepatitis. *Med Update*., 12, 2004, 51-61.
22. Tona L, Cimanga RK, Mesia K, Musuamba CT, De Bruyne T, Apers S. *In vitro* antiplasmodial activity of extracts and fractions from seven medicinal plants used in the Democratic Republic of Congo. *J. Ethnopharmacol*., 93, 2004, 27-32.
23. Sharma N, Trikha P, Athar M, Raisuddin S. Protective effect of *Cassia occidentalis* extract on chemical-induced chromosomal aberrations in mice. *Drug Chem. Toxicol*., 22, 1999, 643-653.
24. Gupta S, Khatri RL, Srivastava G. Therapeutic effects of Liv.52 in post-necrotic Hepatitis. Probe, 1, 1972, 15-18.
25. Mukherjee AB, Das Gupta, M. Treatment of viral Hepatitis by an indigenous drug, Liv. 52. *Indian Pract*., 6, 1970, 357.
26. Silva MGB, Aragao TP, Vasconcelos CFB, Ferreira PA, Andrade BA, Costa IMA, Costa-Silva JH, Wanderleya AG, Lafayette SSL. Acute and subacute toxicity of *C. occidentalis* L. stem and leaf in Wistar rats. *J. Ethnopharmacol*., 136, 2011, 341-346.
27. Arya V, Yadav S, Kumar S, Yadav JP. Antimicrobial activity of *Cassia occidentalis* L (Leaf) against various human pathogenic microbes. *Life Sci. Med. Res*., 9, 2010, 1-11.

28. Sadiq IS, Shuaibu M, Bello AB, Tureta SG, Isah A, Izuagie T, Nasiru S, Kamaru MB. Phytochemistry and antimicrobial activities of *Cassia occidentalis* used for herbal remedies. *J. Chem. Engg*., 1, 2012, 38-41.

29. Daniyan SY, Oloruntimelehin JB, Ifeadi O. Antibacterial activity of *Cassia occidentalis* flower vegetable extract on selected bacteria. *Asian J. Biomed. Pharm. Sci.,* 1, 2011, 23-27.

30. Jain SC, Sharma RA, Jain R, Mittal C. Antimicrobial screening of *Cassia occidentalis* L *in vivo* and *in vitro*. *Phytother. Res*., 12, 1998, 200-204.

31. Mohammed M, Aboki MA, Saidu HM, Victor O, Tawakalitu A, Maikano SA. Phytochemical and some antimicrobial activity of *Cassia occidentalis* L. (*Caesalpiniaceae*). *Int. J. Sci. Technol*., 2, 2012, 4-7.

32. Basri DF, Fan SH. The potential of aqueous and acetone extracts of galls of *Quercus infectoria* as antibacterial agents. *Indian J. Pharmacol*., 37, 2005, 26-29.

33. Mehta S, Kamboj P, Faujdar S, Sawale J, Kalia AN. *In vitro* antioxidant activity of *Cassia occidentalis* seeds. *Pharmacol. Online*., 3, 2010, 217-224.

34. Sreejith G, Latha PG, Shine VJ, Anuja GI, Suja SR, Sini S. Anti-inflammatory and antioxidant effect of *Cassia occidentalis* Linn. *Indian J. Exp. Biol*., 48, 2010, 494-498.

35. Rani MS, Emmanuel S, Sreekant MR, Ignacimuthu S. Evaluation of *in vivo* antioxidant and hepatoprotective activity of *Cassia occidentalis* Linn. against paracetamol-induced liver toxicity in rat. *Int. J. Pharm. Pharm. Sci*., 2, 2010, 67-70.

36. Jafri MA, Subhani MJ, Javed K, Singh S. Hepatoprotective activity of leaves of *Cassia occidentalis* against paracetamol and ethyl alcohol intoxification in rats. *J. Ethnopharmacol*., 66, 1999, 355-361.

37. Tona L, Mesia K, Ngimbi NP, Chrimwami B, Okond'ahoka, Cimanga K, de Bruyne T, Apers S, Hermans N, Totte J, Pieters L, Vlietinck AJ. *In vivo* antimalarial activity of *Cassia occidentalis*, *Morinda morindoides* and *Phyllanthus niruri*. *Ann. Trop. Med. Parasitol*., 95, 2001, 47-57.

38. Sadique J, Chandra T, Thenmozhi V, Elango V. Biochemical modes of action of *Cassia occidentalis* and *Cardiospermum halicacabum* in inflammation. *J. Ethnopharmacol*., 19, 1987, 201-212.

39. Sharma N, Trikha P, Athar M, Raisuddin S. *In vitro* inhibition of carcinogen-induced mutagenicity by *Cassia occidentalis* and *Emblica officinalis*. *Drug Chem. Toxicol*., 23, 2000, 477-484.

40. Bhagat M, Saxena AK. Evaluation of *Cassia occidentalis* for *in vitro* cytotoxicity against human cancer cell lines and antibacterial activity. *Indian J. Pharmacol*., 42, 2010, 234-237.

41. Ajagbonna OP, Mojminiyi FBO, Sofola OA. Relaxant effects of the aqueous leaf extract of *Cassia occidentalis* on rat aortic rings. *Afr. J. Biomed. Res*., 4, 2001, 127-129.

42. Emmanuel S, Rani MS, Sreekant MR. Antidiabetic activity of *Cassia occidentalis* Linn. in streptozotocin-induced diabetic rats: Dose dependent studies. *Int. J. Pharm. Bio Sci*., 1, 2010, 15-25.

43. Sheeba M, Emmanuel S, Revanthi K, Ignacimuthu S. Wound healing activity of *Cassia occidentalis* L. in albino Wistar rats. *Int. J. Integ. Biol*., 8, 2009, 1-6.

44. Bhattacharya SK, Banejee SK, Prakash D, Raina MK. Pharmacological identification of an identical quartenary base isolated from eleven species of *Leguminosae*. *Indian Med. Gaz*., 11, 1971, 16-17.

45. Shafeen S, Reddy TS, Arafath S, Nagarjuna S, Reddy YP. Evaluation of antianxiety and antidepressant activity of *Cassia occidentalis* leaves. *Asian J. Pharm. Clin. Res*., 5, 2012, 47-50.

46. Dhandapani A, Kadarkarai M. HPTLC quantification of flavonoids, larvicidal and smoke repellent activities of *Cassia occidentalis* L. (Caesalpiniaceae) against malarial vector *Anopheles Stephensilis* (Diptera: Culicidae). *J. Phytol. Phytopharmacol*., 3, 2011, 60-72.

47. Lienard V, Seck D, Lognay G, Gaspar C, Severin M. Biological activity of *Cassia occidentalis* L. against *Calloso bruchusmaculatus* (F.) (Coleoptera: Bruchidae). *J. Stored Prod. Res*., 29, 1993, 311-318.

48. Bin-Hafeez B, Ahmad I, Haque R, Raisuddin S. Protective effect of *Cassia occidentalis* L. on cyclophosphamide-induced suppression of humoral immunity in mice. *J. Ethnopharmacol*., 75, 2001, 13-18.

49. Sini KR, Sinha BN, Karpakavalli M, Sangeetha PT. Analgesic and antipyretic activity of *Cassia occidentalis* Linn. *Annal. Biol. Res*., 2, 2011, 195-200.

50. Verma L, Khatri A, Kaushik B, Patil UK, Pawar RS. Antidiabetic activity of *Cassia occidentalis* (Linn) in normal and alloxan-induced diabetic rats. Indian *J. Pharmacol*., 42, 2010, 224-228.

51. Singh PS, Salwan C, Mann AS. Evaluation of anti-diabetic activity of leaves of *Cassia occidentalis. Int. J. Res. Pharm. Chem*., 1, 2011, 904-913.

52. Augustine C, Abdulrahman BS, Masudi B, Ngiki YU. Comparative evaluation of the proximate composition and anti-nutritive components of tropical sickle pod (*Senna obtusifolia*) and coffee senna (*Senna occidentalis*) seed meals indigenous to Mubi area of Adamawa state Nigeria. *Int. J. Mgt. Soc. Sci. Res*., 3, 2014, 9-12.

53. Ingweye JN, Kalio GA, Ubua JA, Umoren EP. Nutritional evaluation of wild sickle pod (*Senna obtusifolia*) seeds from Obanliku, South-Eastern Nigeria. *Am. J. Food Technol*., 5, 2010, 1-12.

Source of Support: Nil, **Conflict of Interest:** None.