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Phytochemical diversity and pharmacological significance of *Cassia occidentalis*

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Abstract
Cassia occidentalis is an annual or perennial medicinal plant used in several folklore medicines across the globe to treat various diseases. It is commonly known as coffee senna, stinking weed and Negro coffee belongs to the family of Caesalpiniaceae and found all over the world. The different plant parts are used to prepare medications for different ailments. Secondary metabolites such as alkaloids, flavonoids, tannins, saponins, sugars, cardiac glycosides, quinones, terpenoids, anthraquinones *etc*. are reported in this plant. A variety of phytochemicals including rhein, emodin, aloe emodin, chrysophenol, physcion, cassiollin, occidentol I, occidental II, methyl physcion, quercetin, questin, betacyanin, coumarins etc. have been isolated and reported from this plant. This weed has been known to possess antibacterial, antifungal, antidiabetic, antioxidant, anti-inflammatory, antipyretic, antitrypanosomal, anticonvolusant, hepatoprotective activities. This review provides a comprehensive overview of the morphological traits, global distribution, traditional medicinal uses, phytochemical profile, herbal formulations, notable patents, pharmacological activities, and toxicological aspects of *Cassia occidentalis*.

Keywords: *Cassia occidentalis*, phytoconstituents, antimicrobial activity, antioxidant acivity, cytotoxicity

Introduction
Since ancient times, plants have served as a fundamental source of traditional medicine and pharmacopoeial drugs for treating severe illnesses, including cancer, diabetes, and malaria. Their medicinal value stems from the presence of various bioactive compounds known as secondary metabolites (Shukla *et al*., 2020) [26]. Medicinal plants have significantly contributed to modern medicine by providing numerous plant-derived therapeutic agents. Many plants contain a diverse range of phytopharmaceuticals with vital applications in agriculture, as well as human and veterinary medicine. These natural compounds play a crucial role in developing innovative drugs for disease treatment and prevention.
Understanding medicinal plants is essential, not only due to their extensive use but also because they can potentially cause adverse reactions or interact with other medications. The growing global preference for natural remedies has led to an increasing demand for knowledge about the properties and benefits of medicinal plants. Despite the significance of drug discovery from natural sources, people often overlook its importance in advancing healthcare for future generations. Currently, no completely effective treatments exist for several life-threatening diseases, and resistance to available drugs for bacterial and fungal infections, AIDS, cancer, and malaria continues to rise. Given these healthcare challenges, it is imperative for policymakers, Governments, international organizations, and pharmaceutical companies to invest in the sustainable development of plant-based medicinal products, particularly in developing nations like India (Mahanthesh *et al*., 2019) [14].
This review explores the traditional medicinal applications of *Cassia occidentalis* Linn., a widely used herb across various populations. Modern pharmacological studies have demonstrated that *C. occidentalis* exhibits multiple biological activities. Research has highlighted it's *in vitro* cytotoxic and antibacterial properties (Bhagat and Saxena, 2010) [5], as well as its antioxidant, antipyretic (Singh *et al*., 2017) [28], antidiabetic (Onakpa and Ajagbonna, 2012) [20], and anti-inflammatory effects (Vijaybhaskar *et al*., 2013). Additionally, the plant has been found to possess antitrypanosomal properties (Ibrahim *et al*., 2010) [9], anticonvulsant effects (Mahanthesh and Jalalpure, 2016) [15] and myostimulant activity (Arsene *et al*., 2017) [2], further showcasing its potential in therapeutic applications.

Plant profile

Cassia occidentalis, commonly referred to as coffee senna, fetid cassia, rubbish cassia, stinking weed, and Negro coffee, is a medicinal plant belonging to the Caesalpiniaceae family. This plant is widely distributed across the globe. Its distinct features are illustrated in Figure 1, while its morphological characteristics are summarized in Table 1. In India, *C. occidentalis* is commonly found as a weed. It is utilized in various regions worldwide and is consumed by both humans and animals

Fig 1: Morphological features of *Cassia occidentalis*.

a. **Flowers of *C. occidentalis***
b. **Habit of the growing plant**
c. **Pods of *C. occidentalis***

Table1: Organoleptic characters of *Cassia occidentalis*

Organ of the plant	Characteristics
Leaves	15 to 20 cm long, pitiolate, stipulate, peripinnate; foetid in odour and slightly bitter in taste. They have slippery and papery texture, entire margin, pubescent surface and reticulate venations.
Stem	Erect, single purplish stem having glabrous surface and sparse branching. Young stems are four-angled, becoming rounded with age. The crushed foliage has an unpleasant odour.
Flowers	Inflorescence is few-flowered axillary racemes with yellow petalled flowers about 2 cm long. Petals are 5, sub equal, 1.3 cm long. Calyx is 1 cm long.
Fruits	Long, straight to slightly Fruits are pod (legume) type having green colour when unripe and brown when ripe, 5 mm thick, glabrous to slight pubescent, 7 to 12 cm curved.
Seeds	Seeds are 40 or more in each pod which are ovoid, compressed at one end and rounded at the other, 6 mm long, 4 mm broad, hard, smooth, shining, dark olive green or pale brown in colour.
Roots	Taproots with subroot

Cassia occidentalis is often referred to as an "Edible Weed of Agriculture" or a "Famine Food" (Yadav *et al*., 2010) [36]. This pantropical Ayurvedic plant is widely distributed across various regions, including Africa (Nigeria, Congo, Mali, Senegal, Benin Republic, and Cameroon) (Neuwinger, 1996 [17]; Chukwujekwu *et al*., 2005 [6]; Ntchapda *et al*., 2015) [19], South America (Brazil, Peru, Panama, Jamaica, and Suriname) (Silva *et al*., 2011) [27] and Asia (India) Manikandaselvi *et al*., 2016). Different parts of the plant are utilized in traditional medicine to address a range of health conditions (Table 2). The seeds and flowers are commonly infused to create a coffee-like beverage, traditionally used for managing asthma and bronchitis. Root decoctions of *C. occidentalis* are employed in treating menstrual irregularities, filarial infections, liver disorders, anemia, fever, and tuberculosis (Arya *et al*., 2011) [3]. Additionally, leaf decoctions are used in newborn baths to prevent skin ailments and are also applied for jaundice, bone fractures, itching, throat infections, yaws, sores, toothaches, and wound healing (Singh *et al*.,2016).

Table 2: Ethnomedicinal importance of *Cassia occidentalis*

Plant part/s used	Ethnomedicinal practices
Whole plant	Plant extract (4-5 drops) is used in curing eye inflammations in Ayurveda. It is also used in Jamaican folk medicines for curing diarrhoea, dysentery, constipation, fever, cancer, eczema and venereal diseases.
Roots	Infusion of roots (10-20 g) is considered beneficial in obstruction of stomach and incipient dropsy. Roots are also used as veterinary medicines for animal diseases, and as antidote in case of poison. Roots of this plant were also used against gastric complaints, to increase lactation, in whooping cough etc. In Nigeria, the roots of this plant were boiled with water and taken as tea for constipation and against white discharge in ladies.
Leaves	Leaf paste is externally applied on healing wounds, sores, itch and cutaneous diseases. Leaves are also used on bone fracture, fever, ringworm, skin diseases, throat infection and wounds. Twigs are used as tooth brushes. Leaves are burnt and the soot obtained is mixed with coconut oil and applied on eye-lids for cooling sleep.
Seeds	Seeds are roasted brown, pulverized, using a small amount (3 g=1/10th of an ounce), to make tea with brown sugar, used in Fujian as a tea substitute for the people with high blood pressure. Mature seeds are used on ring worms and as febrifuge.
Pods	The 8-10 roasted pods of this plant are eaten for cough problems in India. Decoction of fruits and flowers (10 g) are used in the treatment of mental disorders.

(**Source:** Yadav *et al*., 2010) [36]

The plant can be utilized in various forms for therapeutic purposes, including as a tea, decoction, infusion, topical application, or tonic. *C. occidentalis* has been commercialized and is available in the market as tablets, capsules, and syrups. In some cases, it is incorporated into polyherbal formulations alongside other medicinal plants to address specific health conditions.

Geographical distribution

C. occidentalis is a widely distributed weed, native to Brazil and found across the foothills of the Himalayas, West Bengal, South India, Myanmar, and Sri Lanka. It also thrives in tropical and warm regions of South, Central, and North America, including the Amazon (Mahanthesh *et al*., 2019) [14]. Various parts of the plant are traditionally utilized worldwide to prepare medicinal remedies for numerous ailments **(**Table 3).

Table 3: Ethnomedicinal properties of *Cassia occidentalis* practiced across the world

Countries	Ethnomedicinal use
India	For abscesses, bites (scorpion), constipation, diabetes, edema, fever, inflammation, itch, liver diseases, rheumatism, ringworm, skin diseases, snakebite, wounds.
Africa	For bile complaints, birth control, bronchitis, bruises, cataracts, childbirth, constipation, dysentery, oedema, eye infections, fainting, fever, gonorrhea, guinea worms, headache, hematuria, hemorrhages (pregnancy), jaundice, kidney infections, leprosy, malaria, pain (kidney), menstrual disorders, stomach ulcers, stomach-ache, syphilis, tetanus, water retention.
Brazil	For anaemia, constipation, edema, fatigue, fever, gonorrhea, liver disorders, malaria, menstrual disorders, skin problems, tuberculosis, urinary disorders, water retention.
Central America	For abortions, antifungal, birth control, constipation, diarrhoea, fungal infections, headache, menstrual disorders, respiratory infections, ringworm, uterine pain, urinary tract infections.
Mexico	For chills, digestive sluggishness, dyspepsia, earache, eczema, edema, fatigue, fever, headache, inflammation (skin), laxative, leprosy, nausea, pain, rheumatism, ringworms, skin problems, sores, stomach-ache, swelling, tumours, ulcers, venereal disease, water retention, yellow fever.
Panama	For colic, inflammation, stomach problems and as an antiseptic.
Haiti	For acne, asthma, burns, colic, constipation, dropsy, eye infections, gonorrhoea, headache, malaria, rheumatism, skin rashes and infections, and to increase perspiration.

(**Source:** Mahanthesh *et al.*, 2019) [14]

The propagation of this plant occurs through water dispersal or by mud clinging to animals, humans, vehicles, and machinery. It also spreads as a contaminant in agricultural produce. *C. occidentalis* thrives in open woodlands, grasslands, roadsides, pastures, waste areas, coastal regions, disturbed sites, and cultivated fields across tropical, subtropical, and semi-arid climates. It is commonly found in these areas during the rainy season but gradually disappears in winter (Yadav *et al*., 2010) [36].

Phytochemistry

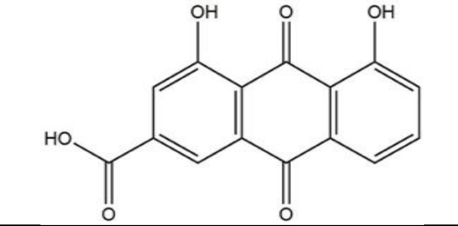
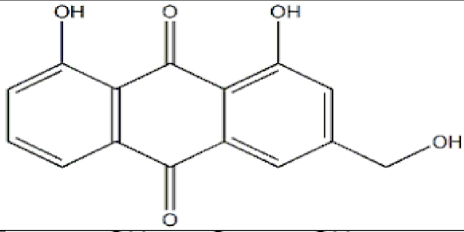
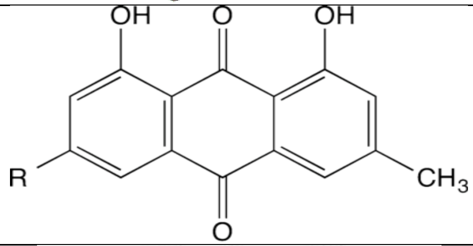
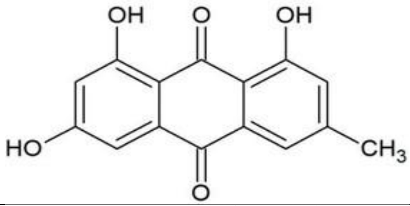
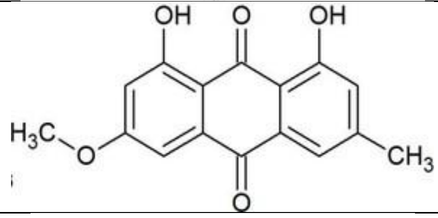
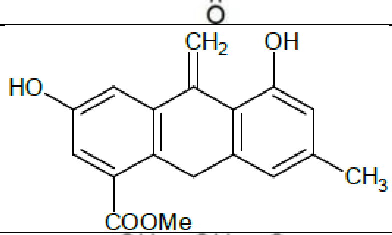
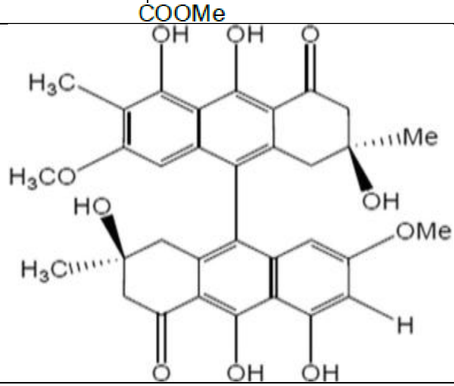
Phytochemical analysis of *C. occidentalis* has revealed the presence of various bioactive compounds. The composition and medicinal efficacy of these phytochemicals are influenced by ecological factors and seasonal variations. The presence of these compounds highlights the plant's significant potential as a source of herbal medicine. A summary of the phytochemical constituents found in different solvent extracts of various plant parts is provided in Table 4. The type and concentration of these phytochemicals vary depending on climate and soil conditions. For instance, in Ivory Coast, Africa, the stems, leaves, and root bark contain small amounts of saponins but lack alkaloids, while sterols, triterpenes, quinones, tannins, and flavonoids are present. In contrast, plant samples from Ethiopia exhibited a high concentration of alkaloids in the stems, leaves, and fruits (Purwar *et al*., 2003) [22].

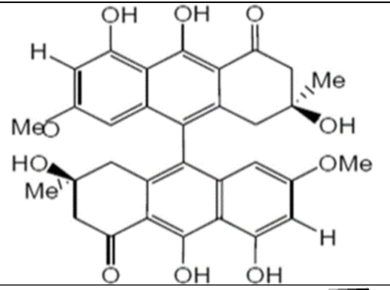
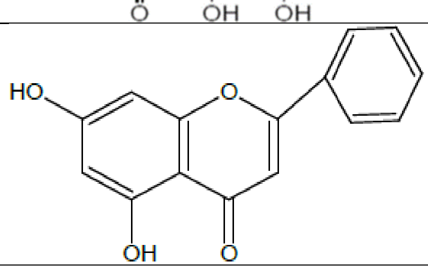
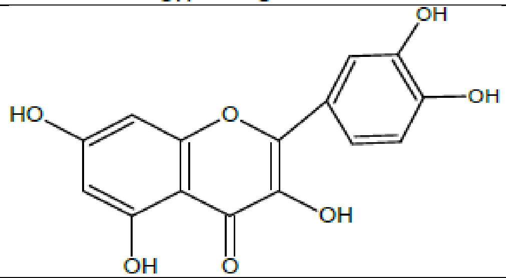
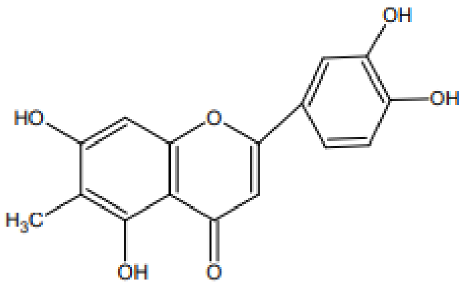
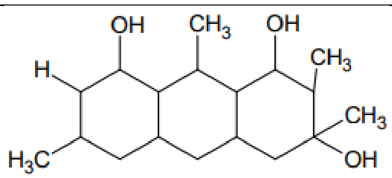
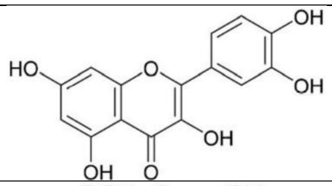
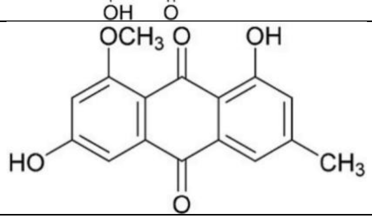
Table 4: Phytoconstituents obtained from various parts of *Cassia occidentalis*

Plant part/s	Phytoconstituents	References
Leaf	Flavanoids, tannins, sugars, cardiac glycosides, coumarins	
	Alkaloids, flavanoids, anthraquinones, lipids and oils, proteins, terpinoids	
	Alkaloids, flavanoids, anthraquinones, cardiac glycosides, lipids and oils, proteins, terpenoids	
	Alkaloids, flavanoids, anthraquinones, tannins, sugars, lipids and oils, coumarins, proteins, terpinoids	Rajarajeswari *et al.* (2020) [23]
	Saponins, anthraquinones, terpinoids, steroids	
	Saponins, tannins, flavonoids, anthraquinones, terpenoids, steroids, alkaloids, phenol	
	Saponins, tannins, flavonoids, terpenoids, alkaloids, phenol	Tamasi *et al*. (2021) [32]
	Alkaloids, tannins, saponins, flavonoids	Yahaya *et al*. (2019) [38]
	Flavanoids, tannins, anthraquinones, volatile oil	Bagega *et al.* (2018) [4]
	Betacyanin, coumarins, quinones, anthraquinones, emodins, steroids, phenols, tannins	Srividya *et al.* (2017) [29]
Root	Alkaloids, coumarins, flavonoids, glycosides, saponins, triterpenes, tannins, sugar, amino acids, proteins	Issa *et al*. (2020) [10]
	Alkaloids, flavonoids, saponins, carbohydrates, proteins, amino acids	Kiranmayi *et al.* (2019) [11]
Seed	Alkaloids, triterpenoids, tannins, anthraquinones	Suleiman *et al*. (2022) [30]
	Alkoloids, flavonoids, saponins, phenols, tannins, terpenoids, carbohydrates	Shafi *et al*. (2021) [25]
Whole plant	Carbohydrates, proteins, steroids, flavonoids, tannins	
	Alkaloids, carbohydrates, glycosides, triterpinoids, tannins, proteins, saponine	
	Alkaloids, carbohydrates, glycosides, amino acids, proteins, tannins and phenolic compounds	
	Carbohydrates, steroids, lipids, saponine	Mahantheshand Jalalpure (2016) [15]

The phytochemicals isolation from *C. occidentalis* yielded different compounds, most of which are reported for the first time and belongs to the class of glycosides. Few reported phytoconstituents are listed in the table (Table 5).

Table 5: Phytochemical compounds from *Cassia occidentalis*

Compound	Structure	References
Rhein		Chukwujekwu*et al.* (2006) [6]
Aloe emodin		Kudav and Kulkarni (1974) [13]
Chrysophenol		Kudav and Kulkarni (1974) [13]
Emodin		Kudav and Kulkarni (1974) [13]
Physcion		Chukwujekwu*et al.* (2006) [6]
Cassiollin		Kudav and Kulkarni (1974) [13]
Occidentol I		Kitanaka and Takido (1994) [12]

Occidentol II		Kitanaka and Takido (1994) [12]
α-L-Arabinopyranoside		Yadav and Satnami (2011) [37]
β-D-Xylopyranoside		Yadav and Satnami (2011) [37]
7-Methyl physcin		Takahashi *et al*. (1976) [31]
7-Methyltorosachrysone		Takahashi *et al*. (1976) [31]
Quercetin		Kitanaka and Takido (1994) [12]
Questin		Kitanaka and Takido (1994) [12]

Herbal Formulation

Cassia occidentalis is used as either a single component or in combination as an ingredient of polyherbal formulations. Very-well-known product Liv.52 is available as tablet and syrup which is widely used in the management of liver diseases, *i.e.*, hepatitis A (HA). The major products belong to Indian companies where one tincture product is from the USA. The products are listed in table (Table 6) with their appropriate uses.

Table 6: Herbal formulations containing *Cassia occidentalis* as an important ingredient

Sl. No.	Product (Brand name)	Company	Uses
1.	BONNISAN	The Himalaya Drug Company, India	Keeps baby healthy
2.	GERIFORTE	The Himalaya Drug Company, India	Rejuvenates body and mind
3.	HERBOLAX	The Himalaya Drug Company, India	Bowel regulator
4.	LIV 52	The Himalaya Drug Company, India	Hepatoprotective

5.	LIV 52 DROPS	The Himalaya Drug Company, India	Hepatoprotective
6.	LIV 52 VET	The Himalaya Drug Company, India	Hepatoprotective
7.	LIV 52 VET DS	The Himalaya Drug Company, India	Hepatoprotective
8.	DIGYTON	The Himalaya Drug Company, India	Digestive stimulant
9.	GERIFORTE AQUA	The Himalaya Drug Company, India	Immune booster
10.	GERIFORTE VET	The Himalaya Drug Company, India	Immune booster
11.	FEDEGOSO-TINCTURE	Tropi Lab INC, USA	Dietary supplement
12.	SAFI	Hamdard laboratory, India	Blood purifier
13.	Bonny-care	Tibb, South Africa	Health supplement

(**Source:** Ali *et al.*, 2019) [1]

The formulation in question is the outcome of extensive clinical research and analysis conducted over a span of approximately 30 years. During this period, thousands of patients were evaluated to assess statistical outcomes, safety parameters, and overall effectiveness. Ultimately, the formulation was determined to be both safe and effective for managing hepatitis A (HA). Gericare has been available in tablet form for many years, promoting overall rejuvenation of both body and mind. Additionally, Geriforte is regarded as a key medication for addressing postmenopausal depression. No significant adverse effects have been reported.

Few patents have been listed in table (Table 7), with their brief details mentioning about their importance in polyherbal formulations.

Table 7: Patents on *C. occidentalis* as an important ingredient of herbal formulations

Sl. No.	Patent Title	Patent Number	Published Date
1.	Herbal formulation for the treatment of piles	WO 2006070386 A1	6 July 2006
		US20070172529A1	26 July 2007
2.	Development of herbal nutritious chocolate and its processing, Herbal nutritious chocolate formulation and process for preparation	248,784US20060141066	26 August 2011
3.	*Cassia occidentalis*-honey beverage for treating irritable bowel syndrome	CN 105434492 A	30 May 2016

(**Source:** Ali *et al.*, 2019)

Pharmacological activities

Antimicrobial activity

Leaf extracts of *C. occidentalis* obtained using different solvents exhibited strong antimicrobial activity against *Escherichia coli* at concentrations ranging from 900 to 1000 mg. Notably, *E. coli* demonstrated the highest susceptibility to hexane extracts within the 500-1000 mg concentration range. However, no antimicrobial effects were observed against other tested microorganisms, including *Pseudomonas multocida, Salmonella typhi, Salmonella typhimurium, Salmonella pyogenes,* and *Salmonella pneumonia* (Saganuwan and Gulumbe, 2008) [24]. The *in vitro* antibacterial potential of alcoholic, hydro-alcoholic, and aqueous extracts from the whole plant was found to be less effective than chloramphenicol, which was used as the standard antibiotic (Bhagat and Saxena, 2010) [5]. Among these extracts, the hydro-alcoholic variant showed greater sensitivity against *Bacillus subtilis* compared to the alcoholic and aqueous extracts.

The antifungal properties of *C. occidentalis* were assessed using leaf, seed, and pod extracts against *Candida albicans, Aspergillus clavatus,* and *Aspergillus niger*. The minimum inhibitory concentration (MIC) of different plant parts ranged from 200 to 1000 µg/ml, with the extracts outperforming standard antifungal drugs such as Nystatin and Griseofulvin, except for leaf extract activity against *Aspergillus* species (Davariya and Vala, 2011) [7]. Another study evaluated antibacterial effects against *Escherichia coli, Klebsiella 344neumonia, Candida albicans, Staphylococcus aureus, Pseudomonas aeruginosa,* and *Salmonella typhi* using the agar well diffusion method at concentrations between 80 and 360 mg/ml. The MIC was determined through serial dilution, while the minimum bactericidal concentration (MBC) was assessed by plating various extract dilutions. The methanolic leaf extract exhibited significant antibacterial activity, with MIC values ranging from 160 to 280 mg/ml and MBC values between 160 and 320 mg/ml. The most susceptible organisms were identified as *Staphylococcus aureus* and *Pseudomonas aeruginosa* (Tsado *et al*., 2016) [33].

Furthermore, chloroform and ethanolic leaf extracts of *C. occidentalis* were tested for antibacterial properties against *Bacillus megaterium, Bacillus subtilis, Staphylococcus aureus*, and *E. coli* using the agar well diffusion method, with Gentamicin serving as the standard antibiotic. MIC values for chloroform extracts were recorded as 250 µg/ml, 300 µg/ml, 800 µg/ml, and 600 µg/ml, while those for ethanolic extracts were 550 µg/ml, 480 µg/ml, 450 µg/ml, and 200 µg/ml against *Staphylococcus aureus, Bacillus megaterium, Bacillus subtilis,* and *E. coli*, respectively. The presence of tannins, flavonoids, and phenolic compounds in these extracts contributed to their antibacterial effects (Rajarajeshwari *et al*., 2021). The antimicrobial activity of methanol, ethyl acetate, and hexane fractions of *C. occidentalis* was also evaluated against *Staphylococcus aureus, Bacillus subtilis, Pseudomonas aeruginosa, Escherichia coli, Candida albicans*, and *Trichophyton rubrum*. The antimicrobial susceptibility test revealed an inhibitory zone ranging from 10 to 16 mm, with the hexane fraction displaying the highest inhibition zone of 16 mm against *Candida albicans*. The lowest MIC values were observed in the ethyl acetate fraction, with 0.6 mg/mL for *Candida albicans* and 0.2 mg/mL for *Escherichia coli*. Conversely, the highest MIC value of 20 mg/mL was recorded for the ethyl acetate fraction against *Staphylococcus aureus*. The minimum microbicidal concentration (MMC) varied widely, with a value of 5 mg/mL for *Bacillus subtilis, Candida albicans,* and *Trichophyton rubrum*, whereas it was 20 mg/mL for *Staphylococcus aureus, Pseudomonas aeruginosa*, and *Escherichia coli* (Tamasi *et al*., 2021) [32].

Antioxidant and antipyretic activities

The antioxidant potential of sequential organic and aqueous leaf extracts of *C. occidentalis* has been analyzed using various *in vitro* models. These include nitric oxide scavenging

(NOS) activity, the carotene-linoleic acid model system, hydroxyl radical scavenging (HRS) activity, reducing power, metal chelating activity (MCA), and superoxide radical scavenging (SRS) activity (Arya *et al*., 2010). Another study focused on the antioxidant properties of aqueous leaf extracts, which demonstrated a reduction in hydroperoxide levels in homogenates, decreased malondialdehyde levels in plasma, and lowered catalase activity in homogenates and hemolysates—key markers of oxidative stress). The polyphenolic compounds in *C. occidentalis* seeds significantly contribute to their overall antioxidant capacity. Additionally, research has shown that the reduction of DPPH radicals occurred in a concentration-dependent manner, with methanolic seed extracts converting stable DPPH radicals into yellow-colored unstable compounds (Ntchpda *et al*., 2015). Methanolic seed extracts of *C. occidentalis* have also exhibited strong antipyretic properties by effectively lowering yeast-induced fever. At a dose of 400 mg/kg, the extract produced effects comparable to paracetamol (20 mg/kg). The antipyretic activity was assessed using an experimentally induced laboratory model, where the extract demonstrated superior hypothermic activity against yeast-induced pyrexia in rats (Singh *et al*., 2017) [28].

Antioxidants, particularly phenolic acids and flavonoids, are known for their ability to neutralize biological free radicals. The aqueous extracts used in traditional medicine have retained their antioxidant potential. Notably, leaves and flowers displayed greater cellular antioxidant activity. A study evaluating *C. occidentalis* cellular antioxidant properties reported that ABTS and DPPH assays confirmed the ability of infusion extracts from different plant parts to scavenge free radicals, as reflected in their IC_{50} values. The presence of phenolic compounds is believed to be a key contributor to the antioxidant effects *C. occidentalis* infusions (Ngombe *et al.*, 2019) [18].

Cytotoxic activity

The *in vitro* cytotoxic effects of *C. occidentalis* were evaluated using alcoholic, hydro-alcoholic, and aqueous extracts against eight human cancer cell lines derived from six different tissue types. Findings indicated that the aqueous extract exhibited greater potency compared to the hydro-alcoholic and alcoholic extracts, particularly against HCT-15, SW-620, PC-3, MCF-7, SiHa, and OVCAR-5 human cancer cell lines at concentrations of 100µg, 30µg, and 10µg (Bhagat and Saxena, 2010) [5].

A separate study identified aloe-emodin (1,8-dihydroxy-3-hydroxymethyl-anthraquinone) as one of the key active anthraquinones extracted from *C. occidentalis*, which has been linked to hepatotoxicity in rats. Cytotoxicity assays (CCK-8) revealed that aloe-emodin reduced the viability of HL-7702 cells in a manner dependent on both dose and exposure duration. Further investigation demonstrated that aloe-emodin induced S and G2/M phase cell cycle arrest in HL-7702 cells. Apoptotic cell death was confirmed through flow cytometry analysis and DAPI staining, which indicated nuclear morphological changes. The findings suggest that aloe-emodin promotes apoptosis in HL-7702 cells by activating both intrinsic and extrinsic pathways, primarily through mitochondrial-mediated reactive oxygen species (ROS) generation (Dong *et al*., 2017) [8]. Additionally, another study assessed the effects of a hydroalcoholic extract of *C. occidentalis* seeds on clonidine-induced mast cell degradation. The extract was compared with oral sodium cromoglycate, a standard treatment, in rats. Results indicated that the seed extract significantly enhanced mast cell protection, demonstrating potential for inhibiting mast cell degradation (Patel *et al*., 2019) [21].

Anti-diabetic activity

Diabetes mellitus is a metabolic disorder characterized by disrupted glucose metabolism, leading to negative effects on lipid and protein metabolism. A study was conducted to assess the anti-hyperglycemic properties of *C. occidentalis* extracts in mice and to provide a scientific basis for its traditional use in diabetes management. The findings revealed that alloxan-induced diabetic mice, when administered methanolic leaf extracts of *C. occidentalis* at a 300 mg/kg dosage, exhibited a significant reduction in fasting blood glucose levels at both 6-hour and 12-hour intervals compared to the control group. Increasing the dosage to 450 mg/kg further enhanced the hypoglycemic effects in diabetic mice (Onakpa and Ajagbonna, 2012) [20].

Additionally, aqueous extracts of *C. occidentalis* significantly reduced fasting blood glucose levels in both normal and alloxan-induced diabetic rats. Apart from the aqueous extract, petroleum ether and chloroform extracts demonstrated activity, with effects observed on days 14 and 7, respectively. Further analysis showed notable differences in serum lipid profiles (cholesterol and triglyceride levels), serum protein levels, and body weight in diabetic animals treated with the aqueous extract, compared to both diabetic control and normal groups. Histopathological examinations of the pancreas revealed signs of regeneration in extract-treated animals, where alloxan had previously caused necrosis (Verma *et al*., 2010) [34].

Other activities

The leaves of *C. occidentalis*, extracted using a cold maceration method with an equal mixture of petroleum ether, ethyl acetate, and methanol, were selected for anti-inflammatory testing. In a rat paw edema model induced by carrageenan, administration of the extract at a 400 mg/kg dosage resulted in a 36.68% inhibition ($p<0.001$) of edema volume after four hours. Similarly, in the acetic acid-induced writhing test, the extract exhibited 39.9% inhibition at a 200 mg/kg dose and 52.4% inhibition at 400 mg/kg.

Another study explored the *in vitro* and *in vivo* antitrypanosomal properties of the ethanol extract of *C. occidentalis* leaves. The crude extract demonstrated significant *in vitro* activity against *Trypanosoma brucei* by completely eliminating parasite motility within 10 minutes post-incubation at an effective concentration of 6.66 mg/ml (Ibrahim *et al*., 2010) [9]. Research on the chloroform extract of the whole plant revealed anticonvulsant properties, particularly in counteracting MES and PTZ-induced convulsions (Mahanthesh and Jalapure, 2016) [15]. Additionally, further investigation showed that *C. occidentalis* leaves possess myostimulant properties, as evidenced by an increase in both rhythm and amplitude of isolated intestinal muscle contractions (Arsene *et al*., 2017) [2].

Conclusion

Research on *Cassia occidentalis* has demonstrated its extensive biological potential, making it an important subject for continued scientific investigation. With its long-standing use in traditional medicine, this plant offers significant opportunities to explore its untapped bioactive properties. Chromatographic analysis has confirmed the presence of anthraquinones, which contribute to its laxative effects. Various phytoconstituents present in the plant play a role in both its medicinal and toxicological properties, showing effectiveness against microbial infections and tumor cells.

Despite its potential toxicity, *C. occidentalis* has been recognized as both safe and effective through standardized validation methods. However, further studies are necessary to isolate its bioactive compounds in their pure form, which may aid in the treatment of several health conditions. Employing advanced extraction and isolation techniques will be essential in fully understanding its pharmacological applications. Additionally, existing polyherbal formulations can serve as a foundation for developing novel medicinal dosage forms. The comprehensive data presented in this review on its phytochemical components and biological activities provide strong scientific evidence supporting its potential therapeutic uses.

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Declaration of Interest Statement

The authors declare that there is no conflict of interest.

Authors' Contributions

The study was conceptualised and designed by MSD and SU. MSD was responsible for literature search, data collection, analyses and interpretation. MSD drafted the manuscript and SU critically revised the manuscript.

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