Review Article

Some members of genus Cassia (Senna): Their Ethnobotany, Potency and Prospects of Drug discovery

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ABSTRACT

Plants from *Cassia* species have been used traditionally all over the world in the treatment of various diseases. Various compounds with diverse bioactivities have been isolated from the *Cassia* species. However, this has not been done exhaustively in all the species. Moreover, only a few drugs are associated with cassia species as their origin despite the knowledge that plants are a good source of drugs. Further investigations are required to isolate more compounds from these species, verify their bioactivities, conduct clinical and toxicological studies and eventually come up with lead drugs. This review relates the ethnobotanical uses of various *Cassia* species with the isolated bioactive compounds. It pinpoints the limited compounds that have been isolated compared to their traditional benefits justifying the potential and potency of the species as a drug source.

Key words: *Cassia*, *Senna*, ethnopharmacology, phytochemicals, bioactivity

Medicinal plants are critical to developing novel medications [1-3]. 70-90% of the population in Asia, Africa, Latin America and the Middle East rely on traditional medicine for primary healthcare [3]. The global acceptability of popular and efficient species from Europe, North America, Africa and Asia is expanding due to increased demand for medicinal plants in many countries [4]. The percentage of individuals using herbal plants has increased: to 40–50% in Germany, 42% in the USA, 48% in Australia, and 49% in France [3,5]. There is also an ever increase in microbial resistance to antibiotics. The trend is causing concern when it involves the continuous evolution of new strains that use resistance strategies against antimicrobial drugs. It could be possible that plant extracts may offer a solution to the puzzle.Such disease management methods rely on ethnobotany and ethnopharmacology methods used in identifying the plants of interest for pharmacological and phytochemical studies [6]. Ethnobotany has played and will continue to play a significant role in drug discovery [7].

In addition, traditional medical practices involving plant or plant parts are embedded in virtually all community cultures [8].During the literature review of *Chamaecrista nigricans* syn. *Cassia nigricans,* it became clear that there was significant documentation; however, there was still room to add more knowledge to this already exciting genus *Senna* (*Cassia*). *Cassia* genus belongs to the family Fabaceae and comprises about 600 species of herbs, shrubs, and trees distributed in tropical and subtropical countries, mainly Africa, Asia, and South America [9,10].

The species have been used, anciently *in vogue*, to treat various ailments that include: skin diseases (such as scabies, eczema, and ringworm), helminthiasis, impetigo, ulcers, pesticide, laxatives, rheumatic diseases, headache, and fever [2]. Most of these species are used as anti-inflammatory, antimicrobial, antivirals, antimutagenic antioxidants, antiplasmodial anticancer, laxative hypoglycaemic, and hyperglycaemic [11-13]. Several secondary metabolites have been isolated and identified from the *Cassia* species. They include peridine alkaloids, anthraquinones, anthracenes, tannins, phenylpropanoids, pentacyclic triterpenoids, essential oils, polyphenols, flavonoids, fatty acids, γ-naphthopyrones, sterols and polysaccharides [13-16]. Such compounds have been proven to be bioactive and found in different parts of plants, such as flowers, seeds, fruits, leaves, roots, and bark [11].

This article has attempted to give an overview of the ethnopharmacology and bioactivity of the phytochemical compounds isolated from various species of the genus *Cassia* and their potency and potential as new drug sources. It summarises advances in bioactive isolates from this genus and the discovery of new therapeutic agents. It is expected to emphasize the importance and traditional utilization of the genus for novel drug discovery. This effort will incentivize more research to isolate bioactive constituents and develop

drugs from the already bioactive compounds from the genus. Virtually all the members of this genus are of economic importance as fodder for foraging bees and nitrogen fixers, thus increasing soil fertility in essential nutrients [14]. The relevant information on the botanical description, ethnopharmacological uses, phytochemicals, and the bioactivities of the isolated compounds were collected from various search engines, including Google Scholar, Google, Springer, Elsevier, PubMed, Science Direct, and ResearchGate. *Cassia* or *Senna* and its associated plant names were employed as keywords to find the pertinent information. The chemical structures of the compounds were drawn using ChemDraw Ultra 8.0 software. PubChem and ChemSpider databases were used to verify the IUPAC names of the isolated phytochemicals. The data includes species name, habitat distribution, extracted phytochemical compounds, and the bioactivities performed on the phytochemical compounds.

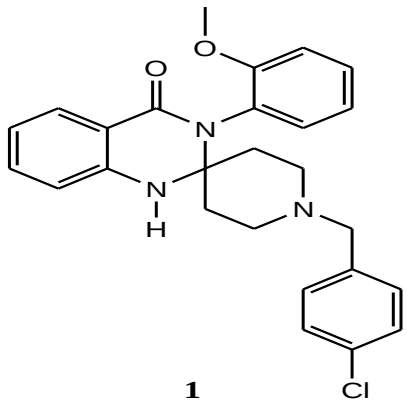
Cassia auriculata Linn synonyms are *Senna auriculata* and *C.densistipulata* (L.) Roxb. It is a fast-growing shrub to a small tree used in green manuring, ornamental, soil reclamation, and tannin. The plant possesses some cardiac glycosides [15]. It is commonly found in Asia [16]. The whole plant treats liver ailments [17]. The leaves have been used for ulcers, skin diseases, anthelmintics, and leprosy [18]. The bark is an astringent [19], while the roots have been used to treat skin conditions such as leprosy, tumours, urethroea, and asthma [20]. The roots are also used in managing ailments in the urinogenital system, fever, constipation, and diabetes [21,22]. The flowers cure nocturnal emissions, urinary discharges, throat irritation, and diabetes [23]. Flowers are also used as a body coolant, treating yellow fever and in blood and liver purification [24]. The seeds are used in chylous urine, diabetes, ophthalmic, and aphrodisiac complaints [25]. The leaves have also been used as hair cleaner and to cure common cold, whereas roots also cure diarrhea, abdominal pains, and vomiting [26]. The plant is also used generally for intestinal problems, female infertility, worms, leprosy, conjunctivitis, rheumatism, and diarrhea [27].

Some compounds that have been isolated from the species include 4-(4-chlorobenzyl)-2,3,4,5,6,7-hexahydro-7-(2-ethoxyphenyl)benzo[h][1,4,7]triazecin-8(1H)-one **(1)**, an anticancer compound, isolated from ethanolic leaves extracts of the plant. This compound has been confirmed to inhibit the growth of human colon cancer cells [28]. Oleanolic acid. **(2)** isolated from methanolic leaf extracts has antimicrobial activity against *Klebsiella pneumonia, Proteus mirabilis, Escherichia coli*, and *Salmonella typhi* [29]. Methanol and chloroform crude extracts showed potent inhibitory activity against the above microbes [30]. Ayurvedic hydro-alcoholic seed extracts of *C. auriculata* have been reported to possess antidiabetic activity [31]. Antidiabetic compounds: 1,3,8-trihydroxyanthraquinone (emodin) **(3)** and quercetin **(4)** have been isolated from n-butanol seeds extracts, while gallic acid **(5)**, quercetin-3-*O*-rutinoside **(6)**, caffeic acid **(7)**, ferulic acid **(8)**, and ellagic acid **(9)** were isolated from methanol: water (1:1)seeds extract [32].

5-*O*-methylquercetin-7-*O*-glucoside **(10)** has been isolated from the plant's 50% acetone flower extracts and has anti-inflammatory activity [33]. Furthermore, α-Tocopherol-β-D-mannoside **(11)** is also an anti-inflammatory compound isolated from the plant's methanolic leaf extracts [34]. Refluxed dried powdered leaves concentrates in 1N NaOH solution contain Luteolin **(12)**, Quercetin **(4)**, Kaempferol **(13)**, and Kaempferol-3-*O*-β-D-rutionoside **(14)**. These compounds inhibit the aluminium corrosion activity without harming living organisms, unlike chemical inhibitors, which are quite toxic and expensive, harmful to bio-organisms and non-biodegradable [35,36].

*Cassia glauca (*Lam) synonym is *Senna sulfurea* (Collad.) H.S.Irwin & Barneby A shrub usually with yellow flowers and is used as an ornamental. It is found in Tropical Asia, India, Australia, South America, Malaysia, Pakistan, and China [37,38]. The leaves have been used to manage blennorrhagia [39,40]. The seeds treat skin diseases and leucoderma, whereas the bark and leaves treat gonorrhea and diabetes [37]. The plant has been used for common cold, as an antimalarial, central depressant, purgative, and diuretic [41]. A compound of biological interest that has been isolated is: Kaempferol 3-O-β-D-rutinoside **(14)** from the methanolic leaves extracts and has been reported to harbour *in vitro* cytotoxic effects against human liver carcinoma (HepG-2) and human breast adenocarcinoma (MCF-7) cell lines [42]. Moreover, it can be combined with other chemotherapeutic drugs to boost their cytotoxic activity and guard against their side effects, suggesting that Kaempferol 3-*O*-β-D-rutinoside can be a potent anticancer agent [38].

Cassia angustifolia Vahl synonyms are *Senna alexandrina* Mill, *C.acutifolia* Delile, *C.lanceolata* Forssk, *C.senna* L., *Senna acutifolia* (Delile) Batka and .*S.angustifolia* (Saheed S.A & Illoh H.C). The plant is also referred to as Indian *Senna*. It is found in India, Saudi Arabia, Pakistan, Egypt, Somalia, Arabia, and Yemen [43,44]. The leaves have been used to manage hepatomegaly, anemia, constipation, malaria, loss of appetite, indigestion, jaundice, ringworm, splenomegaly, and to increase peristaltic movement of the colon [9,43]. The leaves and pods are used for splenic enlargements, cholera, antipyretic in typhoid, anthelminthic, and laxative [44]. Dry tubers have been used as an aphrodisiac, general debility tonic, and rheumatism [45]. Various isolates from parts of the plant, including Quercimeritrin **(15),** scutellarein **(16),** and rutin **(17),** have been isolated from methanol, ethyl acetate, and ethanol seed powdered extracts. All these extracts possess anticancer and antioxidant activities. In addition, the mentioned three compounds have antimicrobial activity; they inhibit the microbial growth of *E. cloacae*, *P. aeruginosa*, *S. mercescens*, and *S. typhi* [44]. The leaves and the pods of this species have been reported to contain dianthone glucosides, sennosides A **(18)** and B **(19),** commonly used as laxatives [46-49].



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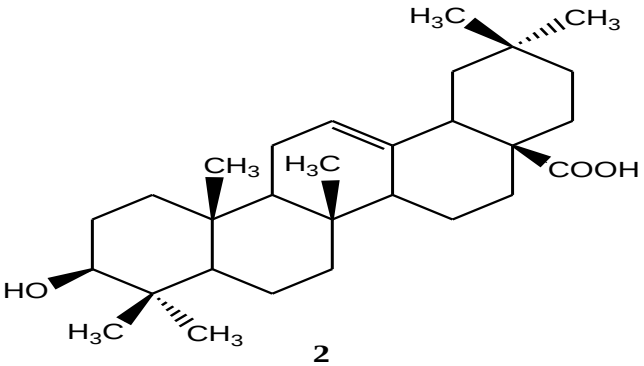

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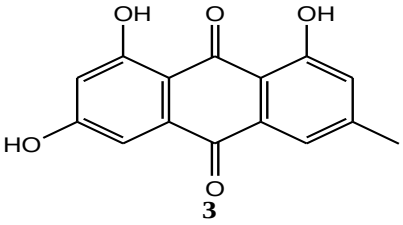

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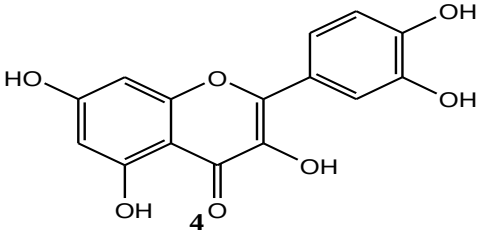

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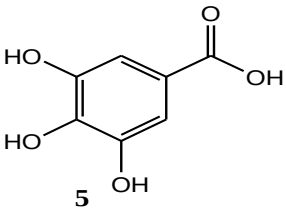

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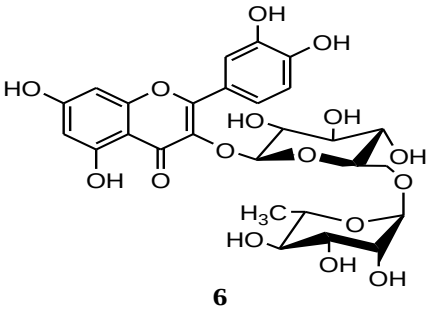

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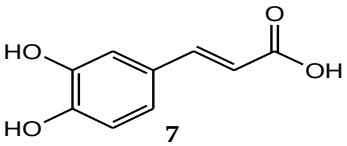

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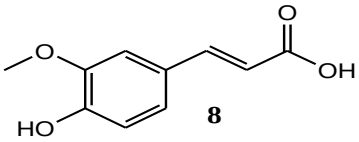

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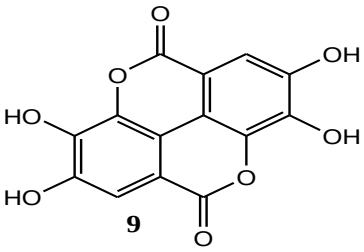

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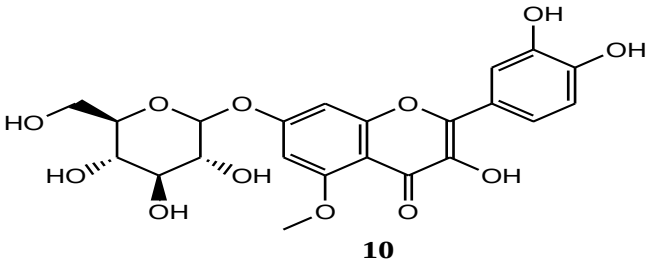

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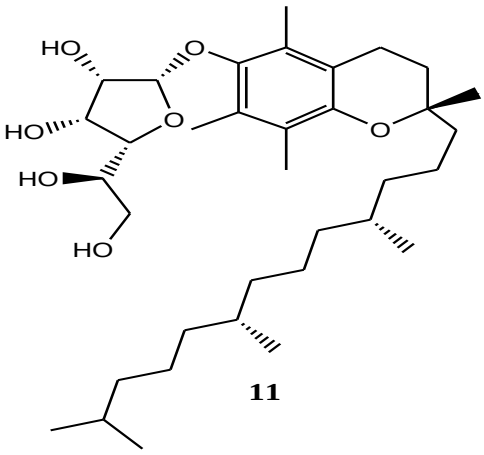

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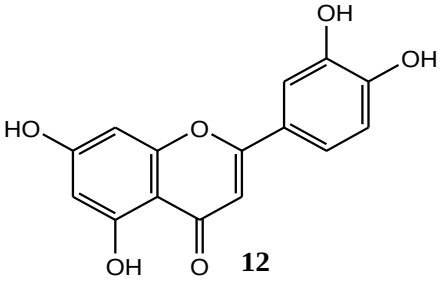

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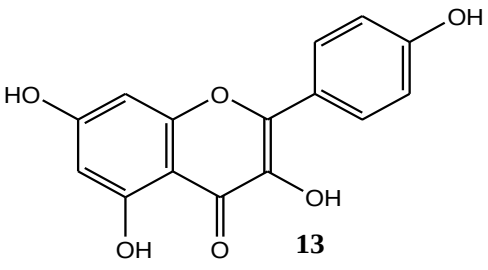

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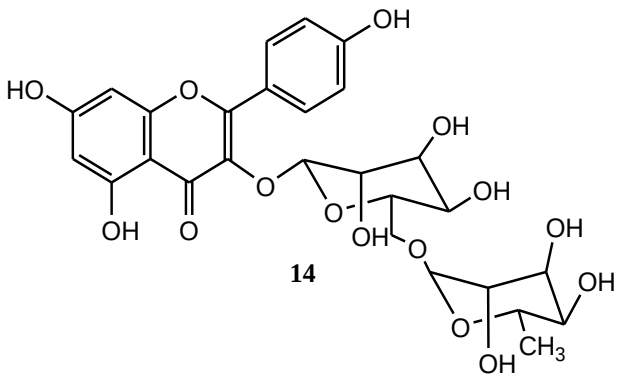

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Other compounds also isolated from methanolic leaves extracts of *C.angustifolia* and known to display various activities, including antimicrobial compounds such as 2, 5-dimethyl-4-hydroxy-3(2h)- furanone **(20)**, 4a-acetoxy-5,5,8a,-trimethyloctahydrobenzo[b] pyran **(21)** and 1-ethynyl-4-fluoro-benzene **(22)**; anti-inflammatory compounds such as caryophyllene**(23)**, estragole**(24)** and 1-(1,5-dimethyl-4-hexenyl)-4-methylbenzene **(25)**; antihyperglycemic compound such as anethole **(26)**; antioxidant compounds such as 2-methylene-(3ß,5α)-5-cholestan-3-ol **(27)**, 2-Methoxy-4-vinylphenol **(28)**; anticancer compounds such as 5-Hydroxymethylfurfural **(29)**, ß-curcumene **(30)** as well as antiviral compound such as 2-[6-(2,6,6-trimethylcyclohex-1-enyl)-4-methyhexa-1,3,5-trienyl]cyclohexanal **(31)** [46]. Cassia fistula L synonyms are: Bactyrilobium fistula (L.) Willd; C.bonplandiana DC; C. excels Kunth; C.fistuloides Collad; C.Rhombifolia Roxb; Cathartocarpus excelsus G. Don; Cathartocarpus fistula (L.) Pers; Cathartocarpus fistuloides (Collad) G. Don; and Cathartocarpusr hombifolius (Roxb) G. Don.The medicinal use of the species date from ancient times and has been the main factor in its spread. It is called "Aragvadha," a word that can be translated as "elimination of diseases" in Sanskrit. The plant must have originated from the Indian Subcontinent. It is widespread in East Africa and several of the Indian Ocean Islands [48]. The roots, bark, leaves, flowers, and seeds are all used for therapeutic purposes. The leaves have been used as a purgative against ringworms [49]. The whole plant treats anorexia, skin diseases, rheumatism, jaundice, and inflammatory diseases [50]. The roots also cure heart diseases, dysentery, joint pain, retained excretions, chest pain, fever, and migraine [51].

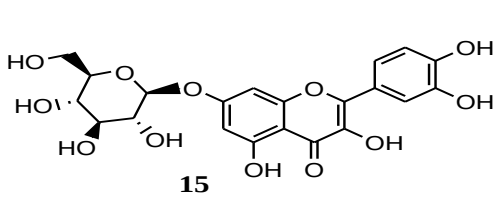
Ayurvedic medicines recognize the use of the plant for skin diseases, tubercular glands, adenopathy, burning sensations, syphilis, and leprosy [52]. The fruit, seeds, flowers, and pulps are all used for skin diseases; the pulp is also used to treat gout and rheumatism, while the leaves have been used as a laxative [53]. In addition, flowers, leaves, bark, root, and pulp have been used in wound healing, liver protection, and as an antimycotic [54]. The whole plant also treats ulcers, purgative, impetigo, and helminthiasis, although the leaves and the seeds act as a liver tonic, cardiotonic, laxative, antihelmintic, ophthalmic, antiperiodic expectorant as well as in treating constipation and bronchitis [55]. The species' seeds have been used in treating swollen throats, oral sores, jaundice, and biliousness [56]. The plant is also used as a hair cleanser and in the treatment of venereal diseases, diarrhea, toothache, muscle pain, cold, inflammation, reducing body heat, vomiting as well as diabetes [26,48].

Phytochemical elucidation of *Cassia fistula* has led to isolating compounds with therapeutic values.:4-hydroxy benzoic acid hydrate **(32) (**from the ethyl acetate extracts of the flower) was confirmed to possess antifungal activity against *Trichophyton mentagrophytes* and *Epidermophyton floccosum* [57]. Rhein (1,8-dihydroxyanthraquinone-3carboxylic acid) **(33)** has also been isolated from ethyl acetate extract of *C. fistula* flower and showed inhibition against fungi such as *Trichophyton mentagrophytes*, *Trichophyton simii*, *Trichophyton rubrum*, and *Epidermophyton floccosum* [58]. Benzyl 2-hydroxy-3,6-dimethoxybenzoate **(34)** and dibenzyl-2,2′-dihydroxy-3,6,3″,6″-tetramethoxy-biphenyl-1,1′-dicarboxylate **(35)** isolated from methanol extracts of seed showed antifungal activity against *Cladosporium cladosporioides* and *Cladosporium sphaerospermum* [59].

Phytol **(36)**, lutein **(37),** and di-lineolylgalactopyranosyl-glycerol (DLGG) **(38)** are antiplasmodial compounds that have been isolated from chloroform leaf extract of the plant. Di-lineolylgalactopyranosyl-glycerol portrayed weak toxicity against cytotoxicity test carried out using the Chinese Hamster Ovarian (CHO) cell line, while phytol and lutein were nontoxic [60]. Rhein **(33)**, 2(3H)-furanone **(39)**, thymol **(40),** and oleic acid **(41)** have been isolated from ethyl acetate extract of seeds and pulp of *C. fistula* [61]. Butanol extracts of the seed yielded inositol **(42)** and palmitic acid **(43),** whereas the butanol extract of the pulp yielded inositol **(42)** and 2-pyrrolidone **(44)**. All these compounds were reported to inhibit breast cancer (MCF-7) and human cervical cancer (SiHa) cell growth, and they also induced cell death [61]. *Cassia alata* L synonyms are *Senna alata* L and *Herpetica alata*. It is distributed in Africa, South and North America, and India [62,63]. The plant leaves treat ulcers, scabies, ringworm, and skin diseases such as eczema, itching, and pruritis [62]. The leaves and stem bark are used to treat burns, diarrhea, jaundice, gastroenteritis, and hepatitis, whereas the immature leaves are effective against food poisoning and constipation [64]. This plant is good against insect bites, worms, goiter, fever, blemishes, sexually transmitted diseases, and fungal skin infections [65-67]. The leaves also cure asthma and bronchitis [67]. The roots are used for uterus disorder [68,69].

Some compounds of interest have been isolated from this species. Cannabinoid alkaloids, 4-butylamine-10- methyl-6-hydroxy cannabinoid dronabinol **(45),** have been isolated from the ethanolic seed extracts of the plant and is known to possess bioactivities against microbes such as *Pseudomonas aeruginosa*, *Klebsiella pneumonia*, *Escherichia coli*,

Staphylococcus aureus, Candida albicans and *Aspergillus niger* [70]. Luteolin **(12),** kaempferol **(13),** and aloe-emodin **(46)** have been isolated from methanolic leaf extracts, and they all showed antibacterial activity against *Vibrio cholerae* and *Shigellaflexneri*., with aloe-emodin showing the highest activity [71]. Kaempferol **(13)** and ω-hydroxyemodin **(47)** have been isolated from the acetone leaves extracts ω-hydroxyemodin showed antibacterial activity against methicillin-resistant *Staphylococcus. aureus* (MRSA) and kaempferol posses antioxidant activity [72].



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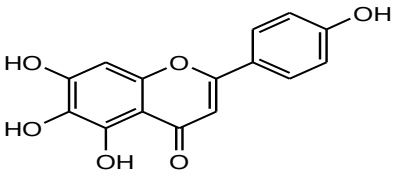

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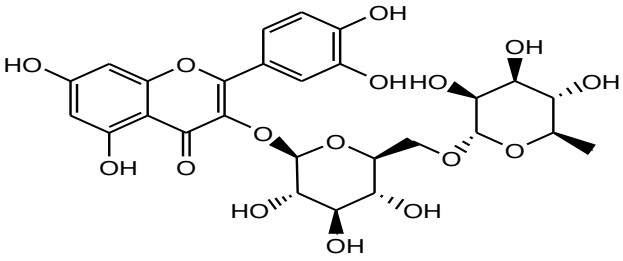

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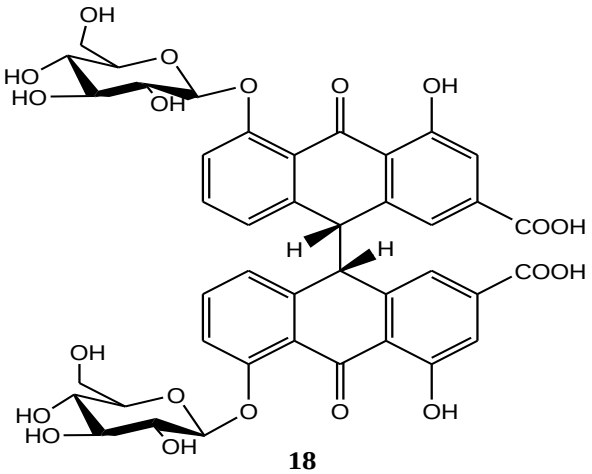

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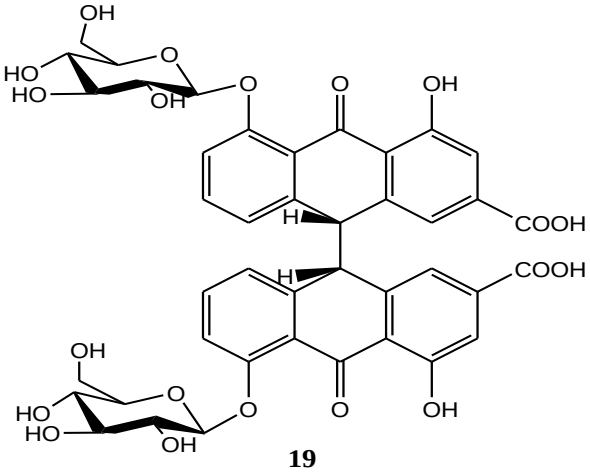

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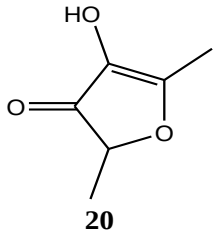

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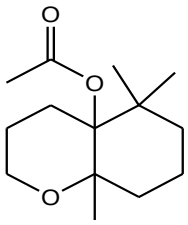

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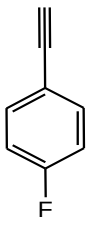

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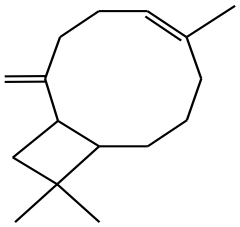

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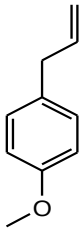

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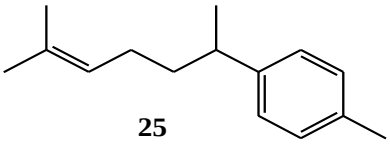

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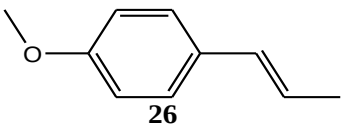

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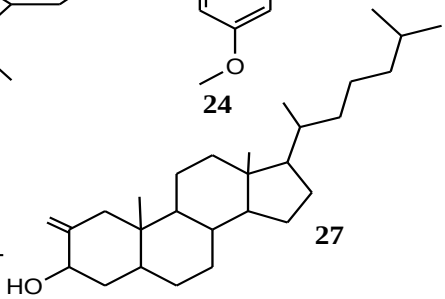

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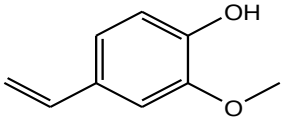

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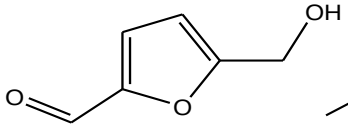

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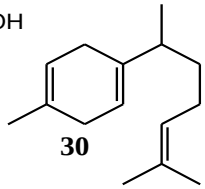

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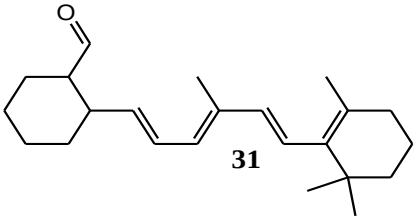

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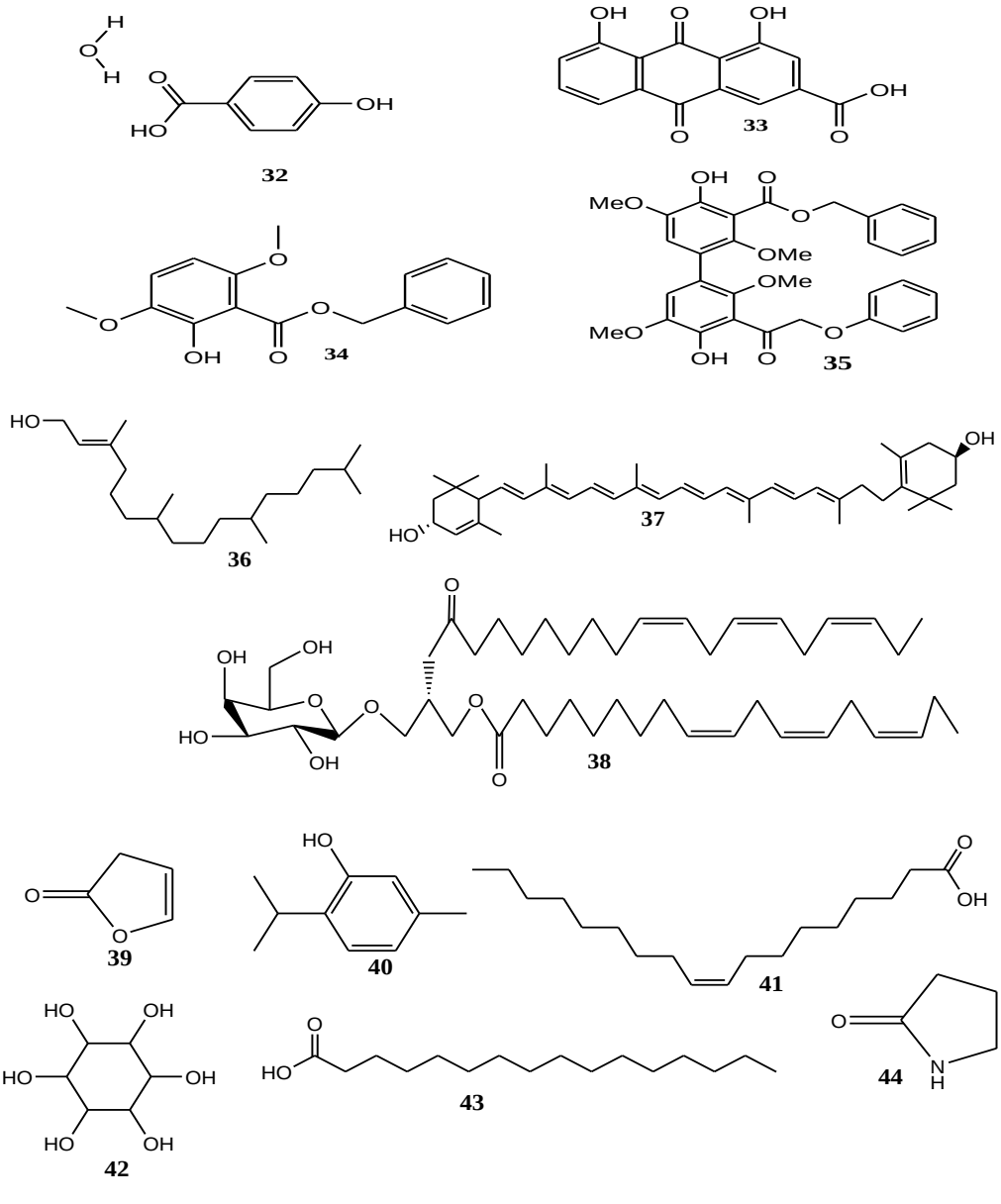
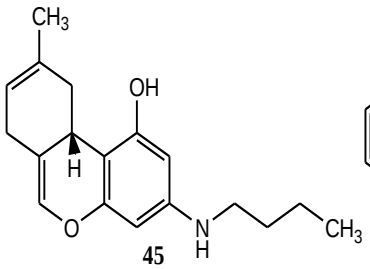
Cassia tora L synonyms are *Senna obtusifolia* (L.) H.S.Irwin & Barneby,*Cassia numilis* Collad, *C. obtusifolia* (L.), *C.toroides* Raf., *Diallobus uniflorus* Raf and *Senna toroides* Roxb. It is found in Africa, Fiji, Southeast Asia, Northern Australia, and Latin America [73,74]. The species has been used in Folklore medicine in that the leaves of the plant are used for the treatment of jaundice, eczema, ringworm, intestinal impetigo, and helminthiasis; the decoction of leaves and flowers are used against asthma and bronchitis; and the seeds are used to treat leprosy, psoriasis, earache, itching, eye diseases, liver problems while pods are used against dysentery and in eye diseases [75]. Its fermented leaves have purgative properties [72]. Traditionally, the plant has been widely employed in managing hemorrhoids, vitiated tridosha, hepatitis, skin diseases, dandruff, cough constipation, and fever [74]. The leaves and seeds possess cardiotonic, ophthalmic, antimicrobial, and liver tonic properties [76].

Emodin**(3)**, aurantio-obtusin **(48)**, chryso-obtusin-2-O-β-D-glucoside **(49)**, and obtusifolin **(50)** have been isolated from ethyl acetate soluble extracts of the seeds of *C. tora*. They are known to inhibit diabetic complications (advanced glycation end products (AGEs)) and cataract formation (rat lens aldose reductase (RLAR)) [77]. Ononitol monohydrate (6-methoxycyclohexane-1,2,3,4,5-pentaol hydrate) **(51)** occurred in the leaves of ethyl acetate extracts and was found to exhibit *in vivo* hepatoprotective activity [78] Aurantio-obtusin **(48)**, chrysophanol **(52),** and chryso-obtusin **(53)** have been isolated from dichloromethane fraction of methanolic seed extracts, and the compounds showed significant antimugenic activity [79].

Additionally, friedelin **(54)**, a triterpene, is a compound that was isolated from ethanolic leaves extract of the plant and found to possess anticancer activity against human cancer cell lines; HeLa (cervical carcinoma) and HSC-1 (squamous carcinoma) [73]. Two phenolic triglucosides: toralactone 9-*O*-[β-D-glucopyranosyl-(1→3)-*O*-β-D-glucopyranosyl-(1→6)-*O*-β-D- glucopyranoside] **(55)** and torachrysone 8-*O*-[β-D-glucopyranosyl(1→3)-*O*-β-D-glucopyranosyl(1→6)- *O*-β-D-glucopyranoside] **(56)** occurred in 70% ethanol extracts of the seeds and was found to possess estrogenic activity [80].





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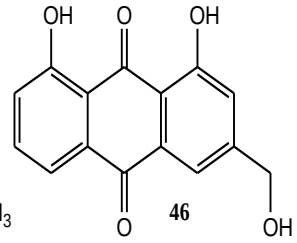

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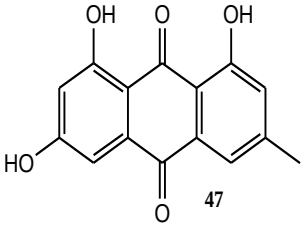

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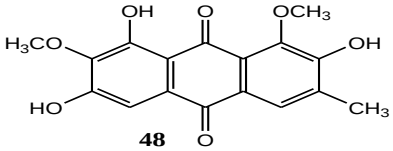

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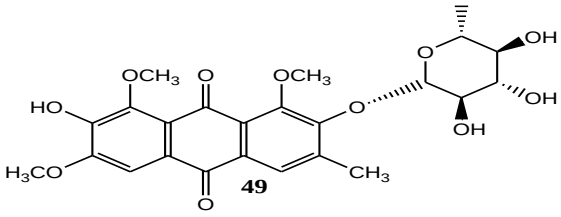

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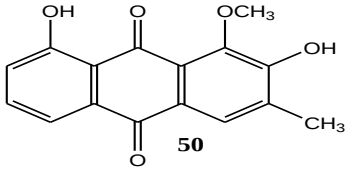

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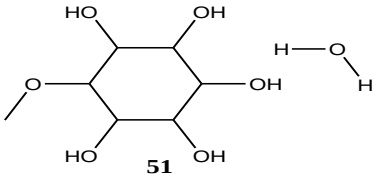

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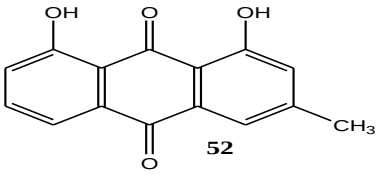

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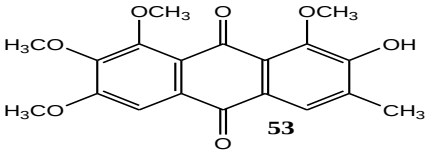

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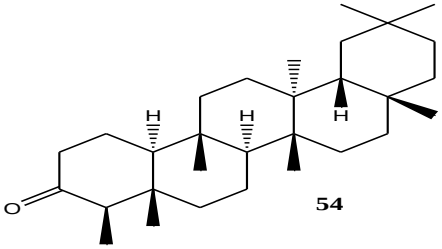

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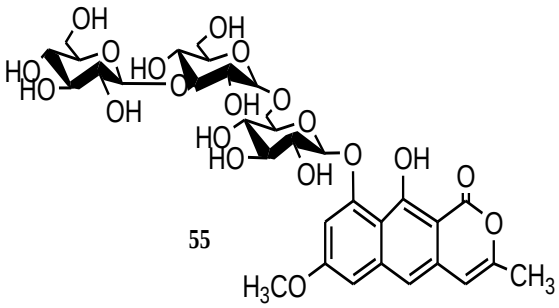

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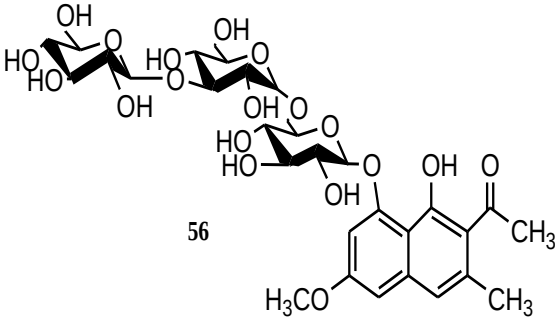


56

Advanced chemical studies and elucidation of ethyl acetate soluble seed extract yielded Emodin **(3)**, rhein **(33)**, aloe-emodin **(46)**, torachrysone **(57)** and toralactone **(58)**, which possess significant antibacterial activity against methicillin-resistant s*taphylococcus aureus* [81].

Cassia abbreviata Oliv synonyms are *Cassia afrofistula* Brenan, *Cassia beareana* Holmes and *Cassia kassneri* Bak. It is a medium-sized tree widely distributed in the tropics of Asia and other tropical Worlds [82] and used as medicine. The roots treat malaria, fever, impotence, abdominal pain, wounds,

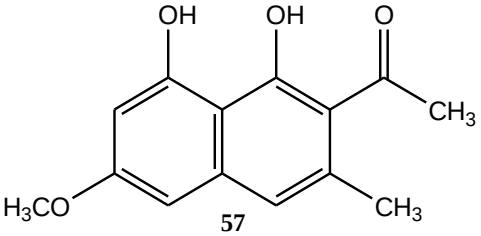
dysentery, syphilis, snake bite, body weakness, and hernia [83-[84]85]. The plant is used to treat cancer [86]. Its root bark manages vaginal candidiasis [87]. The leaves, roots, and bark have been used to treat cough, epilepsy, diarrhea, fever, convulsion, vomiting, abortion, infertility, earache bilharzia, syphilis, hemorrhoids, gonorrhea, jaundice hernia, and stomach ache [88]. The bark and the roots cure dysentery, bloody vomiting, and menstrual cycle problems [89]. Fruits are used against eye infections and malaria [82]. The bark is also used in treating toothache and sexually transmitted diseases [90]. The roots are also used as an aphrodisiac [91].

Further, advanced studies in chemistry identified compounds that could enhance drug discovery. Such compounds are Trimmericproanthocyanidins; 3,7,4'-trihydroxyflavan-(4β→8)-3,5,7,4'-tetrahydroxyflavan-(3'→6)-3,5,7,2',4'-pentahydroxyflavan (cassinidin A) **(59)** and 3,7,2',4'-tetrahydroxyflavan-(4α→8)-3,5,7,4'-tetra-hydroxyflavan-(4α→6)-3,5,7,2',4'-pentahydroxy- flavan (cassinidin B) **(60)** which were isolated from methanol root bark extracts and they exhibited antibacterial activities on *Escherichia coli*, *Bacillus subtilis*, *Staphylococcus aureus* and *Candida mycoderma* [92]. 2,3-dihydro-5-hydroxy-8-methoxy- 2-(4-methoxyphenyl)chromen-4-one **(61)** and 3,4-dihydro-2-(4-hydroxy-phenyl)-4-methoxy-2H-chromen-7-ol **(62)** have been isolated from methanol root extracts and found to have antiplasmodial activities on both chloroquine-resistant and chloroquine-sensitive strains of *Plasmodium falciparum* [93].

Cassiabrevone **(63)**, guibourtinidol-(4α→8)-epiafzelechin **(64)**, taxifolin**(65)**, oleanolic acid **(66)**, piceatannol**(67)**, and palmitic acid **(43)** were isolated from ethanolic bark and root extracts and posses anti-HIV-1 activity [94,95]. *Cassia nigricans* Vahl **s**ynonym **is** *Chamaecrista nigricans* Vahl The roots and leaves are vermifuge and antiperiodic [80]. The leaves also treat fever, sore throat, rheumatoid pains, gastrointestinal disorders, and family planning [12, 96,97]. The plant treats skin diseases, ulcers, diarrhea, and gastrointestinal disorders [98,99]. Various compounds have been isolated from this species, justifying its continued use in folklore medicine. It was reported that 1,3,8-trihydroxy-6-methyl-9,10-anthracenedione (Emodin) **(3)** isolated from methanol extract of the whole plant showed *in vitro* antiplasmodial activities against *Plasmodium falciparum*[100]. Emodin has also been isolated from the ethyl acetate leaf extract and found to be highly cytotoxic despite having antimicrobial activity [101]. Emodin **(3)**, luteolin**(12|)**, citreorosein **(68),** and emodic acid **(69)** have been isolated from n-hexane, ethyl acetate, and methanol combined extracts. Emodin, citreorosein, and emodic acid showed larvicidal activity on *Anopheles gambiae* larvae [102]. Steroidal ester and hydroxyestranic acid ethyl ester **(70)** have been isolated from methanol leaves extracts and showed antimicrobial activities on *Staphylococcus aureus*, *Streptococcus pyogenes*, *Corynebacterium pyogenes*, *Bacillus subtilis*, *Salmonella typhi*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Candida albicans*, *Neisseria gonorrhea* and *Klebsiella pneumoniae* [103].

Cassia sieberiana D.C. This species is a medium-sized tree widely distributed in Sub-Saharan Africa, from Senegal to East Africa [104]. The root bark and rootlets treat toothache, abdominal pains, skin diseases, hemorrhoids, helminths, and leprosy [105]. The roots also treat hemorrhoids and skin irritation and manage indigestion, stomach pains, and gastric ulcer [106,107]. The seeds have been used in weight reduction, clearing of acne, detoxification, and driving out internal heat [108]. The folklore uses of *C. sieberiana* have led to the isolation of such compounds as quercetin **(4),** cassiberianol A **(71),** and piceatannol **(72)** from methanol extracts of the roots. They all had inhibitory activity on 15-lipoxygenase, while piceatannol and quercetin also showed acetylcholinesterase inhibitory activity [109].

Flavanoids, epiafzelechin **(73)**, have been isolated from ethanol extracts of the plant's stem bark and possess antioxidant activity [110]. Moreover, cassiphenol **(74)**, spectaline **(75),** and iso-6-cassine **(76)** are also compounds that have been isolated from ethanol extracts of the stem bark. Cassiphenol has weak antibacterial activity against *Pseudomonas aeruginosa*, *Providencia stuartii*, *Enterobacter aerogenes*, and *Klebsiella pneumoniae*. Spectaline and iso-6-cassine were the only compounds that portrayed antioxidant activity [111,112]. *Cassia absus* L. Synonym is *Chamaecrista absus* H.S.Irwin & Barneby It is a small hairy herb, a native of Africa; however, a common monsoon weed in South East Asia [113]. In folklore medicine, the seeds have been used to treat syphilitic ulcers, skin infections, leukoderma, ophthalmia and as a cathartic [114]. The leaves are used for nasal diseases, cough, and as an astringent to the bowel [115]. The leaves are used in curing tumours, while the roots are used against constipation [116].



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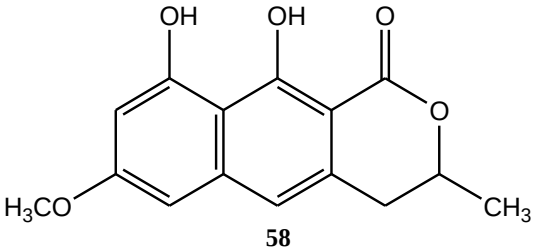

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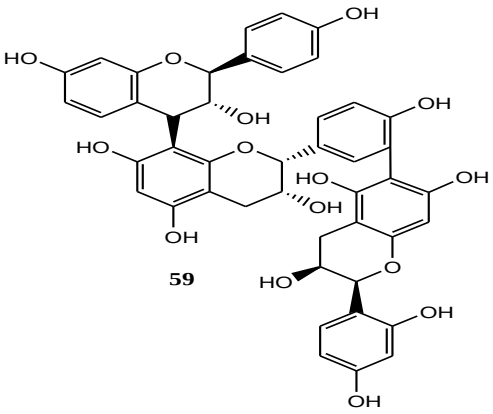
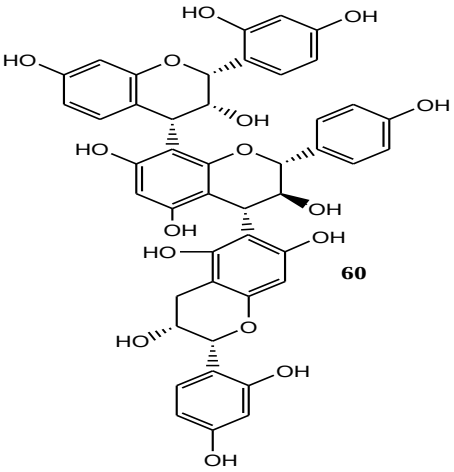
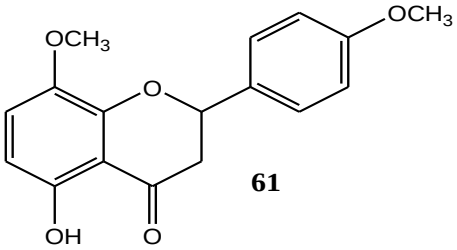
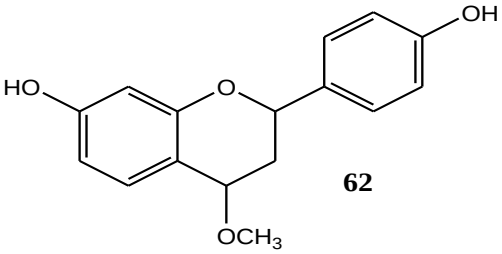
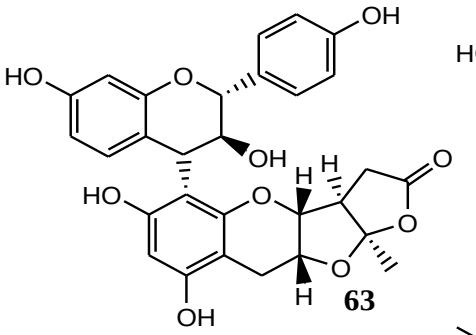
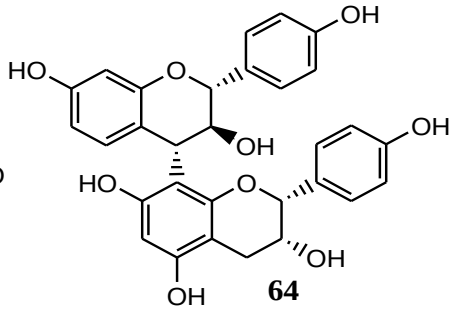

HO
OH
O
59

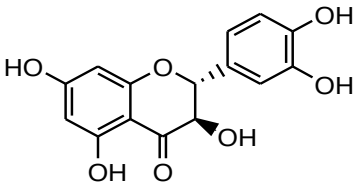

HO
OH
O
60

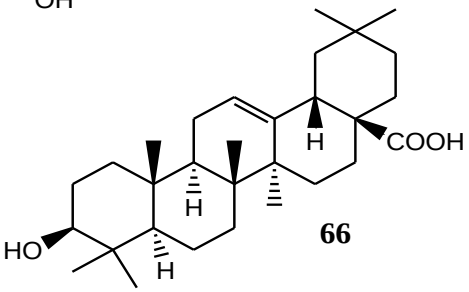

OCH3
O
OH
61

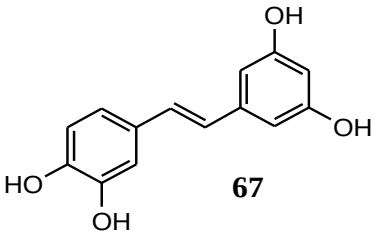

HO
O
OH
OCH3
62

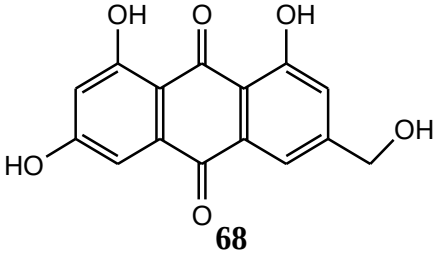

HO
OH
O
H
63

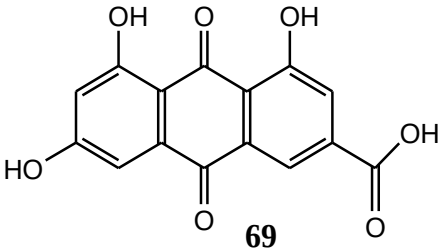

HO
OH
O
64

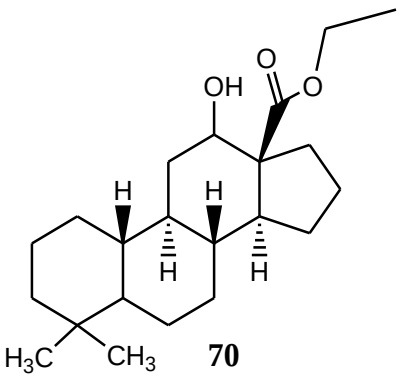

HO
OH
O
65

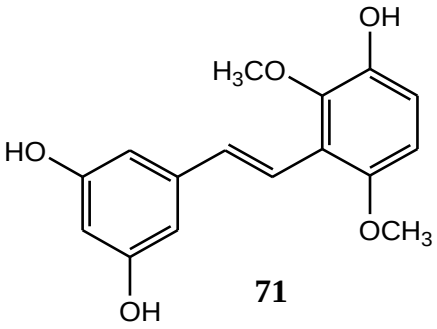

H
COOH
HO
66


OH
HO
67


OH
O
HO
68


OH
O
HO
69


O
OH
H
H3C
CH3
70



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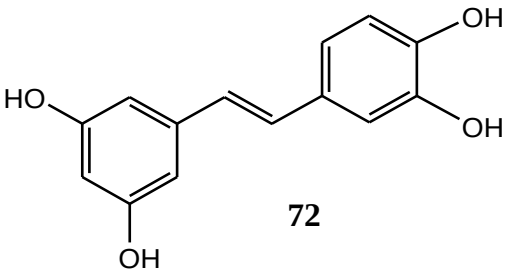

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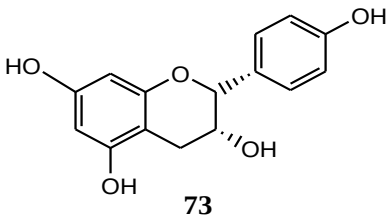

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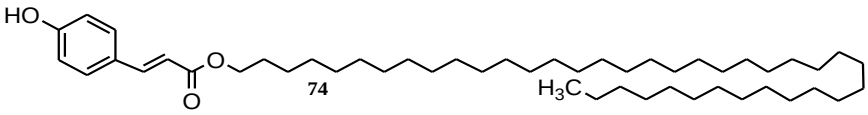
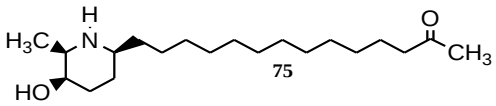
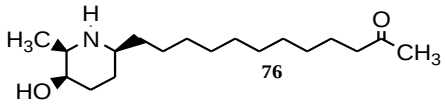






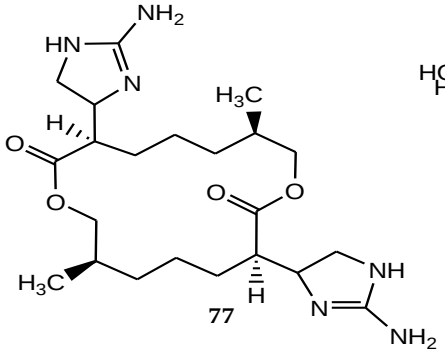
From this Ethnobotanical information, guided chemical profiling has been done, and the following noble compounds like Aloe-emodin **(46)**, chrysophanol **(52)**, and chaksine **(77)** have been isolated from the ethanol root extracts [117, 118]. The ethnomedicinal use of the roots is associated with the presence of chrysophanol and aloe-emodin and has also been verified by the bioactivity of these compounds from this genus. It has been reported that chaksine has antidepressant activity, anesthetic activity, and antibacterial activity against *Streptococcus hemolyticus* [113]. 5,7,4′-trihydroxy-8,3′-dimethoxyflavone-5-O-α-L-rhamnopyranosyl-7-O-β-D-xylopyranosyl-(1→4)-O-β-D-galacto-pyranoside **(78)** is a compound that has been isolated from methanolic seeds of the plant. Reports indicate that the isolates possess antimicrobial activity on *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Penicillium digitatum*, and *Fusarium oxysporum* [119]. *Senna septemtrionalis* H.S.Irwin & Barneby synonyms are *Cassia aurata* Roxb., *C. elegans* Kunth, *C. Floribunda* Kunth *C. laevigata* Willd, *C. quadrangularis*, *C. septemtrionalis* Viv and *C. vernicosa* Clos. A shrub to a

sub-shrub native to America now spreads in the tropic and subtropics up to India and South Africa [120]. The roots treat malaria, gonorrhea, syphilis, intestinal worms, and blood cleansing [120,90]. The leaves are used as a vermifuge [121,122]. It is also used in treating stomach aches, wounds, fever, gastroenteritis, snakebites, burns, epilepsy, hemorrhoids, anxiety, and as a laxative, fungicide agent, antidiuretic as well as expectorant [123]. This plant has also been used as a medication for rabies, cold, alopecia, earache, bile diseases, pain, inflammation, and cholera [124,125]. Its chemical elucidation yielded two compounds. Physcion **(79)** has been isolated from this plant and possesses bioactivities against *Chlorella fusa* and *Bacillus megaterium* [126]. Rutin **(80)** and Kaempferol 3-*O*-rutinoside **(14)** hexoside are also compounds isolated from this plant, posing both anti-inflammatory and antinociceptive activities [125]. *Senna petersiana (Bolle) Lock synonym is Cassia petersiana (Bolle) Lock* This small tree is generally found in Tropical and sub-Tropical Africa and can grow to 12 m [127]. The root extracts treat infertility, malaria and are also used as inhalers and for deworming [128-130]. The leaves cure skin diseases, backaches, stomach aches, and febrifuge [127,130]. The plant is used to treat arthritis and management of diabetes [131]. The roots also treat a loss of appetite [132]. The plant also cures cholera, cold, and fever [133]. The plant's roots, leaves, and stems have been used for convulsion and relieving pain in the bones [134].

As a result of its use in traditional medicine, several natural compounds have been isolated from its various parts. Luteolin **(12)** isolated from ethanol extracts of the seed possesses bioactivities against *Bacillus cereus*, *Bacillus pumilus*, *Serratia* marcescence, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* [135]. Four compounds: 7-acetonyl-5-hydroxy-2-methylchromone (petersinone A) **(81)**, 5-hydroxyl-2-methyl-7-(propan-2β- ol)-chromone (petersinone B) **(82)**, glyceryl-1-hexacosanoate **(83)** and stigmastosterol-3-*O*-β-D-glucoside **(84)** were isolated from CH_2Cl_2-MeOH (1:1) leaves extract of this plant. Stigmastosterol-3-*O*-β-D-glucoside showed the highest anti-inflammatory antitumor, antioxidant, macrophage

proliferation, and immune proliferative activities [127]. *Senna singueana* Del Lock synonyms are *S. goratensis* Fresen, *Cassia zanzibarensis* Vatke, *C. singueana* Delile, and *C. tettensis* Bolle. The species is a medium-sized tree used as ornamental and, like most family members, can fix gaseous nitrogen into the soil, thus enriching it with an essential nutrient**.** It is widely distributed in East and West Africa [136]. Various parts of the plant have been used in traditional medicine in different parts of the world [137]. The leaves and bark have been used to treat skin cancer [138]. The stem, bark, leaves, and roots treat a sprain, stomach pain, and tooth infection [139]. The leaves cure hepatitis, vomiting, and loss of appetite, and the stem bark prevents stillbirth [140]. The roots treat epilepsy and agitation [141]. The flowers are used as an anti-inflammatory, anti-ulcer, antispasmodic agent and in treating respiratory tract infections, malaria, and typhoid [142]). The root bark is also used for abdominal pain, bilharziosis, mental disorder, women's infertility, constipation, convulsion, painful uterus, swollen breast, fever, menstruation, gonorrhea, anti-emetic, hernia, and in managing snakebites [143,144]. Some beneficial compounds that have been isolated from the plant through phytochemistry include 3β-*O*-acetyl betulinic acid **(85)** isolated from the ethyl acetate bark of this plant. It inhibited α-glucosidase and α-amylase activity, thus delaying carbohydrates digestion and glucose assimilation, eventually restraining postprandial hyperglycemia, thus treating type 2 diabetes (T2D) [145]. Lupeol (Lup-20(29)-en- triterpene) **(86)**, Eugenol (4-allyl-2-methoxyphenol) **(87)** and 8-11-Octadecadienoic acid methyl ester (Methyl-8, 11-octadecadienoate) **(88)** are compounds which have been isolated from its methanolic root extracts. Eugenol showed antioxidant activity and a broad spectrum of antimicrobial activity against *Candida albicans*, *Staphylococcus aureus*, *Escherichia coli*, *Streptococcus pneumoniae*, and *Pseudomonas aeruginosa*. Lupeol and Methyl- 8,11-octadecadienoate also possessed certain antioxidant activity and antimicrobial activity levels against *S. aureus* [146].

Senna didymobotyra (Fresen.) H.S.Irwin and Barneby synonyms are *Cassia didymobotrya* Fresen, *C. nairobiensis* H. Bailey, *C.verdickii* De Wild and *Chamaesenna didymobotrya* Sunarno. It is an invasive shrub that forms a dense growth that hinders the development of other plant species in a given area [147]. It is distributed in North, West, East, Southern Africa, and Madagascar [148]. This plant's leaves, stem, and roots have been used in treating sickle cell anaemia, backache, fibroids, inflammation of fallopian tubes, and hemorrhoids [149]. The bark is an antihaemorrhagic [150]. The plant has been used in treating skin disease, jaundice, purgative, malaria, sexually transmitted diseases, intestinal worms, and as an appetizer and antibiotic [148,151,152]. The leaves are used in curing dysentery, diarrhoea, and as an emetic and diuretic, while the root is used to treat ringworm, malaria, intestinal worm, fever, and jaundice [151]. Through natural product chemistry, some compounds have been isolated from this species; they include: Chrysophanol **(52)**, physcion **(76)**, 3β-sitosterol {17-(4-Ethyl-1,5-dimethyl-hexyl)-10,13,dimethyl-2,3,4,7,8,9,-10,11,12,13,14,15,16,17-tetradecahydro-1H cyclopenta[a]phenanthren-3-ol} **(89)** and stigmasterol {(3S,9S,10R,13R,14S,17R)-17-[E,2R,5S)-5-ethyl-6-methylhept-3en-2-yl]-10,13-dimethyl-2,3,4,7,8,911,12,14,-15,17-dodecahydro-1-H-cylopentanal[a]-3-ol **(90)** were compounds isolated from the hexane and DCM root bark extracts of this plant. The specific activity of the individual compounds was not reported; however, the crude extracts showed antimicrobial activities on *Staphylococcus aureus*, *Escherichia coli*, *Bacillus subtilis* and *Candida albicans*[153].



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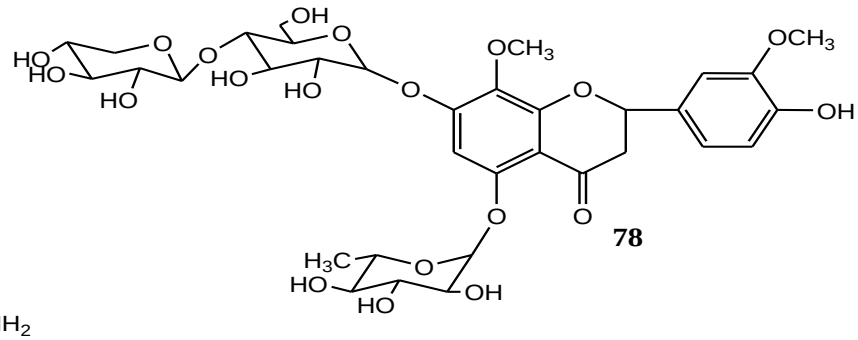

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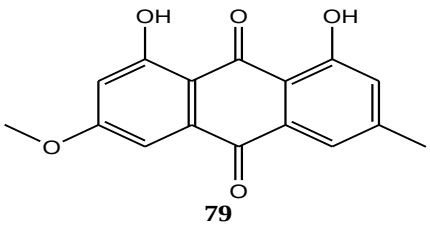

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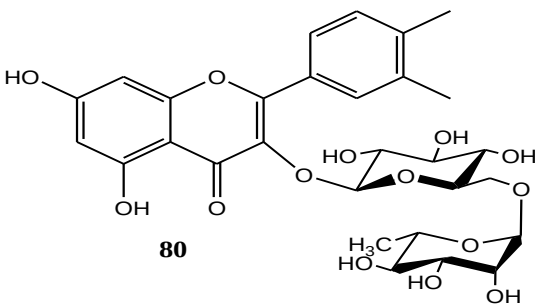

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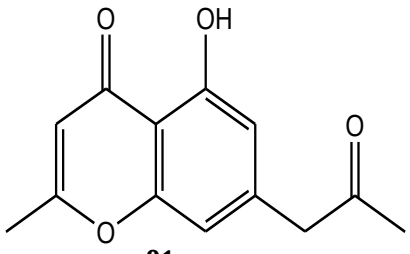

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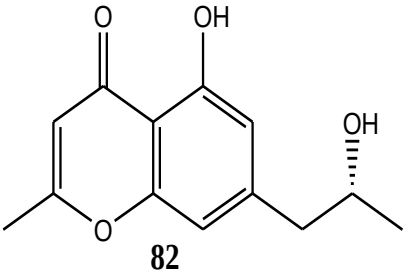

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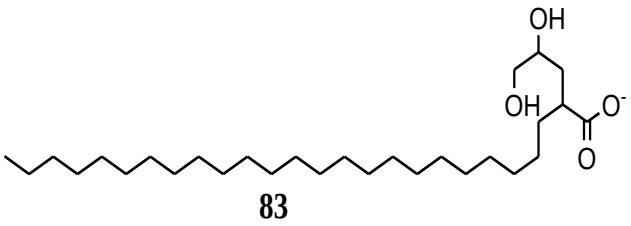

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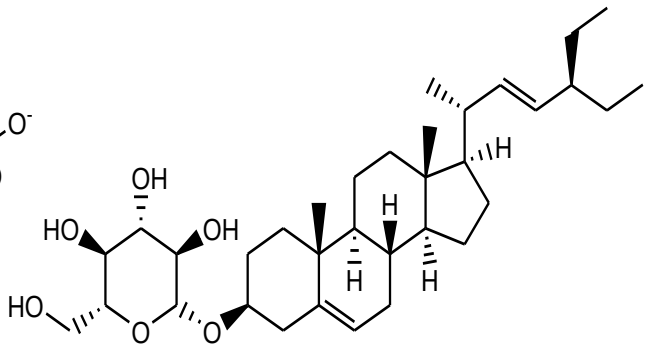

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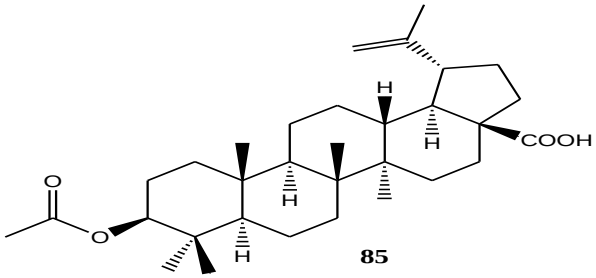

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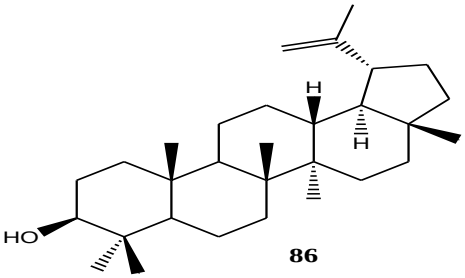

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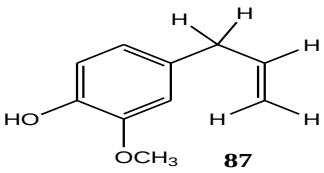

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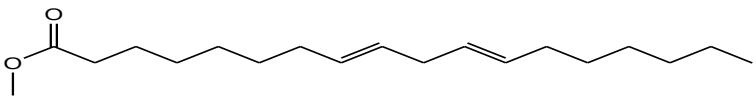

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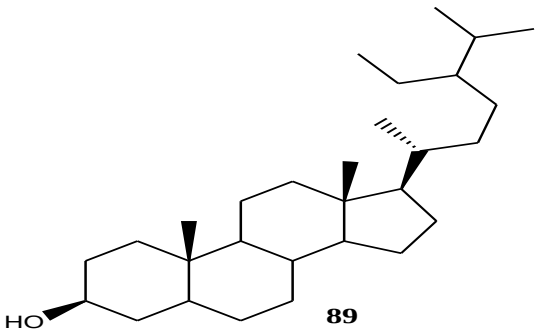

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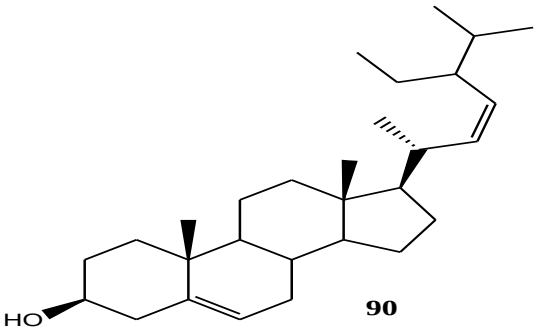

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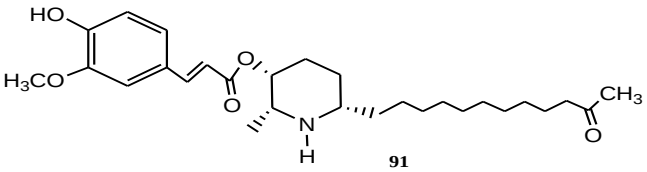
Senna bicapsularis (L) Roxb synonyms are *Cassia bicapsularis* L., *C.emarginata* L, *C. berterii* Colla, *Adipera bicapsularis* (L.), *Adipera spiciflora* Pittier, *Cathartocarpus bicapsularis* (L.) *Ham Isandrina emarginata* (L.) Britt. & Rose ex Britt. & Wilson, *Chamaefistula inflate* G.Don and *Isandrina arborescens* Raf. It is distributed in South America and tropical countries [154] The species is cultivated in many parts of the world; however, it has escaped being naturalized and has an unpleasant odor [155]. Roots and leaves are used for stomach aches [156]. The leaves have been used in treating skin ailments [157]. The flowers have been used as an abortifacient and contraception agent for both males and females [158]. The plant has been used to treat pain as well as a muscle relaxant and purgative [159]. Due to its aromatic nature, several compounds

like Emodin **(3)**, rhein **(33)**, chrysophanol **(52)**, physcion **(76),** and stigmasterol **(90)** have been isolated from it with biological activities including sedative effect, anti-inflammatory, analgesic effect and muscle relaxing effect [159].

Cassia spectabilis (D.C.) H.S. Irwin & Barneby Synonyms: *Cathartocarpus humboldtianus* Loudon; *Cathartocarpus speciosus* (D.C.) G.Don; *Cathartocarpus trinitatis* (D.C.) G.Don; *Cassia trinitatis* Rchb.ex D.C. *Cassia carnaval* Speg, *Pseudocassia spectabilis* (DC.) Britton & Rose, *Senna speciosa* Roxb, *Senna surattensis* (Burm. f.) Irwin & Barneby. *Cassia amazonica* Ducke and *Senna spectabilis* (D.C.) Irwin & Barneby. The species is a native of South America, Brazil, and coastal Ecuador and has migrated throughout Central America, the West Indies, the tropics, and sub-tropic parts of the world [160-162]. The leaves are used in throat inflammation and diarrhoea [162]. The plant is used to cure headaches, malaria, and dysentery, while the leaves treat anxiety, epilepsy, insomnia, constipation, and anxiety [163]. The species has also been used in treating ringworm, skin disease, flu, cold, whooping cough, menstrual cramps, and diabetes [160,164,165]. Natural products that have been isolated from this plant are: (-)-spectaline **(72)**, (+)-2-Methyl-3-feruloyl-6-(dodecyl-11′-one) piperidine ((+)-3-O-feruloylcassine) **(91)** and (-)-3- O-acetylspectaline **(92)**, isolated from methanol extract of green fruits of this plant and they showed moderate antioxidant activities [162]. Iso-6-spectaline (14-[(2R, 3R, 6R)-3-hydroxy-2-methylpiperidine]-tetradecan-13-one) **(93)** was isolated from ethanol leaf extracts and showed central nervous system (CNS) depressant and anticonvulsant activities [166]. Piperidine alkaloids; (–)-3-O-acetylspectaline **(92)** and iso-6-spectaline **(93)**, have also been isolated from the flowers and fruits of the plant, and they possessed DNA damaging activities in *Saccharomyces cerevisiae* [162,167]. (−)-Cassine **(94)** has been isolated from the leaves, flowers, and fruits of this plant and possesses anti-inflammatory and antinociceptive activities [160].

Additionally, alkaloids; (−)-spectaline **(75)** and (−)-cassine **(94)** were isolated from ethanol extracts of the flower of *Senna spectabilis*, and they showed antiproliferative activity on HepG2 cells and antitumor activity against hepatocellular carcinoma cells [168]. (−)-spectaline **(75)** and (−)-cassine ((+)-3-O-feruloylcassine) **(91)** have also been reported to possess schistosomicidal activity against adult worms and cercaricidal activity [169]. Several anthraquinones have been isolated from this plant, including physcion **(76)** and 1,3,8-trihydroxy-2-methylanthraquinone **(95),** which were isolated from methanol leaf extracts of *Senna spectabilis* and showed antimicrobial activity against *Mycobacterium tuberculosis*, *Bacillus subtilis*, *Sarcina lutea*, *Staphylococcus albus*, and *Staphylococcus aureus*. Chrysophanol **(52)** and physcion **(76)** isolated from the plant possessed hepatoprotective, antimicrobial, and anticancer activities [161].



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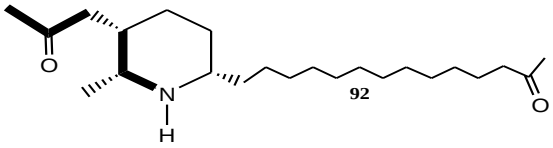

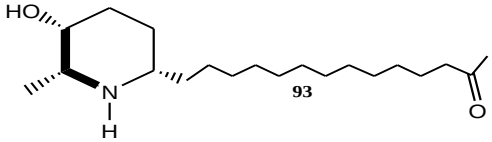

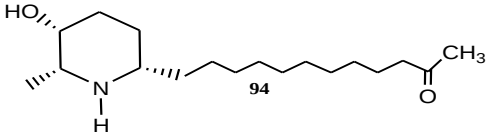

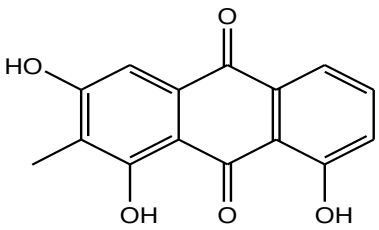

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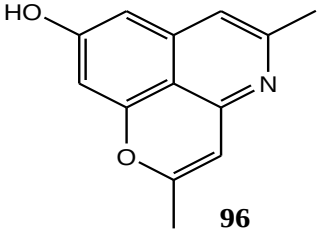

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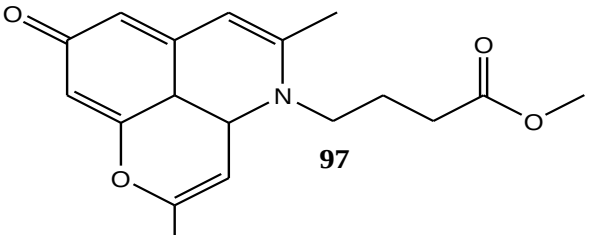

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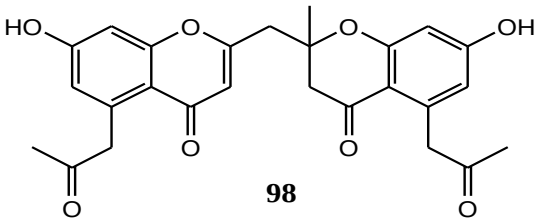

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Cassia siamea Lam synonyms are *Senna siamea* Lam.; *Senna sumatrana* Roxb, *Cassia florida* Vahl, *Cassia arayatensis* Naves, *Cassia sumatrana* Roxb, *Cassia arborea* Macfad, *Cassia gigantea* DC., and *Sciacassia siamea* Lam. It is widely spread in South Africa, East Africa, Brazil, Mexico, China, West Indies, and Asia [170]. The fruits prevent convulsion and expel intestinal worms [171,172]. The plant treats asthma and microbial infections [170]. Leaves treat stomach pains, malaria, constipation, sleeplessness, liver disorder, hypertension, cough, and toothache; the roots are used for diabetes mellitus, malaria, and snake bite; flowers and seeds are used to cure convulsion, typhoid fever, snake and scorpion bites while the stem is used against herpes, scabies, rhinitis, urogenital diseases, diabetes and as a laxative [173,174]. The plant is also used to reduce blood sugar levels and to treat abdominal pain, fever, typhoid, menstrual pain, and jaundice [175]. Compounds isolated from this plant include: cassiarin A **(96)** and cassiarin B **(97)**, isolated from the methanol leaf extracts, and these compounds showed moderate *in vitro* antiplasmodial activity against Plasmodium falciparum [176]. Chrobisiamone A **(98)** has also been isolated from methanolic leaf extracts and possesses antiplasmodial activity [177].

Cassiarin A **(96)** and barakol **(99)** also showed vasorelaxant activity [178,179]. Barakol **(99)**, isolated from this plant's ethanol flower extracts, also showed antioxidant activity [180,181]. Chrysophanol **(52)**, physcion **(76)**, betulinic acid **(85)**, lupeol **(86)**, and lupenone **(100)** are some of the compounds that have been elucidated from the methanol stem bark and showed anti-polio virus activity with lupeol possessing the most significant activity [182]. *Cassia mimosoides* L synonymns are *Chamaecrista mimosoides* L., *Chamaecrista nictitans* (L.) Moench, *Cassia aeschynomene* D.C,*Cassia aspera* Muhl. ex Ell., *Cassia multipinnata* Pollard, *Cassia procumbens* Stickman, and *Cassia nictitans* Sickmann. It is native to China but has spread to different countries [183]. The leaves cure swelling of the legs during pregnancy; [184], facilitate urination, and act as an anti-inflammatory agent [183]. Roots treat colic pain, stomach spasms, and diarrhoea [185]. The plant also cures chronic hepatitis and other liver diseases, including liver cirrhosis and fibrosis [186]. Phytochemicals such as Emodin **(3)**, Luteolin **(12)**, Oleanolic Acid **(66),** β-Sitosterol **(101)**, α-L-Rhamnose **(102),** and Carotene **(103)** have been isolated from this species, and showed anti-HMG-CoA reductase activity, with Emodin and luteolin showing the highest activity; an indication that the plant has potential in treating liver diseases.

Chrysophanol**(52)**, an essential bioactive component of the plant, possesses blood lipid regulation, antidiabetic, anti-inflammatory, and anticancer activities, as well as alleviating metabolic disorders and obesity properties [187]. *Cassia occidentalis* L synonyms are *Senna occidentalis* (L.) Roxb, *Cassia caroliniana* Walter, *Cassia obliquifolia* Schrank, *Cassia ciliata* Raf, *Cassia planisiliqua* L, *Cassia falcate* L, *Cassia macradenia*, *Cassia torosa* Cav, and *Ditrimexa occidentalis* (L.) Britt & Rose. It is distributed in Asia, South America, Australia, and Africa [188]. The plant treats diarrhoea and dysentery [189]. The leaves are used for throat infections, itching, and bone fractures. It also manages fever, anaemia, leprosy, tuberculosis, menstrual, and liver problems [190]. Moreover, the leaves and seeds are used for skin disorders such as eczemas and mycoses [191]. Additionally, the plant is used to treat cancer, eye inflammation, and venereal diseases [192]. The roots cure diabetes, elephantiasis, epilepsy, and convulsion [193,194].

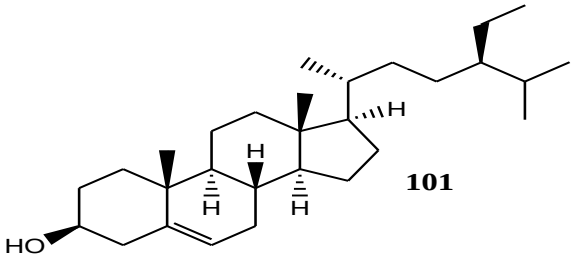
The *C. occidentalis* isolates include 1, 3,8-trihydroxy-6-methyl-anthraquinone (Emodin) **(3)** and 4, 5-dihydroxy-9, 10-dioxo-4a, 9, 9a, 10- tetrahydro-anthracene-2-carboxylic acid (rhein) **(33)**; isolated from alcoholic extracts (R-spirit) and found to possess antimicrobial activity on β-Lactum resistant strains of *Aspergillus niger*, *Pseudomonas aeruginosa*, *Aspergillus clavatus*, *Candida albicans*, *Escherichia coli*, *Streptococcus pyogenus*, and *Staphylococcus aureus* [195]. Chrysophanol **(52)** was isolated from the leaf extracts and showed wound healing activities [192]. *Cassia italica* Mill synonyms *are Senna italica* Mill, *Cassia obovata* Collad, and *Cassia aschrek* Fors., Its origin is in the equatorial region and surrounding areas [196]. The plant treats venereal diseases [197]. The roots are used for dysmenorrhoea, nausea, and liver problems, whereas the pods and the leaves are used for burns, skin diseases, and ulcers [198]. Leaves are used as hair conditioners, while roots are used to cure diarrhoea [199]. The whole plant is used as a urinary tract purifier and laxative, while its leaves, seeds, and pods are used as a purgative and also to treat elephantiasis and eye diseases [200]. Compounds isolated from the species is 2-methoxy-emodin-6-O-β-D-glucopyranoside **(104)**, which was isolated from DCM/MeOH (1:1) extract of aerial parts of the plant and possessed mild anticancer activity against hepatocellular carcinoma (HePG-2) and mammary gland breast cancer (MCF-7) [201].

Cassia afrofistula Brenan synonyms are *Cassia beareana* Holmes and *Cassia kassneri* Bak. F. It is distributed in Madagascar, Mozambique, Tanzania, and Kenya [202]. The roots treat hernia and body weaknesses, while the stem is used for kidney diseases and liver pains [83]. The bark is used as an aphrodisiac and laxative. The bark also cures pneumonia, fever, stomach aches, backache, and blood pressure [203]. It is also used to manage uterine complaints, fever, malaria, syphilis, gonorrhea, pneumonia, and snakebites [203]. No bioactive compounds have been reported from this species. *Cassia falcinella* Oliv synonym is *Chamaecrista afalcinella* Oliv. It is found in Kenya, Tanzania, Uganda, Rwanda, Namibia, Zambia, Zimbabwe, Mozambique, Botswana, and DR Congo [202]. The roots are used as an aphrodisiac and in treating gonorrhea [204]. Its leaves are used to cure broken bones and rheumatism, while the roots are also used to treat diarrhoea [202]. Bioactive compounds have not *Cassia kirkii* Oliv synonym is *Chamaecrista kirkii* Oliv. It is widely spread in tropical and

subtropical Africa [205]. Leaves are used for upsetting pains [206]. The plant is used for skin diseases and fertility [207]. Bioactive compounds have not been isolated from this species.

Cassia leptocarpa Benth. Synonyms are *Senna hirsuta*

L, *Cassia caracasana* Jacq, *Cassia hirsuta* L, *Cassia tomentosa* L, *Cassia. longisiliqua* Blanco, *Cassia. venenifer* Rodsch. ex G.Mey, *Cassia neglect* Vogel var. *acuminata* Benth, *Cassia pubescens* Jacq, and *Cassia gooddingii* A. Nelson. It is distributed in North, Central, South America, and tropical regions [208,209]. It is used to treat liver diseases, malaria, high blood pressure, diarrhoea, typhoid fever, and skin rashes and to reduce cholesterol levels [9,210]. Various compounds have been isolated from this plant; however, there is no literature report on their bioactivities.



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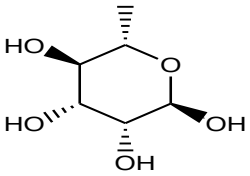

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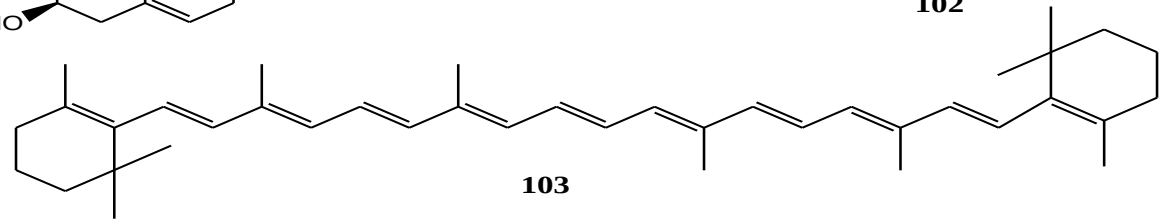

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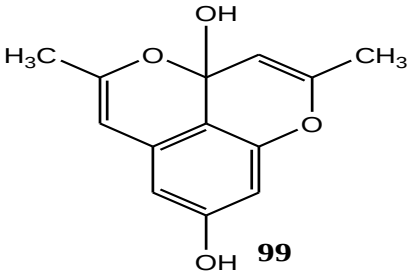

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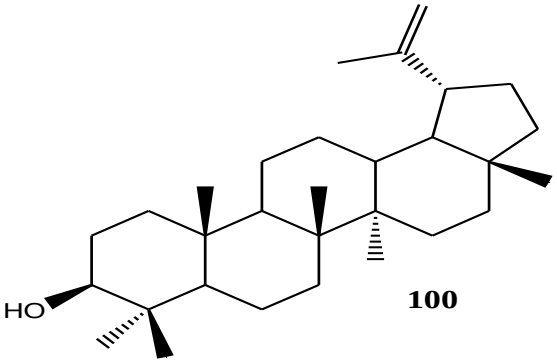

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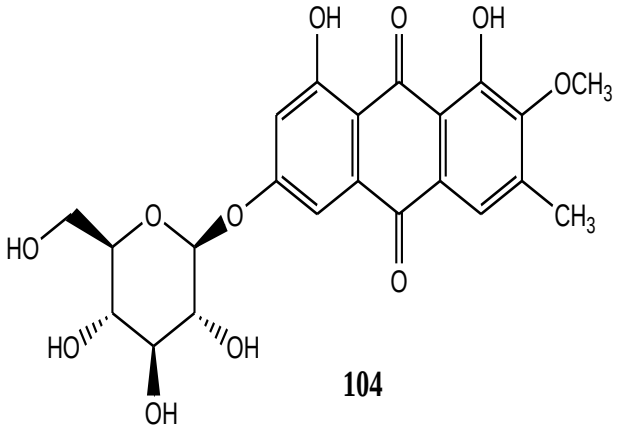

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CONCLUSION

The genus *Cassia* has been widely used in Chinese, Ayurveda, African, and South American folklore medicines to manage various ailments. Various studies have been done on their crude extracts, and isolated phytochemicals from different plant parts of individual species of this genus have been accomplished. It has been established that several species have a wide range of bioactivities: antimalarial, larvicidal, antimicrobial, wound healing, laxative, antiasthmatic, hepatoprotective, antidiabetic, antiparasitic, antioxidant, analgesic, anti-inflammatory and anticancer. This makes the genus a hive under pharmacological research. Despite the genus portraying a lot of bioactivities, most of the compounds responsible for these bioactivities have not been entirely isolated and their activities verified. Additionally, studies on synergistic effects, toxicology, in vivo activities, and clinical trials on isolated compounds with biological potency have not been done effectively. Unfortunately, this has been a setback in discovering new drugs that could have solved drug resistance issues and side effects.

Regardless of all these challenges, some countries use dosage forms of *Cassia*, including *Senna*, under different brand names [12]. Some compounds isolated from *Cassia* species, such as sennosides, are currently being used as allopathic laxative medicine with a prescribed dosage, while others, such as ononitol monohydrate and chrysophanol, are still under clinical assessment as hepatoprotective agents. This indicates

the potential of the isolated compounds as leads for new drug discovery as most conventional drugs are currently unaffordable; hence, the genus Cassia species continues to serve communities as a cheap drug source. They are assumed to be safe even though many side effects have been reported from herbs, including interactions with allopathic medicines and herbs, preparations, contaminations, allergic reactions, transformed food consumption, distorted body and organ weights [211,212]. Hence, further toxicological studies, dosage determination, and regimes are imperative to avoid side effects and complicated conditions in these herbal preparations. It is expected that this review will stimulate more research for the elucidation and isolation of bioactive compounds from the genus leading to more new drug discoveries for the sake of humanity.

REFERENCES

1. Busia K. Medical provision in Africa - Past and present. Phyther Res. 2005, 19:919–23. 10.1002/ptr.1775
2. Sundaramoorthy S, Gunasekaran S, Arunachalam S, et al. A phytopharmacological review on cassia species. J Pharm Sci Res. 2016, 8:260–4.
3. Barata AM, Rocha F, Lopes V, et al. Conservation and sustainable uses of medicinal and aromatic plants genetic resources on the worldwide for human welfare. Ind Crops Prod. 2016, 88:8–11. 10.1016/j.indcrop.2016.02.035
4. Noorhosseini SA, Fallahi E, Damalas CA, et al. Factors affecting the demand for medicinal plants: Implications for rural development in Rasht, Iran. Land use policy. 2017, 68:316–25. 10.1016/j.landusepol.2017.07.058
5. Alamgeer, Sharif A, Asif H, et al. Indigenous medicinal plants of Pakistan used to treat skin diseases: A review. Chinese Med (United Kingdom). 2018, 13:1–26. 10.1186/s13020-018-0210-0
6. Albuquerque UP, de Medeiros PM, Ramos MA, et al. Are ethnopharmacological surveys useful for the discovery and development of drugs from medicinal plants? Brazilian J Pharmacogn. 2014, 24:110–5. 10.1016/j.bjp.2014.04.003
7. Pandey AK. Ethnobotany and its relevance in contemporary research. J Med Plants. 2017, 5:123–9.
8. Chebii WK, Muthee JK, Kiemo K. The governance of traditional medicine and herbal remedies in the selected local markets of Western Kenya. J Ethnobiol Ethnomed. 2020, 16:1–24. 10.1186/s13002-020-00389-x
9. Dave H, Ledwani L. A review on anthraquinones isolated from Cassia species and their applications. Indian J Nat Prod Resour. 2012, 3:291–319.
10. Fonkou MFY, Kamdem JP, Fono LA, et al. Identification keys of seven Cassia species from the (Caesalpinioideae: Fabaceae). Int J Plant, Anim Enviromental Sci. 2018, 8:5–18. 10.21276/Ijpaes
11. Deshpande H, Bhalsing S. Recent advances in the phytochemistry of some medicinally important Cassia species: A Review. Int J pharma Med Biol Sci. 2013, 2:60–78.
12. Khurm M, Wang X, Zhang H, et al. The genus Cassia L.: Ethnopharmacological and phytochemical overview. Phyther Res. 2021, 35:2336–85. 10.1002/ptr.6954
13. Hafez SA, Osman SM, Ibrahim HA, et al. Chemical Constituents and Biological Activities of Cassia Genus. 2019,3:195–227.
14. Nduwayezu J., Lulandala LL., Chamshama SAO. Managing Decomposition and Minaralization of Senna singueana (Del.) lOCK. Manure to improve N use Efficiency and Maize Yield in Morogoro, Tanzania. J Agron. 2005, 4:349–59.
15. Kanthimathi M, Soranam R. Phytochemical screening and Invitro antibacterial Potential of Cassia auriculata Linn . Flowers Against Pathogenic Bacteria. Int Res J Pharm Biosci. 2014, 1:45–56.
16. Gowri R, Durgadevi K, Mini ST, et al. Phytochemical Profiling of Ethanolic Leaves Extract of Cassia auriculata. Int J Pharm Biol Sci. 2018, 8:1177–83.
17. Ayyanar M, Ignacimuthu S: Pharmacological Actions of Cassia auriculata L. and Cissus quadrangularis Wall. J Pharmacol Toxicol. 2008, 3:213–21. 10.3923/jpt.2008.213.221
18. Jaydeokar A V., Bandawane DD, Bibave KH, et al. Hepatoprotective potential of Cassia auriculata roots on ethanol and antitubercular drug-induced hepatotoxicity in experimental models. Pharm Biol. 2014, 52:344–55. 10.3109/13880209.2013.837075
19. Yoganandam P. “Aavarai Kudineer”- A Potent Polyherbal Siddha Formulation for Management of Diabetes Mellitus. Int J Pharm Dev Technol. 2014, 2:45–61.
20. Nille G, Reddy KRC. A Phytopharmacological Review of Plant – Cassia auriculata. Int J Pharm Biol Arch. 2015, 6:1–9.
21. Saritha P. Medicinal Properties of Telangana State Flower Tangedu (Cassia Auriculata Linn). World J Pharm Res. 2017, 6:1597–605. 10.20959/wjpr20178-9036
22. Nille GC, Mishra SK, Chaudhary AK, et al. Ethnopharmacological, Phytochemical, Pharmacological, and Toxicological Review on Senna auriculata (L.) Roxb.: A Special Insight to Antidiabetic Property. Front Pharmacol. 2021, 12:1–23. 10.3389/fphar.2021.647887
23. Aye MM, Aung HT, Sein MM, et al. A review on the phytochemistry, medicinal properties and pharmacological activities of 15 selected myanmar medicinal plants. Molecules. 2019, 24:. 10.3390/molecules24020293
24. Jayaseelan V. Herbal Treatment for Alcohol Use Disorder - An Experiment in Tamilnadu , South India. Int J Heal Sci Res. 2019, 9:164–70.
25. Haripriya VM, Dhamotharan K, Shukla SK, et al. Aphrodisiac properties of hydro-alcoholic extract of Cassia auriculata flower in male rats. Andrologia. 2019, 51:. 10.1111/and.13180
26. Salma B, Muthukumar SP, Avinasha S, et al. Review on ethnobotany, phytochemistry, and pharmacological properties of Cassia auriculata. Pharm Pharmacol Int J. 2020, 8:106–11. 10.15406/ppij.2020.08.00286
27. Karim A: Constituents of Sudanese Cassia auriculata Linn .(Caesalpiniaceae) Oil. Pharm Chem J. 2020, 7:28–33.
28. Esakkirajan M, Prabhu NM, Arulvasu C, et al. Anti-proliferative effect of a compound isolated from Cassia auriculata against human colon cancer cell line HCT 15. Spectrochim Acta - Part A Mol Biomol Spectrosc. 2014, 120:462–6. 10.1016/j.saa.2013.09.102
29. Senthilkumar PK, Reetha D. Isolation and identification of antibacterial compound from the leaves of Cassia auriculata. Eur Rev Med Pharmacol Sci. 2011, 15:1034–8.
30. Dichayal SS, Murade VD, Deshmukh KK, et al. Journal of Pharmaceutical and Life Sciences WJPLS PHYTOCHEMISTRY OF CASSIA AURICULATA (L .): A REVIEW. World J Pharm Life Sci. 2016, 2:81–8.
31. Puranik AS, Halade G, Kumar S, et al. Cassia auriculata: Aspects of safety pharmacology and drug interaction. Evidence-based Complement Altern Med. 2011, 2011:. 10.1093/ecam/nep237
32. Girme A, Saste G, Chinchansure A, et al. Simultaneous

determination of anthraquinone, flavonoids, and phenolic antidiabetic compounds from cassia auriculata seeds by validated uhplc based ms/ms method. Mass Spectrom Lett. 2020, 11:82–9. 10.5478/MSL.2020.11.4.82
33. Manogaran S, Sulochana N. Anti-inflammatory activity of cassia aauriculata. Anc Sci Life. 2004, 24:65–657.
34. Anandan A, Eswaran R, Doss A, et al. Chemical compounds investigation of Lucas aspera leaves - a potential folklore medicinal plant. Asian J Pharm Clin Res. 2012, 5:86–8.
35. Meenupriya J, Vinisha A, Priya P. Cassia alata and Cassia auriculata – Review of their bioactive potential. World J Pharm Sci. 2014, 2:1760–9.
36. Sirajunnisa A, Fazal Mohamed MI, Subramania A, et al. Green Approach To Corrosion Inhibition Of Aluminium By Senna Auriculata Leaves Extract In 1 N NaOH Solution. Int J Sci Eng Adv Technol IJSEAT. 2014, 2.
37. Singh RB. Nature of seed polysaccharide isolated from Cassia glauca Lam . plant. Int J Multidiscip Sci. 2018, 01:1–3.
38. Osman SM, Ayoub NA, Hafez SA, et al. Aldose reductase inhibitor form Cassia glauca: A comparative study of cytotoxic activity with Ag nanoparticles (NPs) and molecular docking evaluation. PLoS One. 2020, 15:. 10.1371/journal.pone.0240856
39. Salahuddin M, Jalalpure SS. Evaluation of antidiabetic activity of Cassia glauca lam. Leaf in streptozotocin induced diabetic rats. Iran J Pharmacol Ther. 2010, 9:29–33.
40. Kittur BS, Srinivas Y, Deshpande SR. Evaluation of Leaf and Stem Extracts From Cassia Glauca L. for Antimicrobial Activity. Int J Pure Appl Zool ISSN. 2015, 3:98–102.
41. Rashed K. Phytochemical propertiead and biological activities from Cassia nigricans: A Review. Int J Innov Pharm Sci Res. 2021, 09:8–13. 10.21276/IJIPSR.2021.09.01.851
42. El-Sayed MM, Abdel-Aziz MM, Abdel-Gawad MM, et al. Chemical constituents and cytotoxic activity of cassia glauca lan. leaves. Life Sci J. 2013, 10:1617–25.
43. Tripathi YC. Cassia angustifolia, a versatile medicinal crop. For Trees Livelihoods. 1999, 10:121–9. 10.1080/01435698.1999.9752999
44. Ahmed SI, Hayat MQ, Tahir M, et al. Pharmacologically active flavonoids from the anticancer, antioxidant and antimicrobial extracts of Cassia angustifolia Vahl. BMC Complement Altern Med. 2016, 16:1–9. 10.1186/s12906-016-1443-z
45. Patra S, Samal P. Medicinal Plants - Therapeutic Potential in Today's Context. Int J Curr Microbiol Appl Sci. 2018, 7:3841–8. 10.20546/ijcmas.2018.708.393
46. Al-Marzoqi AH, Hadi MY, Hameed IH. Determination of metabolites products by Cassia angustifolia and evaluate antimicobial activity. J Pharmacogn Phyther. 2016, 8:25–48. 10.5897/JPP2015.0367
47. Shafiei M, Peyton L, Hashemzadeh M, et al. History of the development of antifungal azoles: A review on structures, SAR, and mechanism of action. Bioorg Chem. 2020, 104:104240. 10.1016/j.bioorg.2020.104240
48. Sharma A, Kumar A, Jaitak V. Pharmacological and chemical potential of Cassia fistula L- a critical review. J Herb Med. 2021, 26:100407. 10.1016/j.hermed.2020.100407
49. Bhakta T, Mukherjee PK, Mukherjee K, et al. Studies on in vivo wound healing activity of Cassia fistula linn. Leaves (Leguminosae) in rats. Nat. Prod. Sci. 1998, 4:84–7.
50. Raju I, Malika M, Venkataraman S. Anti-inflammatory and antioxidant activities of Cassia fistula linn bark. Afr J Trad. 2005, 2:70–85. 10.4314/ajtcam.v2i1.31105
51. Danish M, Singh P, Mishra G, et al. Cassia fistula Linn. (Amulthus)- An Important Medicinal Plant: A Review of Its Traditional Uses, Phytochemistry and Pharmacological Properties. J Nat Prod Planet Resour. 2011, 1:101` – 118.
52. Raji P, Sreenidhi J, Sugithra M, et al. Phytochemical screening and bioactivity study of Cassia fistula leaves. Biosci Biotechnol Res Asia. 2014, 6:5096–100. 10.13005/bbra/2202
53. Limtrakul P, Yodkeeree S, Thippraphan P, et al. Anti-aging and tyrosinase inhibition effects of Cassia fistula flower butanolic extract. BMC Complement Altern Med. 2016, 16:1–9. 10.1186/s12906-016-1484-3
54. Biji C. Plant Drug Analysis- A Comparative Analysis of Cassia Fistula. Int J Appl Res Technol. 2017, 2:60–72.
55. Pawar A V, Patil SJ, Killedar SG. Uses of Cassia Fistula Linn as a Medicinal Plant. Int J Adv Res Dev. 2017, 2:85–91.
56. Maqsood A, Ayesha M, Sammia S A Phytopharmacological Evaluation of Cassia fistula . A Comprehensive Review. Int J Pharm Sci Rev Res. 2020, 62:45–53.
57. Duraipandiyan V, Ignacimuthu S Antibacterial and antifungal activity of Cassia fistula L.: An ethnomedicinal plant. J Ethnopharmacol. 2007, 112:590–4. 10.1016/j.jep.2007.04.008
58. Duraipandiyan V, Ignacimuthu S Antifungal activity of rhein isolated from Cassia fistula L. flower. Webmedcentral Pharmacol. 2010, 1:1–8.
59. Sartorelli P, Lago JHG, Cunha RLOR, et al. A new minor dimmeric ester from seeds of Cassia fistula L. (Leguminosae). Nat Prod Res. 2012, 26:36–41. 10.1080/14786419.2010.532128
60. Grace MH, Lategan C, Graziose R, et al. Antiplasmodial activity of the ethnobotanical plant Cassia fistula. Nat Prod Commun. 2012, 7:1263–6. 10.1177/1934578x1200701002
61. Irshad M, Mehdi SJ, Al-Fatlawi AA, et al.: Phytochemical Composition of Cassia fistula Fruit Extracts and its Anticancer Activity Against Human Cancer Cell Lines. J Biol Act Prod from Nat. 2014, 4:158–70. 10.1080/22311866.2014.933084
62. Abubacker MN, Ramanathan R, Kumar TS. *In vitro* antifungal activity of *Cassia alata* linn. flower extract. Nat Prod Radiance. 2008, 7:6–9.
63. Halim-Lim S, Ramli N., Fadzil FA, et al. The antimicrobial and antioxidant properties of Cassia alata extraction under different temperature profiles. Food Res. 2020, 1–6.
64. Okpuzor J, Ogbunugafor H, Kareem GK, et al. In vitro investigation of antioxidant phenolic compounds in extracts of Senna alata. Res J Phytochem. 2009, 3:68–76. 10.3923/rjphyto.2009.68.76
65. Sugumar M, Victor Arokia Doss D. Biochemical Properties and Bioactive Compounds With Multiple Therapeutic Values of Senna Alata (L.), an Ornamental Shrub From the Botanical Family of Fabaceae (Leguminosae). Int J Curr Res. 2015.
66. Priya RR, Bhaduhsha N, Manivannan V, et al. Extraction and Isolation of Bioactive Compounds from a Therapeutic Medicinal Plant-Wrightia tinctoria (Roxb.) R. Br. J Pharmacogn Phytochem Res. 2019, 11:199–204.
67. Lahare RP, Bisen YK, Yadav HS, et al. TLC Based Phytochemical Analysis and Antioxidant Activity of Senna Alata. Int J Adv Res. 2020, 8:1099–107. 10.21474/ijar01/12106
68. Okwu DE, Nnamdi FU. Cannabinoid Dronabinol alkaloid with antimicrobial activity from Cassia alata Linn. Der Chem Sin. 2011, 2:247–54.
69. Tatsimo SJN, Tamokou J-D, Tsague VT, et al. Antibacterial-guided isolation of constituents from *Senna alata* leaves with a particular reference against Multi-Drug-Resistant *Vibrio cholerae*

and *Shigella flexneri*. Int J Biol Chem Sci. 2017, 11:46. 10.4314/ijbcs.v11i1.4
70. Promgool T, Pancharoen O, Deachathai S. Antibacterial and antioxidative compounds from Cassia alata Linn . Songklanakarin J Sci Technol. 2014, 36:459–63.
71. Zahari A, Ablat A, Sivasothy Y, et al. Asian Paci fi c Journal of Tropical Medicine. Asian Pac J Trop Med. 2016, 9:328–32. 10.1016/j.apjtm.2016.03.008
72. Sirappuselvi S, Chitra M. In vitro Antioxidant Activity of Cassia tora Lin. Int Res J Biol Sci I Res J Biol Sci. 2012, 1:57–61.
73. Prabhu A, M. Krishnamoorthy MK, Prasad DJ, et al. Anticancer Activity of Friedelin Isolated from Ethanolic Leaf Extract of Cassia tora on HeLa and HSC-1 Cell Lines. Indian J Appl Res. 2011, 3:1–4. 10.15373/2249555x/oct2013/121
74. Bhalerao SA, Verma DR, Teli NC, et al. Bioactive Constituents , Ethnobotany and Pharmacological Prospectives of Cassia Tora. Int J Bioassays. 2013, 1421–7.
75. Choudhary M, Gulia Y, Nitesh. Cassia tora: Its chemistry, medicinal uses and pharmacology . Pharmacologyonline. 2011, 3:78–96.
76. Sreelakshmi V, Abraham A. Protective effects of Cassia tora leaves in experimental cataract by modulating intracellular communication, membrane co-transporters, energy metabolism and the ubiquitin-proteasome pathway. Pharm Biol. 2017, 55:1274–82. 10.1080/13880209.2017.1299769
77. El-Halawany AM, Chung MH, Nakamura N, et al. Estrogenic and anti-estrogenic activities of Cassia tora phenolic constituents. Chem Pharm Bull. 2007, 55:1476–82. 10.1248/cpb.55.1476
78. Dhanasekaran M, Ignacimuthu S, Agastian P. Potential hepatoprotective activity of ononitol monohydrate isolated from Cassia tora L. on carbon tetrachloride induced hepatotoxicity in wistar rats. Phytomedicine. 2009, 16:891–5. 10.1016/j.phymed.2009.02.006
79. Choi JS, Lee HJ, Park KY, et al. In vitro antimutagenic effects of anthraquinone aglycones and naphthopyrone glycosides from Cassia tora. Planta Med. 1997, 63:11–4. 10.1055/s-2006-957593
80. Akah PA, Orisakwe OE, Gamaniel KS, et al. Evaluation of Nigerian traditional medicines: II. Effects of some Nigerian folk remedies on peptic ulcer. J Ethnopharmacol. 1998, 62:123–7. 10.1016/S0378-8741(98)00060-9
81. Hatano T, Uebayashi H, Ito H, et al. Phenolic constituents of cassia seeds and antibactrerial effect of some naphthalenes and anthraquinones on methillicin-resistant Staphylococcus aureus. Chem Pharm Bull. 1999, 47:1121–7.
82. Mongalo NI, Mafoko B, I. N. Cassia abbreviata Oliv. A review of its ethnomedicinal uses, toxicology, phytochemistry, possible propagation techniques and Pharmacology. African J Pharm Pharmacol. 2013, 7:2901–6. 10.5897/ajpp12.1017
83. Hedberg I, Hedberg O, Madati PJ, et al. Inventory of plants used in traditional medicine in Tanzania. I. Plants of the families acanthaceae-cucurbitaceae. J Ethnopharmacol. 1982, 6:29–60. 10.1016/0378-8741(82)90070-8
84. Chhabra SC, Mahunnah BLA, Mshiu EN. Plants used in traditional medicine in eastern Tanzania. I. Pteridophytes and angiosperms (acanthaceae to canellaceae). J Ethnopharmacol. 1987, 21:253–77. 10.1016/0378-8741(87)90103-6
85. Gessler MC, Nkunya MHH, Mwasumbi LB, et al. Screening Tanzanian medicinal plants for antimalarial activity. Acta Trop. 1994, 56:65–77. 10.1016/0001-706X(94)90041-8
86. Moshi M, Kamuhabwa A, Mbwambo Z, et al. Cytotoxic Screening of Some Tanzania Medicinal Plants. East Cent African J Pharm Sci. 2005, 6:52–6. 10.4314/ecajps.v6i3.9700
87. Runyoro DKB, Ngassapa OD, Matee MIN, et al. Medicinal plants used by Tanzanian traditional healers in the management of Candida infections. J Ethnopharmacol. 2006, 106:158–65. 10.1016/j.jep.2005.12.010
88. Augustino S, Hall JB, Makonda FBS, et al. Medicinal resources of the Miombo woodlands of Urumwa, Tanzania: Plants and its uses. J Med Plant Res. 2011, 5:6352–72. 10.5897/JMPR10.517
89. Bruschi P, Morganti M, Mancini M, et al. Traditional healers and laypeople: A qualitative and quantitative approach to local knowledge on medicinal plants in Muda (Mozambique). J Ethnopharmacol. 2011, 138:543–63. 10.1016/j.jep.2011.09.055
90. Ngarivhume T, Van'T Klooster CIEA, De Jong JTVM, et al. Medicinal plants used by traditional healers for the treatment of malaria in the Chipinge district in Zimbabwe. J Ethnopharmacol. 2015, 159:224–37. 10.1016/j.jep.2014.11.011
91. Aparicio H, Hedberg I, Bandeira S, et al. South African Journal of Botany Ethnobotanical study of medicinal and edible plants used in Nhamacoa area , Manica province À Mozambique. South African J Bot. 2021, 139:318–28. 10.1016/j.sajb.2021.02.029
92. Erasto P, Majinda R. Bioactive proanthocyanidins from the root bark of Cassia abbreviata. Int J Biol Chem Sci. 2011, 5:2170–9. 10.4314/ijbcs.v5i5.36
93. Kiplagat DM, Akala HM, Liyala PO, et al. Antiplasmodial activity of flavan derivatives from rootbark of Cassia abbreviata Oliv. J Saudi Chem Soc. 2016, 20:S140–4. 10.1016/j.jscs.2012.10.002
94. Zheng Y, Yang XW, Schols D, et al. Active components from cassia abbreviata prevent hiv-1 entry by distinct mechanisms of action. Int J Mol Sci. 2021, 22:. 10.3390/ijms22095052
95. Yang X, He Z, Zheng Y, et al. Chemical constituents of cassia abbreviata and their anti-hiv-1 activity. Molecules. 2021, 26:1–8. 10.3390/molecules26092455
96. Nwafor PA, Okwuasaba FK. Contraceptive and estrogenic effect of a methanol extract of Cassia nigricans leaves in experimental animals. Pharm Biol. 2001, 39:424–8. 10.1076/phbi.39.6.424.5886
97. Nwafor PA, Okwuasaba FK. Effect of methanolic extract of Cassia nigricans leaves on rat gastrointestinal tract. Fitoterapia. 2001, 72:206–14. 10.1016/S0367-326X(00)00303-8
98. Ayo RG, Amupitan JO, Ndukwe IG, et al. Some chemical constituents of the leaves of Cassia nigricans Vahl . African J Pure Appl Chem. 2009, 3:208–11.
99. Ayo RG. Phytochemical constituents and bioactivities of the extracts of Cassia nigricans Vahl : A review. J Med Plants Res. 2010, 4:1339–48. 10.5897/JMPR10.010
100. Obodozie OO, Okpako LC, Tarfa FD, et al. Antiplasmodial principles from Cassia nigricans. Pharm Biol. 2004, 42:626–8. 10.1080/13880200490902545
101. Ayo RG, Amupitan JO, Zhao Y. trihydroxy-3-methyl-anthraquinone (emodin) isolated from the leaves of Cassia nigricans Vahl. African J Biotechnol. 2007, 6:1276–9.
102. Georges K, Jayaprakasam B, Dalavoy SS, et al. Pest-managing activities of plant extracts and anthraquinones from Cassia nigricans from Burkina Faso. Bioresour Technol. 2008, 99:2037–45. 10.1016/j.biortech.2007.02.049
103. Ayo RG, Amupitan JO, Oyewale AO. Isolation, characterisation and antimicrobial activity of a steroidal ester from the leaves of Cassia nigricans Vahl. Res J Med Plant. 2009, 3:69–74.
104. Toma I, Karumi Y, Geidam MA. Phytochemical screening and toxicity studies of the aqueous extract of the pods pulp of Cassia sieberiana DC. (Cassia Kotchiyana Oliv.). African J Pure Appl

Chem. 2009, 3:26–030.
105. Sam GH, Mensah MLK, Nyakoa-Ofori N. Pharmacognostic studies and standardization of Cassia Sieberiana roots. Pharmacogn J. 2011, 3:12–7. 10.5530/pj.2011.21.2
106. Nartey ET, Ofosuhene M, Kudzi W, et al. Antioxidant and gastric cytoprotective prostaglandins properties of Cassia sieberiana roots bark extract as an anti-ulcerogenic agent. BMC Complement Altern Med. 2012, 12:. 10.1186/1472-6882-12-65
107. Briggs J, Liu L, Lu A, et al. The Art and Science of Traditional Medicine. 2014.
108. Olapade AA, Ajayi OA, Ajayi IA. Physical and chemical properties of Cassia sieberiana seeds. Int Food Res J. 2014, 21:767–72.
109. Jibril S, Sirat HM, Basar N. A New Stilbene from the root of cassia sieberiana D.C. (Fabaceae). Nat Prod Commun. 2017, 12:1095–8. 10.1177/1934578x1701200723
110. Kpegba K, Agbonon A, Petrovic AG, et al. Epiafzelechin from the Root Bark of Cassia sieberiana : Detection. J Nat Prod. 2010, 0–4.
111. Ambadiang MMM, Atontsa BCK, Tankeo SB, et al. Bark extract of Cassia sieberiana DC. (Caesalpiniaceae) displayed good antibacterial activity against MDR gram-negative phenotypes in the presence of phenylalanine-arginine β-naphthylamide. BMC Complement Med Ther. 2020, 20:1–11. 10.1186/s12906-020-03148-3
112. Atontsa BCK, Bitchagno GTM, Mpetga JDS, et al. Caffeate and piperidine-3-ol derivatives from the stem bark of Cassia sieberiana. Nat Prod Res. 2021, 35:2507–14. 10.1080/14786419.2019.1684278
113. Adhma S, Hassan A, Abbasi WM, et al. Phytochemistry and pharmacological potential of Cassia absus – a review. J Pharm Pharmacol. 2018, 70:27–41. 10.1111/jphp.12816
114. Hosamani KM. A Rich Source of Novel 9-Ketooctadec-cis-15-enoic Acid from Cassia absus Seed Oil and Its Possible Industrial Utilization. Ind Eng Chem Res. 1994, 33:1058–61.
115. Nancy P, Ashlesha V. Pharmacognostic and phytochemical studies of cassia absus seed extracts. Int J Pharm Pharm Sci. 2016, 8:325–32.
116. Reddy DS, Reddy AV. Pollen morphology of medicinally valuable Cassia L. spp. (sensu lato) belong to Nalgonda District, Telangana State. Int J Pharm LIFE Sci. 2016, 7:5360–8.
117. Krishna R V., Rao JVLN, Rao S, et al. Phytochemical investigation of Cassia absus (Roots and Leaves). J Nat Prod. 2005, 42:299–300.
118. Annalakshmi R, Mahalakshmi S, Guganathan K, et al. Brief Investigations on Isolated Bioactive. Int J Sci Reserach Mod Educ. 2016, 10:182–99.
119. Yadava RN, Vishwakarma UK. New biologically active allelochemical from seeds of cassia absus linn. Indian J Chem - Sect B Org Med Chem. 2013, 52:953–7.
120. Kamau LN, Mbaabu PM, Mbaria JM, et al. Ethnobotanical survey and threats to medicinal plants traditionally used for the management of human diseases in Nyeri County, Kenya. Tang [Humanitas Med. 2016, 6:21.1-21.15. 10.5667/tang.2016.0007
121. Irakiza R, Vedaste M, Elias B, et al. Assessment of traditional ecological knowledge and beliefs in the utilisation of important plant species: The case of Buhanga sacred forest, Rwanda. Koedoe. 2016, 58:1–11. 10.4102/koedoe.v58i1.1348
122. Rakotondrafara A, Rakotondrajaona R, Rakotoarisoa M, et al. Ethnobotany of medicinal plants used by the Zafimaniry clan in Madagascar. J Phytopharm. 2018, 7:483–94. 10.31254/phyto.2018.7606
123. Alonso-Castro AJ, Alba-Betancourt C, Yáñez-Barrientos E, et al. Diuretic activity and neuropharmacological effects of an ethanol extract from Senna septemtrionalis (Viv.)H.S. Irwin & Barneby (Fabaceae). J Ethnopharmacol. 2019, 239:111923. 10.1016/j.jep.2019.111923
124. Jones L, Bartholomew B, Latif Z, et al. Constituents of Cassia laevigata. Fitoterapia. 2000, 71:580–3.
125. Arana-Argáez VE, Domínguez F, Moreno DA, et al. Anti-inflammatory and antinociceptive effects of an ethanol extract from Senna septemtrionalis. Inflammopharmacology. 2020, 28:541–9. 10.1007/s10787-019-00657-7
126. Kuete V, Wabo HK, Eyong KO, et al. Anticancer activities of six selected natural compounds of some Cameroonian medicinal plants. PLoS One. 2011, 6:4–10. 10.1371/journal.pone.0021762
127. Djemgou PC, Gatsing D, Tchuendem M, et al. Antitumor and immunostimulatory activity of two chromones and other constituents from Cassia petersiana. Nat Prod Commun. 2006, 1:961–8. 10.1177/1934578x0600101109
128. Lovett JC, Ruffo CK, Gereau RE, et al. Field Guide to the Moist Forest Trees of Tanzania. 1994, 1–193.
129. Loffler L, Loffler P. Swaziland Tree Atlas -including selected shrubs and climbers. Southern African Botanical Diversity Network (SABONET) c/o South African National Biodiversity Institute, Private Bag X101, 0001, Pretoria. Printed: Pretoria; 2005.
130. Amri E, Kisangau DP. Ethnomedicinal study of plants used in villages around Kimboza forest reserve in Morogoro, Tanzania. J Ethnobiol Ethnomed. 2012, 8:1.
131. Tshidzumba P. An inventory and pharmacological evaluation of medicinal plants used as anti-diabetes and anti-arthritis in Vhembe District Municipality , Limpopo Province , RSA By Tshidzumba P . W Student Number : 11595304 Submitted in fulfilment of the requirements of. 2015.
132. Semenya SS, Maroyi A. Ethnobotanical survey of plants used by Bapedi traditional healers to treat tuberculosis and its opportunistic infections in the Limpopo Province, South Africa. South African J Bot. 2019, 122:401–21. 10.1016/j.sajb.2018.10.010
133. Nicosia E, Valenti R, Guillet A, et al. ABS Provides Opportunities for Indigenous and Local Communities in the Limpopo National Park. An ethnobotanical survey of plants used by the Changana community, Limpopo National Park, Mozambique. Res Sq. 2020, 1–19.
134. Manuel L, Bechel A, Noormahomed EV, et al. Ethnobotanical study of plants used by the traditional healers to treat malaria in Mogovolas district, northern Mozambique. Heliyon. 2020, 6:. 10.1016/j.heliyon.2020.e05746
135. Tshikalange TE, Meyer JJM, Hussein AA. Antimicrobial activity, toxicity and the isolation of a bioactive compound from plants used to treat sexually transmitted diseases. J Ethnopharmacol. 2005, 96:515–9. 10.1016/j.jep.2004.09.057
136. Kolawole O, Isyaka M, Dahiru M, et al. Chemical constituents of leaves of Senna singueana (Del.) lock. J Pharmacogn Phytochem. 2021, 10:131–6. 10.22271/phyto.2021.v10.i1b.13299
137. Hiben MG, Sibhat GG, Fanta BS, et al. Evaluation of Senna singueana leaf extract as an alternative or adjuvant therapy for malaria. J Tradit Complement Med. 2016, 6:112–7. 10.1016/j.jtcme.2014.11.014
138. Gebrelibanos M. In vitro Erythrocyte Haemolysis Inhibition Properties of Senna singueana Extracts. Momona Ethiop J Sci. 2012, 4:16. 10.4314/mejs.v4i2.80113
139. Zenebe G, Zerihun M, Solomon Z. An ethnobotanical study of

medicinal plants in Asgede Tsimbila District, Northwestern Tigray, Northern Ethiopia. Ethnobot Res Appl. 2012, 10:305–20. 10.17348/era.10.0.305-320
140. Yemane B, Berhane Y, Surender Reddy DK. Ethnobotanical Study of Medicinal Plants in Sub region Logo Anseba, Region Gash Barka, Eritrea. IOSR J Pharm Biol Sci. 2016, 11:63–73. 10.9790/3008-1104046373
141. Mairaira, Pierre J, Omam O, Bougolla DP, et al. Anxiolytic Effects of Senna singueana in Mice after Exposure to Chronic Restraint-Stress. Int J Brain Cogn Sci. 2018, 7:36–41. 10.5923/j.ijbcs.20180702.02
142. Adedoyin B, Muhammad A, Dangoggo SM, et al. Chemical Composition and Bioactivity of the Essential Oil of Cassia singueana Flowers Growing in Nigeria. Pharm Biomed Res. 2019, 5:1–7. 10.18502/pbr.v5i3.2110
143. Mokua SK, Mbaria JM, Maitho TE, et al. Ethnobotanical Documentation, Phytochemical Screening, and Cytotoxicity Evaluation of Medicinal Plants Used to Manage Snakebite Envenomation in Mwingi West Subcounty, Kenya. Evidence-Based Complement Altern Med. 2021, 2021:1–12. 10.1155/2021/4167296
144. Momoh H, Olaleye AA, Ibrahim SM, et al. Evaluation of Phytochemicals and Antimicrobial Activities of Cassia singueana Root Extracts. Dutse J Pure Appl Sci (DUJOPAS),. 2021, 7:16–21.
145. Ibrahim MA, Habila JD, Koorbanally NA, et al. α-Glucosidase and α-Amylase inhibitory compounds from three African medicinal plants: An enzyme inhibition kinetics approach. Nat Prod Commun. 2017, 12:1125–8. 10.1177/1934578x1701200731
146. Adedoyin BA, Adeniran OI, Muhammed AB, et al. Isolation and characterization of propitious bioactive compounds from Cassia singueana L. Adv Med Plant Res. 2020, 8:89–100. 10.30918/ampr.84.20.027
147. Mukungu N, Abuga K, Okalebo F, et al. Medicinal plants used for management of malaria among the Luhya community of Kakamega East sub-County, Kenya. J Ethnopharmacol. 2016, 194:98–107. 10.1016/j.jep.2016.08.050
148. Israel A, Sisay T, Fikre M, et al. Phytochemical analysis of the roots of Senna didymobotrya. J Med Plants Res. 2015, 9:900–7. 10.5897/jmpr2015.5832
149. Anthoney Swamy Thangiah, Mutuku Chrispus Ngule OJK. Phytopharmacological Analysis of Methanolic-Aqua Extract (Fractions) of Senna Didymobotrya Roots. Int J Bioassays. 2013, 02:1473–9.
150. Kipkore W, Wanjohi B, Rono H, et al. A study of the medicinal plants used by the Marakwet Community in Kenya. J Ethnobiol Ethnomed. 2014, 10:1–22. 10.1186/1746-4269-10-24
151. Nyamwamu LB, Ngeiywa M, Mulaa M, et al. Phytochemical constituents of Senna didymobotrya fresen irwin roots used as a traditional medicinal planta in Kenya. Int J Educ Res. 2015, 3:1–12.
152. Omara T. Antimalarial Plants Used across Kenyan Communities. Evidence-based Complement Altern Med. 2020, 2020:. 10.1155/2020/4538602
153. Mining J, Lagat ZO, Akenga T, et al. Bioactive metabolites of Senna didymobotrya used as biopesticide against Acanthoscelides obtectus in Bungoma , Kenya. J Appl Pharm Sci. 2014, 4:56–60. 10.7324/JAPS.2014.40910
154. Mak YW, Chuah LO, Ahmad R, et al. Antioxidant and antibacterial activities of hibiscus (Hibiscus rosa-sinensis L.) and Cassia (Senna bicapsularis L.) flower extracts. J King Saud Univ - Sci. 2013, 25:275–82. 10.1016/j.jksus.2012.12.003
155. Jaca T. Senna didymobotrya (Fabaceae : Caesalpinioideae): Northwestern , east and southern Africa, and Madagascar. Flower Plants Africa. 2017.
156. Ruffo CK, Birnie A, Tenganäs B. Edible Wild Plants of Tanzania. 2002.
157. Boulogne I, Germosén-Robineau L, Ozier-Lafontaine H, et al. TRAMIL ethnopharmalogical survey in les Saintes (Guadeloupe, French West Indies): A comparative study. J Ethnopharmacol. 2011, 133:1039–50. 10.1016/j.jep.2010.11.034
158. Missoum A. An update review on Hibiscus rosa sinensis phytochemistry and medicinal uses. J Ayurvedic Herb Med. 2018, 4:135–46.
159. Alhumaydhi FA. In vivo analgesic, muscle relaxant, sedative and toxicological studies of Senna bicapsularis (L.) Roxb . J Taibah Univ Sci. 2021, 15:340–6. 10.1080/16583655.2021.1978806
160. Jothy SL, Torey A, Darah I, et al. Cassia spectabilis (DC) Irwin et Barn: A Promising Traditional Herb in Health Improvement. Molecules. 2012, 17:10292–305. 10.3390/molecules170910292
161. Selegato DM, Monteiro AF, Vieira NC, et al. Update: Biological and chemical aspects of Senna spectabilis. J Braz Chem Soc. 2017, 28:415–26. 10.21577/0103-5053.20160322
162. Viegas C, Silva DHS, Pivatto M, et al. Lipoperoxidation and cyclooxygenase enzyme inhibitory piperidine alkaloids from Cassia spectabilis green fruits. J Nat Prod. 2007, 70:2026–8. 10.1021/np070312g
163. Bum EN, Nkantchoua GN, Njikam N, et al. Anticonvulsant and Sedative Activity of Leaves of Senna spectabilis in Mice. Int J Pharmacol. 2010, 6:123–8. 10.3923/ijp.2010.123.128
164. Karau GM, Nyagah E, Njagi M, et al. Phytonutrients, Minerals and in vitro Antioxidant Capacity of Leaf and Stem Bark Powders of Senna spectabilis. IC J J Pharmacogn Phytochem. 2013, 8192:2668735–5.
165. Torey A, Vijayarathna S, Jothy SL, et al. Exploration of the anticandidal mechanism of Cassia spectabilis in debilitating candidiasis. J Tradit Complement Med. 2016, 6:97–104. 10.1016/j.jtcme.2014.11.017
166. Fo S, Mgv S, Gs C, et al. Central Nervous System Effects of Iso-6-spectaline Isolated from Senna Spectabilis var . Excelsa (Schrad) in Mice. J Young Pharm. 2011, 3:232–6. 10.4103/0975-1483.83772
167. Bolzani V da S, Valli M, Pivatto M, et al. Natural products from Brazilian biodiversity as a source of new models for medicinal chemistry. Pure Appl Chem. 2012, 84:1837–46. 10.1351/PAC-CON-12-01-11
168. Pereira RM, Ferreira-Silva GÁ, Pivatto M, et al. Alkaloids derived from flowers of Senna spectabilis, (-)-cassine and (-)-spectaline, have antiproliferative activity on HepG2 cells for inducing cell cycle arrest in G1/S transition through ERK inactivation and downregulation of cyclin D1 expression. Toxicol Vitr. 2016, 31:86–92. 10.1016/j.tiv.2015.11.018
169. De Castro AT, Castro AP, Silva MS, et al. In vitro evaluation of the schistosomicidal effect of the extracts, fractions and major 3-hydroxy-2,6-dialkyl-substituted piperidine alkaloids from the flowers of Senna spectabilis (Fabaceae). Bioorganic Med Chem Lett. 2016, 26:4197–204. 10.1016/j.bmcl.2016.07.058
170. Ogbiko C. Phytochemical, GC-MS Analysis and Antimicrobial Activity of the Methanol Stem Bark Extract of Cassia siamea (Fabaceae). Asian J Biotechnol. 2019, 12:9–15. 10.3923/ajbkr.2020.9.15
171. Smith, . YR. Determination of Chemical Composition of Senna-

siamea (Cassia Leaves). Pakistan J Nutr. 2009, 8:119–21.
172. Patil SH, Kurlapkar DD, Gaikwad DK. Phytochemical Characterization of Natural Dye Extracted from Senna siamea Pods. Int J PharmTech Res. 2020, 07:1–11. 10.4236/oalib.1106148
173. Kamagaté M, Koffi C. Ethnobotany, phytochemistry, pharmacology and toxicology profiles of Cassia siamea Lam. J Phytopharm. 2014, 3:57–76.
174. Venkateshwar Chinna SKR. Quantitative Analysis of Phytochemicals in the Bark Extracts of Medicinally Important Plant Cassia fistula, Linn. Int J Curr Microbiol Appl Sci. 2017, 6:1073–9. 10.20546/ijcmas.2017.604.133
175. Nas F., Oyeyi TI, Ali M. Antibacterial efficacy and phytochemical screening of Senna siamea leaves extracts on some pathogenic bacteria. J Microbiol Exp. 2018, 6:159–63. 10.15406/jmen.2018.06.00208
176. Morita H, Oshimi S, Hirasawa Y, et al. Cassiarins A and B, novel antiplasmodial alkaloids from Cassia siamea. Org Lett. 2007, 9:3691–3. 10.1021/ol701623n
177. Oshimi S, Tomizawa Y, Hirasawa Y, et al. Bioorganic & Medicinal Chemistry Letters Chrobisiamone A , a new bischromone from Cassia siamea and a biomimetic transformation of 5-acetonyl-7-hydroxy-2-methylchromone into cassiarin A. Bioorganic Med Chem Lett. 2008, 18:3761–3. 10.1016/j.bmcl.2008.05.041
178. Deachapunya C, Poonyachoti S, Thongsaard W, et al. Barakol extracted from cassia siamea stimulates chloride secretion in rat colon. J Pharmacol Exp Ther. 2005, 314:732–7. 10.1124/jpet.105.084210
179. Matsumoto T, Kobayashi T, Ishida K, et al. Vasodilator effect of cassiarin a, a novel antiplasmodial alkaloid from Cassia siamea, in rat isolated mesenteric artery. Biol Pharm Bull. 2010, 33:844–8. 10.1248/bpb.33.844
180. Kaur G, Alam MS, Jabbar Z, et al. Evaluation of antioxidant activity of Cassia siamea flowers. J Ethnopharmacol. 2006, 108:340–8. 10.1016/j.jep.2006.05.021
181. Kaur D, Jain A, Verma A. Phytochemical and Pharmacological Investigation of Cassia Siamea Lamk: An Insight. Nat Prod J. 2017, 7:. 10.2174/2210315507666170509125800
182. Kayalvizhi V, Antony U. Microbial a nd physico-chemical changes in tomato juice subjected to pulsed electric field treatment. African J Agric Res. 2011, 6:6348–53. 10.5897/A
183. Alayo MA, Femi-Oyewo MN, Bakre LG, et al. Larvicidal Potential and Mosquito Repellent Activity of Cassia Mimosoides Extracts. Southeast Asian J Trop Med Public Health. 2015, 46:596–601.
184. Ekwueme FN, Oje OA., Nwodo OFC., et al. Anti-inflammatory capacity of the aqueous leaf extract of Senna mimosoides on inhibition of rat oedema, platelet aggregatory activity and prostaglandin synthase activity. J Med Plants Res. 2011, 5:3028–36. 10.13140/2.1.2487.3607
185. Fichadiya G, Harisha CR. Detailed Pharmacognostical Evaluation of Root of Cassia Mimosoides L. Along With the Whole Plant Powder Microscopy. World J Pharm Res. 2017, 756–65. 10.20959/wjpr20175-8329
186. Yang Y, He P, Zhang J, et al. Induction of callus in Cassia mimosoides. E3S Web Conf. 2020, 189:2–6. 10.1051/e3sconf/202018902017
187. Liu X, Yang Z, Li H, et al. Chrysophanol Alleviates Metabolic Syndrome by Activating the SIRT6/AMPK Signaling Pathway in Brown Adipocytes. Oxid Med Cell Longev. 2020, 2020:. 10.1155/2020/7374086
188. Chhapola V, Kanwal SK, Sharma AG, et al. Hepatomyoencephalopathy secondary to Cassia occidentalis poisoning: Report of three cases from North India. Indian J Crit Care Med. 2018, 22:454–6. 10.4103/ijccm.IJCCM_85_18
189. Saidu AN, Aina EO, Mann A, et al. The effect of aqueous extract of Senna occidentalis leaves on rats infected with Salmonella typhi. Aust J Basic Appl Sci. 2011, 5:1863–7.
190. Malviya R, Sharma R. Kasamarda (Senna Occidentalis Linn): Ayurvedic Approach. J Pharm Sci Innov. 2013, 2:25–7. 10.7897/2277-4572.02214
191. Lombardo M, Kiyota S, Kato ETM, et al. Evaluation of in vitro biological properties of senna occidentalis (L.) link. Acta Sci - Biol Sci. 2015, 37:9–13. 10.4025/actascibiolsci.v37i1.22525
192. Manikandaselvi S, Vadivel V, Brindha P. Review on nutraceutical potential of cassia occidentalis L. – An indian traditional medicinal and food plant. Int J Pharm Sci Rev Res. 2016, 37:141–6.
193. Singh VV, Jain J, Mishra AK. Determination of antipyretic and antioxidant activity of Cassia occidentalis linn methanolic seed extract. Pharmacogn J. 2014, 9:913–6. 10.5530/pj.2017.6.143
194. Issa TO, Mohamed Ahmed AI, Mohamed YS, et al. Physiochemical, Insecticidal, and Antidiabetic Activities of Senna occidentalis Linn Root. Biochem Res Int. 2020, 2020:. 10.1155/2020/8810744
195. Mehta JP, Davariya VS, Parmar PH. An antimicrobial activity of anthraquinones from Cassia occidentalis. Int J Chem Sci. 2012, 10:413–9.
196. Mohammed OE, Rahman A, Mahdi AEL. Autecology and biology of Senna (cassia italica mill) desert plants. Assiut J Agric Sci. 2008, 39:(11-24.
197. Masoko P, Gololo SS, Mokgotho MP, et al. Evaluation of the antioxidant, antibacterial, and antiproliferative activities of the acetone extract of the roots of Senna italica (fabaceae). Afr J Tradit Complement Altern Med. 2010, 7:138–48.
198. Shunmuga Jothi R, Bharathy V, Uthayakumari F. Antioxidant potential of aerial part of senna italica sub species micrantha mill. J Pharm Sci Res. 2015, 7:621–5.
199. Mahmuda A, Sani M, Adamu T, et al In vivo Anthelminthic Activity of Ethanolic Leaf Extract of Senna italica on Rats with Hymenolepis diminuta Infection. Adv Res. 2020, 21:18–27. 10.9734/air/2020/v21i830223
200. Qari SH, Alrefaei AF, Filfilan W, et al. Exploration of the medicinal flora of the aljumum region in Saudi Arabia. Appl Sci. 2021, 11:. 10.3390/app11167620
201. Khalaf OM, Ghareeb MA, Saad AM, et al. Phenolic constituents, antimicrobial, antioxidant, and anticancer activities of ethyl acetate and n-butanol extracts of senna italica. Acta Chromatogr. 2019, 31:138–45. 10.1556/1326.2018.00412
202. Schmelzer GH, Gurib-Fakim A. Plant Resources of Tropical Africa. 2008.
203. Chagonda LS, Mericli AH. Screening of traditional medicinal plants from Zimbabwe for phytochemistry, antioxidant, antimicrobial, antiviral and toxicological activities. 2009.
204. Makhatsa WL. Evaluation of Antimicrobial Activity of Some Plants Used By Traditional Healers for Treatment of Microbial Infections in Kakamega District. 2007.
205. de la Estrella M, Cabezas FJ, Aedo C, et al. The Papilionoideae (Leguminosae) of Equatorial Guinea (Annobón, Bioko and Río Muni). Folia Geobot. 2010, 45:1–57. 10.1007/s12224-010-9057-6
206. Chhabra S. C., Mahunnah R. L. A. Plants Used in Traditional Medicine by Hayas of the Kagera Region , TEB. 1994, 48:121–9.

207. Sikolia SF. Medicinal Plants of Kakamega Forests and Their Consistency Applications : Opportunities and Challenges To-Date . IOSR J Pharm Biol Sci (IOSR-JPBS. 2018, 13:48–54.
208. Queensland Department of Agriculture and Fisheries. Invasive plant risk assessment: Hairy sicklepod Senna hirsuta. 2016.
209. Hidayati E, Wardani I, Susyanti D, et al. Research Journal of Pharmaceutical , Biological and Chemical Sciences Antimicrobial Assay and GC-MS Analysis of Leaves Extracts Medicinal Plant Senna hirsuta (L .). Res J Pharm Biol Chem Sci. 2020, 11:215–9.
210. Agbafor KN, Nwaka AC, Dasofunjo K, et al. Glucose-6-Phosphate Dehydrogenase Activity in Albino Rats Treated With Aqueous Extract of Fresh Leaves of Morinda Lucida. ©IDOSR Publ Int Digit Organ Sci Res. 2017, 2:10–7.
211. Ogunbanjo O, Onawumi O, Gbadamosi M, et al. Chemical speciation of some heavy metals and human health risk assessment in soil around two municipal dumpsites in Sagamu, Ogun state, Nigeria. Chem Speciat Bioavailab. 2016, 28:142–51.
212. Zeng X, Xu X, Boezen HM, et al. Children with health impairments by heavy metals in an e-waste recycling area. Chemosphere. 2016, 148:408–15. 10.1016/j.chemosphere.2015.10.078

How to cite this article: Salome Osunga, Omari Amuka, Alex K. Machocho, Albert Getabu, Martin O. Onani. Some members of genus Cassia (Senna): Their Ethnobotany, Potency and Prospects of Drug discovery. Indian J Pharm Drug Studies. 2023: 2(2) 41-62.

Funding: None *Conflict of Interest: None Stated*