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A review of medicinal, chemical, and pharmacological properties of *Cissus cornifolia* (Baker) Planch. (Vitaceae family)

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ABSTRACT

Cissus cornifolia (Baker) Planch. is a scandent shrub used as food and traditional medicine in tropical Africa. The present review compiles existing information on the medicinal uses, chemical, and pharmacological properties of *C. cornifolia.* Literature searches on the traditional, medicinal, phytochemistry, and biological activities of *C. cornifolia* were conducted using online databases which included Web of Science, Google Scholar, Scopus®, SpringerLink®, ScienceDirect®, SciELO, and PubMed®, as well as using pre-electronic literature sources obtained from the university library. The current study showed that fruits, bark, leaf sap, leaves, root bark, roots, rootstock, stem bark, and twigs of *C. cornifolia* are used against 33 human and animal ailments and diseases. The chemical evaluation of the plant revealed that it contains alkaloids, alkanes, methyl esters, steroids, triterpenoids, organoheterosilane, prenylated benzo-lactone, cardiac glycosides, catechol, coumarins, flavonoids, fatty acids, phenolics, dicarboxylic acid, saponins, terpenoids, and tannins. Ethnopharmacological evaluations showed that the crude extracts and chemical compounds isolated from the species have antifungal, antibacterial, anticonvulsant, anti-diabetic, antidiarrhoeal, anti-inflammatory, antioxidant, antiproliferative, central nervous system depressant, nematicidal and neuropharmacological activities. Detailed studies focusing on toxicological evaluations, *in vivo* studies, and clinical assessments aimed at corroborating the documented traditional medical uses of *C. cornifolia* are recommended.

INTRODUCTION

Cissus cornifolia (Baker) Planch. (Fig. 1) is a wild plant commonly used in tropical Africa as food and traditional medicine. *Cissus cornifolia*, commonly known as "black wild grape", "ivy grape", or "wild grape" belongs to the Vitaceae or the grape family. The Vitaceae family consists of about 14 genera and 910 species distributed in tropical Africa, America, Asia, and Australia [1,2]. The Vitaceae family is well-known for edible grape vines (several species of *Vitis* L. genus), this is one of the most valuable fruit species in the world in terms of its ecological, economic, and social importance [3], with the berries often fermented to produce wine. Plant species belonging to the Vitaceae family are also ecologically important as climbers or lianas in the montane, temperate and tropical forests [4]. The largest genus of the Vitaceae family is *Cissus* L. with approximately 350 species recorded in the tropical areas or regions such as east, south, west, and central Africa with about 135 species, approximately 85 species in southern Asia, the Americas with about 77 species and roughly 12 species in Australia [5]. *Cissus* species are herbaceous to woody climbers or small shrubs, occasionally succulent and fleshy with tuberous roots, corky, finely striate, often angulate stems that are constricted at nodes, and tendrils that are usually opposite the leaves [6]. Recent molecular phylogenetic research showed that the genus *Cissus* is polyphyletic, and characterized by enormous morphological diversity [5,7]. Species within the genus *Cissus* are commonly used in African traditional medicine, Ayurveda, Medieval Islamic medicine, and European and Chinese traditional medicine systems [8]. *Cissus* species have also been

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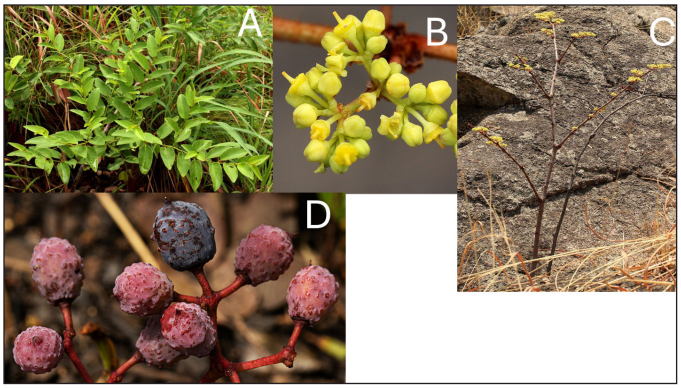

Figure 1. *Cissus cornifolia*: A: general habit of the species, B: a branch showing flowers, C: plant specimen in flower, and D: a branch showing ripe fruits) (photos: B Wursten).

reported to contain numerous phytochemical compounds such as ascorbic acid, alkaloids, terpenoids, saponins, flavonoids, sterols, quinones, phenolics, lignins, and tannins which display various pharmacological properties such as anti-inflammatory, antimicrobial, anti-diabetic, anti-ulcer, antiviral, anti-arthritic, anticancer, and antioxidant [8]. *Cissus* species widely used as sources of traditional medicines in different parts of the world include *C. aralioides* (Welw. ex Baker) Planch., *C. assamica* (M.A.Lawson) Craib, *C. populnea* Guill. & Perr., *C. pteroclada* Hayata, *C. quadrangularis* L., *C. repens* Lam., *C. rotundifolia* Lam., *C. verticillata* (L.) Nicolson & C.E.Jarvis, and *C. vitiginea* L. [8–10]. Similarly, *C. cornifolia* has been incorporated into the traditional *materia medica* in central, southern, western, and eastern Africa, characterized by a wide range of medicinal applications throughout its distributional range [11]. It is, therefore, within this background and context that this study was conducted aimed at evaluating the ethnomedicinal, chemical, and biological activities of *C. cornifolia*.

MATERIALS AND METHODS

Multiple literature searches on ethnomedicinal uses, chemical and biological activities of *C. cornifolia* were conducted from July 2023 to April 2024. This information on these aspects was obtained using online databases such as PubMed® (https://pubmed.ncbi.nlm.nih.gov/), Web of Science (https://www.webofknowledge.com), Google Scholar (https://scholar.google.com/), Scopus® (http://www.scopus.com/), SpringerLink® (https://link.springer.com/), SciELO (https://search.scielo.org/) and ScienceDirect® (https://www.sciencedirect.com/search). Additional information on the medicinal uses, and chemical and pharmacological properties of *Cissus cornifolia* was also obtained by a systematic search of various resources that are not covered by electronic databases, and these included journal papers, books, book chapters, dissertations, heses, and other scientific articles secured from the University library. The keywords used incorporated into the search included "*C. cornifolia*", the synonyms of the species "*Cissus cornifolia* (Baker) Planch.", English common names "black wild grape", "ivy grape" and "wild grape". An additional search was also conducted using the keywords "biological activities of *Cissus cornifolia*", "pharmacological properties of *Cissus cornifolia*", "ethnobotany of *Cissus cornifolia*", "medicinal uses of *Cissus cornifolia*", "phytochemistry of *Cissus cornifolia*" and "traditional uses of *Cissus cornifolia"*. The literature sources that have been included in the current review are those that evaluated the botany, taxonomy, ethnomedicinal uses, and chemical and pharmacological properties of *C. cornifolia* (Fig. 2). The literature sources excluded from the current review are those scientific publications that are partially accessible, that is, accessible only as abstracts, or published as ethnopharmacological surveys with limited information on botany, taxonomy, ethnomedicinal uses, chemical and pharmacological properties of *C. cornifolia.*

RESULTS AND DISCUSSION

Morphological description and taxonomy of *C. cornifolia*

The generic name "*Cissus*" is based on the Greek word "*kissos*", meaning "ivy", describing the climbing habit of most *Cissus* species that is also a key characteristic of "ivy", a common name for climbing *Hedera* L. species [12]. The specific name "*cornifolia*" comes from two Latin words "*cornu*" meaning "horn" and "folium" meaning "leaf" [13]. The synonyms associated with the name *C. cornifolia* (Baker) Planch. include *C. volkensii* Gilg, *C. lonicerifolia* C.A.Sm., and *Vitis cornifolia* Baker [14–21]. The English common names of *C. cornifolia* include "black wild grape", "ivy grape", and "wild grape" [22,23].

Cissus cornifolia is a scandent shrub, sometimes even a small tree, reaching 3 meters in height [24]. The plant grows from a large, tuberous, fire-resistant, and sometimes watery rootstock. The stems are woody at the base, thick, rusty, hairy, tomentose, cylindrical with swollen nodes, and only occasionally with tendrils. The leaves are alternate, simple, elliptic to ovate in shape, appearing after the flowers. The leaves of *C. cornifolia* are hairless with serrated margins, gives off a strong smell when crushed, midrib has prominent veins, apex tapering to a point, base tapering to rounded, and sometimes lobed. The flowers of *C. cornifolia* are small, bisexual, on leaf-opposed cymes on a common stalk. The fruit is ovoid, purple to black in color with a single seed [22]. *Cissus cornifolia* has been recorded in Uganda, Malawi, Benin, Sudan, Burkina Faso, Ghana, Botswana, Nigeria, Cameroon, Zambia, Chad, Central African Republic, Ethiopia, the Democratic Republic of Congo, Gabon, Ivory Coast, Guinea, Kenya, Mozambique, South Sudan, South Africa, Togo, Tanzania, and Zimbabwe [14–21] (Fig. 3). The species has been recorded in thickets, open woodland, and grassland, often on black soil and granite outcrops, sometimes in cultivated land, fallow agricultural land, and conspicuous growth observed after bush fire. *Cissus cornifolia* has been recorded from 300 m in altitude to 1,800 m above sea level [14,22,24,25].

Ethnomedicinal and traditional uses of *C. cornifolia*

Throughout tropical Africa, *C. cornifolia* have been used as food, ornamental plant, traditional medicine, fodder, and for various cultural applications. In Tanzania, *C. cornifolia* is widely used as a garden and ornamental plant and a valuable

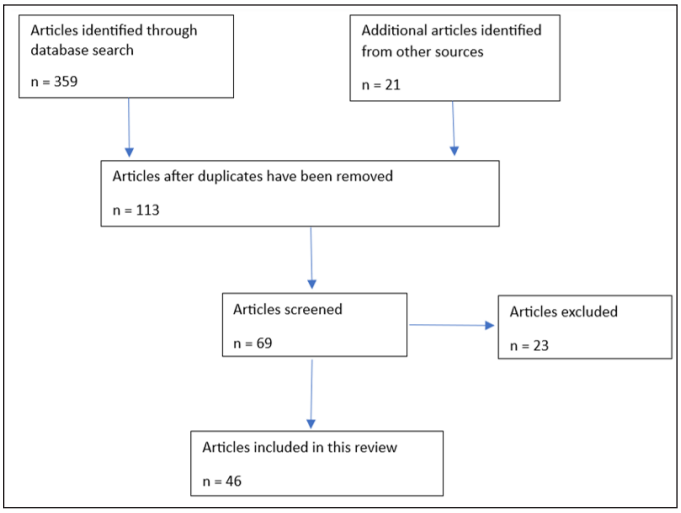

Figure 2. Flow diagram showing the identification and screening of the articles used in this review.

source of bee forage in local communities [25]. In Ethiopia, Malawi, Tanzania, and Zimbabwe, the ripe fruits that resemble commercial grapes (*Vitis* species) are eaten raw [25–31]. In Ethiopia, South Sudan, and Sudan, *C. cornifolia* is used as fodder [32]. Current reports show that *C. cornifolia* is mainly collected from the wild and not threatened with extinction is common in woodland, thickets, and grassland. For example, in South Africa, *C. cornifolia* is widespread, recorded in a wide range of habitats, characterized by a large population size, and categorized as of Least Concern on IUCN Red List Categories and Criteria [33].

In traditional medicine, the bark, fruits, leaf sap, leaves, root bark, roots, rootstock, stem bark, and twigs of *C. cornifolia* are used against 33 human and animal diseases and ailments (Tables 1 and 2). The ethnomedicinal uses of *C. cornifolia* have been documented in Botswana, Ghana, Mozambique, Nigeria, South Africa, Malawi, Tanzania, Zimbabwe, and Uganda, representing 37.5% of the countries in tropical Africa where *C. cornifolia* is indigenous. The main ailments and diseases treated by *C. cornifolia* crude extracts include its use to induce labor, and traditional medicine against diabetes, convulsions, gastro-intestinal problems, gonorrhea, hernia, malaria, respiratory problems, skin infections, and wounds (Fig. 4). This long list of medicinal uses and overlap in medicinal applications of the bark, fruits, leaf sap, leaves, root bark, roots, rootstock, stem bark, and twigs of *C. cornifolia* in Botswana, Ghana, Mozambique, Malawi, Nigeria, South Africa, Tanzania, Uganda, and Zimbabwe and this is an indication that local communities in these countries in tropical Africa have an interest in *C. cornifolia* as a source of traditional medicines. While there are still some gaps in ethnomedicinal knowledge in 62.5% of the countries were *C. cornifolia* is indigenous, it is clear that this widespread species has tremendous potential as a source of traditional medicines.

In Tanzania, the leaves of *C. cornifolia* are mixed with those of *Senna singueana* (Delile) Lock as remedy for convulsions [34,35] while in South Africa, the rootstock is mixed with roots of *Pollichia campestris* Aiton and *Ipomoea bolusiana* Schinz tubers as a remedy for foot ache [36]. In Malawi, the leaves and roots of *C. cornifolia* are mixed with those of *Cissus integrifolia* Planch., *Cissus quadrangularis, Cissus rotundifolia, Diospyros zombensis* (B.L.Burtt) F.White and *Piliostigma thonningii* (Schumach.) Milne-Redh. as remedy to induce labour [37]. In South Africa, the rootstock of *C. cornifolia* is mixed with the roots of *Harpagophythum procumbens* (Burch.) DC. ex Meisn., *Ipomoea albivenia* (Lindl.) Sweet, *Waltheria indica* L. and *Senna italica* Mill., and stem bark of *Peltophorum africanum* Sond. as traditional medicine for infertility [36]. *Cissus cornifolia* is a popular medicinal southern African, and its bark and roots are sold in informal herbal medicine markets in Malawi [38]. Similarly, the species is also listed in the monograph "Medicinal and magical plants of southern Africa: An annotated checklist" [39].

Phytochemistry and pharmacological properties of *C. cornifolia*

Qualitative chemical analyses of *C. cornifolia* root bark and leaves revealed that the species has alkaloids, steroids, triterpenoids, flavonoids, cardiac glycosides, coumarins, saponins, tannins, and terpenoids [42,44,49,51,61–65]. Similarly, various reports on the phytochemical screening of leaves, rootstock, and roots of *C. cornifolia* revealed the presence of alkanes, methyl esters, organoheterosilane, prenylated benzo-lactone, catechol, fatty acids, phenolics, and dicarboxylic acid (Table 3) which are characteristic of the root bark, leaves, rootstock and roots of *C. cornifolia*. Some of the phytochemical compounds isolated from *C. cornifolia* and its crude extracts exhibited antibacterial, antifungal, anticonvulsant, anti-diabetic, antidiarrhoeal, anti-inflammatory, antioxidant, antiproliferative, central nervous system depressant, nematicidal, and neuropharmacological activities.

Antibacterial activities

Atiku *et al.* [64] assessed antibacterial activities of the crude methanolic extracts of *C. cornifolia* leaves against *Salmonella typhi, Streptococcus pneumoniae, Staphylococcus aureus* and *Proteus vulgaris* using microdilution assay. The extract demonstrated antibacterial activities against tested pathogens with a minimum inhibitory concentration (MIC) value of 5.0 mg/ml [64]. Musa *et al.* [60] assessed antibacterial activities of the phytochemical compound 4, 6-dihydroxy-5-methoxy-3-(1,2,3,4,5-pentahydroxypentyl)-2-benzofuran-1(3H)-one identified from the rootstock of *C. cornifolia* against *S. aureus, S. typhi, Streptococcus pyogenes, Bacillus subtilis,* and *Shigella dysentriae* using agar well diffusion method with sparfloxacin and fluconazole as the positive controls. The compound demonstrated antibacterial activities against the tested pathogens exhibiting a zone of inhibition of 17.0–25.0 mm [60]. Mongalo *et al.* [59] assessed antibacterial activities of acetone, methanol, dichloromethane, ethyl acetate and hexane extracts of *C. cornifolia* rootstock against *Mycoplasma hominis, Pseudomonas aeruginosa, Escherichia coli, P. vulgaris, Enterococcus faecalis, Bacillus cereus, S. aureus, Streptococcus agalactiae* and *Moraxella catarrhalis*

Figure 3. Distribution of *C. cornifolia* in tropical Africa (map drawn using mapchart.net).

using microdilution assay with neomycin as the positive control. The extracts demonstrated antibacterial activities against tested pathogens with MIC values of 0.2–≥12.5 mg/ml [59].

Antifungal activities

Musa *et al.* [60] assessed antifungal activities of the phytochemical compound 4,6-dihydroxy-5-methoxy-3-(1,2,3,4,5-pentahydroxypentyl)-2-benzofuran-1(3H)-one identified from the rootstock of *C. cornifolia* against *Candida albicans* using agar well diffusion with fluconazole as the positive control. The compound demonstrated activities against the tested pathogen showing a zone of inhibition of 17.0 mm [60]. Mongalo *et al.* [59] assessed antifungal activities of acetone, methanol, dichloromethane, hexane, and ethyl acetate extracts of *C. cornifolia* rootstock against *Candida parapsilosis, C. albicans,* and *Cryptococcus neoformans* using the microdilution assay with amphotericin B as a positive control. The extracts demonstrated antifungal activities against the tested pathogens with MIC values of 0.2–≥12.5 mg/ml [59].

Anticonvulsant activities

Yaro *et al.* [42] assessed anticonvulsant activities of the methanol extract of *C. cornifolia* root bark using maximal electroshock test, pentylenetetrazole, strychnine and 4-aminopyridine-induced seizure models. The extracts exhibited anticonvulsant activities [42]. Yaro *et al.* [43]

Table 1. Mono-therapeutic applications of *C. cornifolia.*

Medicinal applications	Parts used	Country	Reference
Back pain	Root decoction taken orally	Zimbabwe	[40]
Bilharzia	Root decoctiodn taken orally	Tanzania	[25,41]
Cardiac problems	Root decoction taken orally	Zimbabwe	[40]
Convulsions	Leaf and root bark decoction taken orally	Nigeria	[42,43]
Diabetes	Leaf and root decoction taken orally	Nigeria and Zimbabwe	[40,44–46]
Fever	Bark decoctions taken orally	Mozambique	[47]
Gastro-intestinal problems (abdominal pains, diarrhoea and stomach ache)	Root, rootstock and twig decoction taken orally	Ghana, Tanzania and Zimbabwe	[25,40,48,49]
General medicine	Rootstock decoction taken orally	South Africa	[36]
Gonorrhoea	Root decoction taken orally	Nigeria and Zimbabwe	[40,45,50,51]
Hernia	Root and twig decoction taken orally	Ghana and Tanzania	[25,41,49]
Impotence	Leaf and root decoction taken orally	Malawi	[29]
Induce labour	Leaf and root decoction taken orally	Botswana, Malawi and South Africa	[29,52–54]
Malaria	Leaf, root and twig decoction taken orally	Ghana and Nigeria	[45,49,51]
Menstrual problems	Leaf and root decoction taken orally	Malawi	[29]
Mental problems	Leaf sap taken orally	Tanzania	[11]
Oedema	Leaf and root decoction taken orally	Malawi	[29]
Painful legs	Burnt and swollen root applied topically	Zimbabwe	[48,55]
Respiratory problems (pharyngitis and sore throat)	Bark decoction taken orally	Mozambique, Nigeria and Zimbabwe	[11,40,44,45,47]
Septic tonsils	Root decoction taken orally	Nigeria	[11,44,45]
Skin infections (boils and burns)	Bark and root paste applied topically	Mozambique and Uganda	[47,56,57]
Snake bites	Root decoction applied topically	Tanzania	[41]
Wounds (cancer, chronic wounds and injuries)	Bark, fruit, root and stem bark decoction applied topically	Malawi, Mozambique and Zimbabwe	[40,47,56,58]
Ethnoveterinary medicine	Not specified	Zimbabwe	[31]

Table 2. Use of *C. cornifolia* as traditional medicine in combination with other plant species.

Medicinal applications	Parts used	Country	Reference
Convulsions	Leaves mixed with those of *Senna singueana* (Delile) Lock	Tanzania	[34,35]
Foot ache	Rootstock mixed with roots of Pollichia campestris Aiton and Ipomoea bolusiana Schinz tubers	South Africa	[36]
Induce labour	Leaves and roots mixed with those of Cissus integrifolia Planch., C. quadrangularis, C. rotundifolia, Diospyros zombensis (B.L.Burtt) F.White and Piliostigma thonningii (Schumach.) Milne-Redh.	Malawi	[37]
Infertility	Rootstock mixed with roots of Harpagophythum procumbens (Burch.) DC. ex Meisn., Ipomoea albivenia (Lindl.) Sweet, Waltheria indica L. and Senna italica Mill., and stem bark of Peltophorum africanum Sond.	South Africa	[36]

evaluated anticonvulsant activities of methanol extracts of *C. cornifolia* leaves in chicks using the maximal electroshock assay, and in male mice by making use of 4-aminopyridine, strychnine, pentylenetetrazole, and picrotoxin induced seizure assays. The extracts exhibited activities [43].

Anti-diabetic activities

Jimoh *et al.* [44] evaluated the anti-diabetic activities of the methanol extracts of *C. cornifolia* leaves on alloxan-induced hyperglycemic in male Wistar rats. The effect of the extract on glucose levels, concentration, and histopathology of the liver and pancreas were evaluated. The methanolic extract exhibited activities by lowering the glucose level in alloxan-induced diabetic male rats [44]. Jimoh *et al.* [51] assessed the hypoglycemic properties of the methanolic extract of *C. cornifolia* leaves on blood glucose levels of normoglycemic Wistar rats. The extracts exhibited hypoglycemic activities [51]. Chipiti *et al.* [46] assessed the antidiabetic properties of ethanol

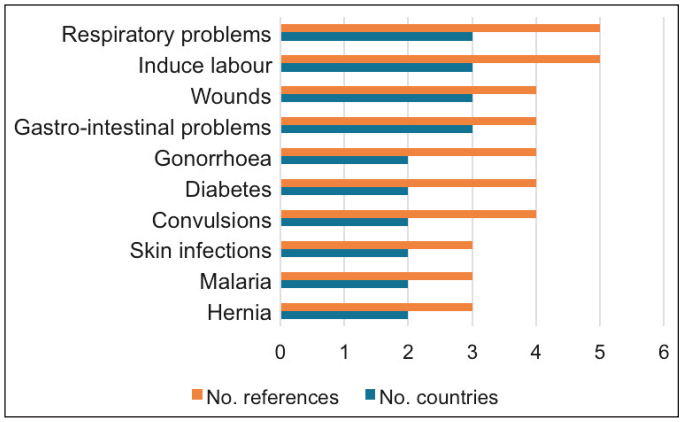

Figure 4. Main ethnomedicinal applications of *C. cornifolia* in tropical Africa.

and aqueous extract of *C. cornifolia* leaves and roots using *α*-glucosidase and *α*-amylase inhibitory assays with acarbose as the positive drug. The extracts demonstrated properties with the half maximal inhibitory concentrations (IC_{50}) value of 2.8–33.7 µg/ml [46].

Antidiarrhoeal activities

Tanko *et al.* [62] assessd the antidiarrhoeal properties of methanol extract of *C. cornifolia* leaves using castor oil-induced diarrhoeal in mice. The extract exhibited dose-dependent activities [62]. Although more tests are required, but these preliminary findings corroborate the use of root, rootstock, and twig decoction against gastro-intestinal problems in countries such as Ghana, Tanzania, and Zimbabwe [25,40,48,49].

Anti-inflammatory activities

Borquaye *et al.* [49] assessed anti-inflammatory properties of ethanol extract of *C. cornifolia* leaves by making use of the carrageenan-induced edema model of inflammation in 7-day-old chicks with diclofenac and dexamethasone as the positive controls. The extract demonstrated weak anti-inflammatory activities with half-maximal reduction in edema (ED_{50}) value of 79.4 mg/kg in comparison with 0.6 mg/kg and 10.6 mg/kg demonstrated by positive controls [49]. Mongalo *et al.* [59] assessed anti-inflammatory properties of dichloromethane, methanol, and ethyl acetate extract of *C. cornifolia* bulb using the cyclooxygenase (COX-1 and COX-2) and soybean lipoxygenase (15-LOX) assays with celecoxib and quercetin as positive controls. The extracts exhibited activities against 15-LOX) and COX-2 with IC_{50} value of 15.6–68.9 µg/ml [59]. These findings somehow corroborate the traditional applications of *C. cornifolia* crude extracts against various inflammatory diseases and ailments ranging from injury to microbial infections that lead to cell injury and death.

Antioxidant activities

Chipiti *et al.* [40] assessed the antioxidant properties of the ethanol and aqueous extract of leaves and roots of *C. cornifolia* making use of 2,2-diphenyl-1-picrylhydrazyl, ferric reducing power, hydroxyl radical scavenging and nitric oxide (NO) radical scavenging assays. The extracts exhibited activities using all four *in vitro* experimental models [40]. Borquaye *et al.* [49] assessed antioxidant properties of ethanol extract of *C. cornifolia* leaves by making use of the NO scavenging method with the ascorbic acid as a positive control. The extract demonstrated weak activities with IC_{50} value of 1,381.0 µg/ml in comparison to 23.3 µg/ml demonstrated by positive control [49].

Antiproliferative activities

Chipiti *et al.* [46] assessed the cytotoxicity properties of ethanol extracts of *C. cornifolia* leaf and roots against the HEK 293 cell lines using the tetrazolium-based colorimetric (MTT) assay. The leaf and root extracts demonstrated cytotoxicity properties with IC_{50} values of 1.6 µg/ml and 2.7 µg/ml, respectively [46]. Mongalo *et al.* [59] assessed the antiproliferative properties of methanol and ethyl acetate extracts of *C. cornifolia* bulb against the breast cancer (MCF7-21) cells using the MTT assay with doxorubicin as the positive control. The methanol and ethyl acetate extracts demonstrated cytotoxicity properties against MCF7-21 cells with IC_{50} values of 10.8 µg/ml and 24.1 µg/ml in comparison with 1.3 µg/ml demonstrated by a positive control [59].

Central nervous system depressant activities

Yaro *et al.* [65] evaluated the central nervous system depressant activities of aqueous, chloroform, ethyl acetate, and methanol fractions *C. cornifolia* leaves in male mice by making use of the head-dip, diazepam-induced sleep, and motor-coordination assays. The fractions exhibited the central nervous system depressant activities [65].

Nematicidal activities

Nyoni *et al.* [66] assessed nematicidal properties of aqueous and acetone extracts of *C. cornifolia* root against *Meloidogyne javanica* in *in vivo* screening. The extracts exhibited moderate and weak activities causing 53.0% and 18.0% reduction in gall formation in aqueous and acetone extracts, respectively [66]. Therefore, *C. cornifolia* has potential to be used as a biocontrol agent against insect pests.

Neuropharmacological activities

Musa *et al.* [61] assessed neuropharmacological properties of methanol extracts of *C. cornifolia* leaves in male mice by making use of diazepam sleeping time, motor coordination and exploratory behaviour models. The extract exhibited activities [61]. Yaro *et al.* [67] assessed the neuropharmacological properties of methanol extract of *C. cornifolia* roots and leaves in male mice employing diazepam-induced sleep, motor coordination, and exploratory behavior. The extracts exhibited activities [67]. Yaro *et al.* [68] evaluated the neuropharmacological activities of the butanol-soluble extracts generated from the methanol extracts of *C. cornifolia* leaves by making use of the head-dip, diazepam-induced sleep, and motor coordination assays in male mice. The extracts exhibited sedative and central nervous depressant activities [68].

Table 3. Phytochemical composition of *C. cornifolia.*

Compound	Method of phytochemical characterization	Plant part	Reference
1,3-Dioxolane	GC-ToF-MS	Rootstock	[59]
1,6-Heptadiene	GC-ToF-MS	Rootstock	[59]
2-(2',4',4',6',6',8',8'-heptamethyltetrasiloxan-2'-yloxy)-2,4,4,6,6,8,8,10,10-decamethylcyclopentasiloxane	GC-ToF-MS	Rootstock	[59]
2-(2',4',4',6',6',8',8'-heptamethyltetrasiloxan-2'-yloxy)-2,4,4,6,6,8,8,10,10-nonamethylcyclopentasiloxane	GC-ToF-MS	Rootstock	[59]
2,6-Nonadienoic acid	GC-ToF-MS	Rootstock	[59]
2-Pyrrolidinone, 1-methyl-	GC-ToF-MS	Rootstock	[59]
3-Butoxy-1,1,1,7,7,7-hexamethyl-3,5,5-tris(trimethylsiloxy)tetrasiloxane	GC-ToF-MS	Rootstock	[59]
4,6-dihydroxy-5-methoxy-3-(1,2,3,4,5-pentahydroxypentyl)-2-benzofuran-1(3H)-one	H- and C-NMR	Rootstock	[60]
5,8,11-Heptadecatriynoic acid	GC-ToF-MS	Rootstock	[59]
9-Borabicyclo[3.3.2]decan-10-ol,9-(1-oxopropoxy)-, propanoate	GC-ToF-MS	Rootstock	[59]
Butylated hydroxytoluene	GC-ToF-MS	Rootstock	[59]
Catechol	GC-MS	Roots	[40]
Hexadecane	GC-ToF-MS	Rootstock	[59]
n-Hexanoic acid	GC-MS	Roots	[40]
Hydroquinone	GC-MS	Roots	[40]
Octanedioic acid	GC-ToF-MS	Rootstock	[59]
Pyrogallol	GC-MS	Roots	[40]
Quinoline	GC-ToF-MS	Rootstock	[59]
Resorcinol	GC-MS	Roots	[40]
Spiro[2.4]hept-5-ene,5-trimethylsilylmethyl-1-trimethylsilyl-	GC-ToF-MS	Rootstock	[59]
Stigmasterol	UV, IR, H- and C-NMR	Leaves	[63]
Trisiloxane, 1,1,1,5,5,5-hexamethyl-3,3-bis[(trimethylsilyl)oxy]-	GC-ToF-MS	Rootstock	[59]
Vanillin	GC-MS	Roots	[40]

Toxicity activities

Jimoh *et al.* [44] and Yaro *et al.* [65] independently conducted toxicological studies of aqueous, chloroform, methanol, and ethyl acetate extracts of *C. cornifolia* leaves and roots by using specific doses of 1,600.0 mg/kg bw, 2,900.0 mg/kg bw and 5,000.0 mg/kg bw which were administered in Wistar rats using the intraperitoneal route and the male mice were monitored for any signs of toxicity which also included death. Results obtained from the oral acute toxicity studies showed that the median lethal dose (LD_{50}) values of all the extracts were in excess of 5,000.0 mg/kg body weight [44,65]. In addition to this, the histopathological assessment of the diabetic Wistar male rats treated with methanolic extract of *C. cornifolia* leaves exhibited the restoration of pancreatic disturbance and damage caused by the alloxan [44]. These findings seem to suggest that the leaves and roots of *C. cornifolia* to be safe and nontoxic, and therefore, an excellent candidate for clinical studies as traditional medicine [45].

CONCLUSION

The current study provides a summary of medicinal, phytochemical, and biological properties of *C. cornifolia.* Such evaluations are needed considering that *C. cornifolia* is widely used as a traditional medicine throughout tropical Africa, and it is clear that the therapeutic potential of the species is not fully realized. Literature studies show that there is a growing demand for medicinal plants such as *C. cornifolia* used as traditional medicines, nutraceuticals, and sources of complementary treatments. This is usually the case with medicinal plants that are characterized by bioactive components such as flavonoids, phenolics, methyl esters, and terpenoids which are beneficial to human health. However, the lack of standardized quality control procedures in the usage of *C. cornifolia* as traditional medicine throughout its distributional range is a major concern for regulatory authorities. Therefore, future studies should focus on detailed ethnopharmacological evaluations of the species, emphasizing phytochemical, pharmacological, toxicological, *in vivo,* and clinical research aimed at corroborating the traditional medical and food applications of the species.

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AUTHOR CONTRIBUTIONS

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work. All the authors are eligible to be an author as per the international committee of medical journal editors (ICMJE) requirements/guidelines.

CONFLICTS OF INTEREST

The author declares that there are no conflicts of interest associated with this research work.

ETHICAL APPROVALS

This study does not involve experiments on animals or human subjects.

DATA AVAILABILITY

All data generated and analyzed are included in this research article.

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USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declares that they have not used artificial intelligence (AI)-tools for writing and editing of the manuscript, and no images were manipulated using AI.

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