MedCrave
Step into the World of Research
Pharmacy & Pharmacology International Journal

Literature Review
Open Access
CrossMark

A mini-review on ethnomedical uses, chemical constituents, pharmacological activities and toxicological study of *Alchornea cordifolia* (Schum & Thonn) Muell. Arg

Abstract

Medicinal plants have played and continue to play a very important role as medicines or sources of therapeutic molecules throughout the world. Numerous people in developing countries use their therapeutic virtues to treat their health. Among those plants, *Alchornea cordiflia* is in a prominent position due to its numerous beneficial effects on both human and animal health. This plant is known in several African pharmacopoeias as an effective remedy against many diseases, including toothaches, inflammation, malaria, and worms. Advanced research on this plant has revealed a number of bioactive compounds such as cardiac glycosides, anthraquinones, polyphenols, triterpenes, and steroids, which give this plant its extraordinary pharmacological activities. Thus, many biological activities such as anti-inflammation, anticancer, antioxidant, antidiarrhoeal, antimicrobial, hepatoprotective, antiplasmodial are reported in this plant. More recently, a study has reported that this plant is included in the food chain of the *Okapia johnstoni* in the wild. Because of its composition rich in alkaloids, flavonoids, tannins, triterpenoids, an assessment of the anthelmintic activity of this plant on the intestinal worms of the *Okapia johnstoni* would be very interesting for the ex situ conservation of this emblematic animal.

Keywords: Alchornea cordifolia, pharmacologic property, compound isolated, traditional uses

Volume 10 Issue 4 - 2022

Mbembo Wa Mbembo Blaise,[1] Ndjoko Kambuya Damien,[2] Mbuyi Lunkondo Patience,[3] Masengo Ashande Colette,[4] Amogu Domondo Jean-Jacques,[1] Clarisse Falanga Mawi,[1] Koto-Te-Nyiwa Ngbolua,[1,4] Pius T Mpiana[5]

[1]Department of Biology, Faculty of Sciences, University of Kinshasa, Democratic Republic of the Congo
[2]Higher Institute of Trade of Ilebo, Democratic Republic of the Congo
[3]Research Unit in Health Development and Pedagogy, National Pedagogical University, Democratic Republic of Congo
[4]Department of Environmental Sciences, University of Gbado-Lite, Democratic Republic of the Congo
[5]Department of Chemistry, Faculty of Science, University of Kinshasa, Democratic Republic of the Congo

Correspondence: Koto-Te-Nyiwa Ngbolua, Department of Biology, Faculty of Sciences, University of Kinshasa, Kinshasa, Democratic Republic of the Congo, Tel +243 81 68 79 527, Email jpngbolua@unikin.ac.cd

Received: August 14, 2022 | **Published:** August 30, 2022

Introduction

Folk medicine is based exclusively on the use of plants endowed with therapeutic properties.[1-3] Because of their relatively easy accessibility and cheapness, medicinal plants are very important for populations in developing countries.[4,5] Several research and publications highlight that populations in developing countries are increasingly using medicinal plants for their health care.[6,7] Thus, it is notable that plants are a significant source of molecules used not only in traditional medicine, but also in modern medicine around the world.[2,8-10] This renewed interest in plant-based molecules is accentuated by the emergence of the chemoresistance phenomenon, which obliges researchers to find palliative solutions to this problem.[11,12] *Alchornea cordifolia* is counted among the plants traditionally used in the pharmacopoeia of several African countries for the treatment of various diseases such as wound, rheumatism, arthritis, pile, toothache, inflammatory, malaria, worms.[13-17] Several compounds possessing therapeutic virtues have been isolated and identified from this plant, including gallic acid (**1**), protocatechuic acid (**2**), quercetin (**3**), quercetin arabmose (**4**), Stigmasterol (**5**), Flavonoids, cardiac glycosides, anthraquinones, polyphenols, triterpenes, steroids, saponins and tannins;[18-20] these provide *A. cordifolia* with its numerous pharmacological properties, including entomotoxicant, antiplasmodial, antidiabetic, antibacterial, antifungal activities.[16,37,21]

Native of Sub-Saharan African countries, this plant belongs to the Euphorbiaceae family.[22,23] Web data certify that almost all parts of this plant (roots, bark, leaves, fruits, etc.) play a role in the treatment of many diseases.[24-26] In addition to being counted among the most widely used medicinal plants in Africa for human health, this plant is also found to be one of the most prized by the iconic *Okapia Johnstoni*, an endemic species of the Democratic Republic of the Congo.[28] The Okapi's choice of this plant is not trivial, but is thought to be motivated by the need for self-care.[27,28] Literature shows that *A. cordifolia* is rich in secondary metabolites such as Stigmasterol, stigmasta-4,22-dien-3-one, friedelin, methylgallate, L-chicoric acid, alkaloids, flavonoids, tannins, triterpenoids and triterpen glycoside,[18,29-35] which confer anthelmintic properties to many plants.[36] The aim of this review is to collect data on *A. cordifolia*, a plant species which is part of the Okapi diet in the wild which will help to guide future researchers on the investigation into the structure and reactivity of biologically secondary metabolites for controlling gastrointestinal helminths of Okapi in order to ensure its survival in captivity.

Literature review method

The information presented here is derived from scientific articles published in English or French that were found using Internet search engines such as Google Scholar, PubMed/Medline, Science Direct, Scopus, and any other useful search engine. The keyword *Alchornea cordifolia* was used alone or associated with any biological activity, with time restriction, from 1990 until now. In total, 120 articles were downloaded from scientific engines, but only 75 items that focused on at least one biological activity and/or on the chemical composition of

A. cordifolia were selected. Finally, the selected papers were divided and classified according to the type of biological activity.

Botanical description of *Alchornea cordifolia*

Alchornea cordifolia (Shum & Thon.) is a small tree or shrub growing in swampy or dry areas, which can reach 5 m high and approximately 30 cm in circumference. This tree is sometimes climbing or erect with stems armed with blunt spines. The leaves are long-stalked and broadly oval. The flowers are greenish in hanging clusters measuring 30 cm in length, grouped in spikes or racemes. Regarding the fruits, they are two-celled, small, stellate and pubescent. This plant can reproduce both by seed and by cuttings.[14,30,37,38]

Taxonomical classification of *A. cordifolia*

Kingdom: Plantae

Clade: Angiosperme

Class: Magnoliopsida

Order: Malpighiales

Family: Euphorbiaceae

Subfamily: Acalyphoideae

Genus: *Alchornea*

Species: *Alchornea cordifolia* (Schumach. & Thonn.) Müll. Arg (Figure 1).[39]

Figure 1 *A. cordifolia* parts (A: Fruits; B: Leaves; C: Flowers).

Ethno-medicinal knowledge

Table 1 presents a description of the data collected during the ethnopharmacological survey on the Internet. It contains information including the names of the parts used, vernacular names, traditional uses, formulations/method of administration and references for each country. The results show that the leaves were the most used parts, followed by the stem bark. Several authors defended the leaves as the most commonly used component in traditional medical remedies all over the world. Moshi et al.[40] stipulated that the frequent use of leaves would be associated with their relatively easy access compared to other aerial plant parts in nature. Furthermore, the same result (Table 1) shows that decoction is the most commonly used formulation method, followed by infusion. It is stated that decoction is the method of preference when working with tough and fibrous plants, barks and roots, as well as plants with water soluble chemicals.[41]

Table 2 describes compounds isolated and characterized from *A. cordifolia*. Some of those compounds are drawn by using the ChemBioDraw Ultra 12.0 software package (Figure 2).

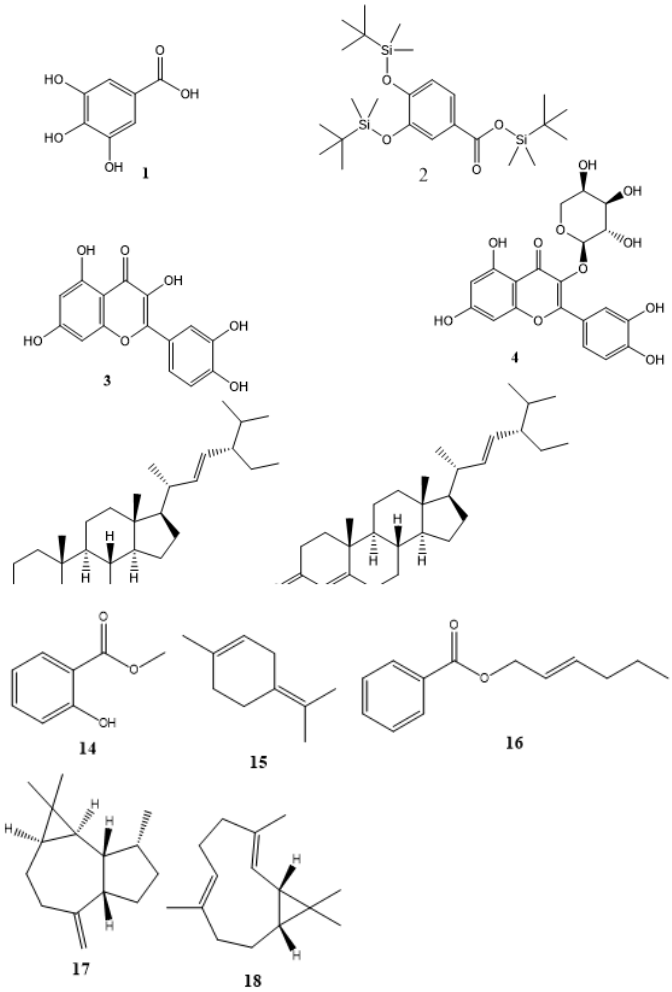

Figure 2 Structures of some significant compounds from *A. cordifolia* (Chem BioDraw Ultra 12.0 software package)

In relation to various medicinal uses, *A. cordifolia* is reported in the treatment of several pathologies in humans, including cold, cough and diarrhea, feverish chills, rheumatic pains, sores, sore feet, gastrointestinal disorders, respiratory and urinary tract infections in different countries.

Phytochemistry

Several bioactive compounds were isolated and characterized from *A. cordifolia* such as gallic acid (**1**), protocatechuic acid (**2**),

quercetin (**3**), quercetin arabmose (**4**), Stigmasterol (**5**), tigmasta-4,22-dien-3-one (**6**), Friedelin (**7**), Friedelane-3-one-28-al (**8**), 3-o-acetyl-erythrodiol (**9**), Methyl gallate (**10**), L-chicoric acid (**11**), O- acetyl-aleuritolic acid (**12**), Myricentin-3-O-β-D-glucopyranoside (**13**), Methyl salicylate (**14**); terpinolene (**15**); (E)-2-Hexenyl benzoate (**16**); Alloaromadendrene (**17**); Bicyclogermacrene (**18**).[20,58,59]

Table 1 Traditional uses of the different parts of *A. cordifolia*

Part(s) used	Vernacular names	Traditional uses	Formulation/method of administration	Countries	References
Leaves	Ewe ipa, Ubobo and Bambami	Rheumatic pains, problems of convulsion, fever, wounds and diarrhea	Decoction	Nigeria	Adeneye et al.,[42]
Leaves		Gonorrhoea, yaws, rheumatic pain and cough		Nigeria	Adeshina et al.,[43]
Leaves	Ububo, ipaesinyin, banbani	Cold, rheumatism, arthritis, muscle pains, against poison		Nigeria	Ebenyi et al.,[37]
Leaves		Sore throat, cough, bronchitis, venereal diseases, female sterility, gastric ulcers, diarrhoea, amoebic dysentery and worms		Nigeria	Okoye et al.,[44]
Leaves		Cold, cough and diarrhea, feverish chills, rheumatic pains, sores, sore feet, gastrointestinal disorders, respiratory and urinary tract infections	Decoction	Nigeria	Eliakim-ikechukwu & Obri[45]
Leaves		Urinary, respiratory and gastro intestinal disorders, asthma, cough and skin infections	Decoction	Nigeria	Okwu & Ukanwa[46]
Stem Bark		Fever, rheumatic pains, as a purgative, and leprosy		Nigeria	Ajali[47]
Leaves		urinary, respiratory, gastrointestinal disorders and cough		Cameroon	Agbor et al.,[38]
Stem Bark		Bacteria, fungi, parasitic, inflammatory disorder, ulcers, wounds and for cicatrisation		Nigeria	Emudainohwo et al.,[48]
Leaves and stem bark	Aboe, Bondji (or Dibobunji)	Intestinal ailments and gonorrhea, anaemia, dermatitis, malaria, dysentery, toothache, Stomach pains and tooth aches	Maceration	Cameroon	Noundou et al.,[20]
Leaves		chancre, yaws, wounds, cicatrisation, ulcers, caries and toothache		Congo(DRC)	Manga et al.,[49]
Leaves		Malaria	Decoction	Ivory Coast	Banzouzi et al.,[50]
Leaves		Cough, gonorrhoea, ulcers, rheumatic, pains, fever, wounds and diarrhoea	Decoction	Nigeria	Umukoro & Aladeokin[51]
Leaves		Sore throat, cough, bronchitis, gastric ulcers, diarrhea, amoebic dysentery, worms, wounds, leprosy and snake venom	Infusion	Cameroon	Njila et al.,[17]
Leaves		Anti-inflammatory, antibacterial and antifungal		Nigeria	Osadebe et al.,[52]
Leaves		Colds, bronchial problems, stomachache, dysmenorrheal, fever and eye problems	Infusion/decoction	Nigeria	George et al.,[53]
Leaves		Diarrhea, pains of the chest, cough, anemia, urinary tract infections, infected wounds, skin diseases, dental caries and diabetes	Infusion/decoction	Congo(DRC)	Muanza et al.,[54]
Leaves		Pain, rheumatism, arthritis, pile, toothache, inflammatory disease, wound, cold, cough, diarrhoea	Decoction/ infusion/ maceration	Nigeria	Osadebe & Okoye[34]

Table 2 Secondary metabolites isolated/ identified, biological activities and type of study in *A. cordifolia*

Compound	Part used	Extract	References
Tannins, flavonoids, glycosides, resins and carbohydrates	Leaves	Hexane, ethyl acetate and methanol	Adeshina et al.,[30]
Tannin, alkaloid, anthraquinone and saponin	Leaves	Aqueous and ethanol	Adeleye et al.,[31]
5' methyl 4' propenoxy anthocyanidine 7-O-β-D-diglucopyranoside, 5'-methyl 4', 3, 5, 7- tetrahydroxy anthocyanidines	Leaves	Ethanol	Okwu & Ukanwa[46]
Alkaloids, flavonoids, saponins, steroidal glycosides, tannins and terpenoids	Stem bark	Petroleum ether, acetone, methanol, ethanol	Ajali[47]
Stigmasta-4,22-dien-3-one, friedelin, friedelane-3-one-28-al, 3-O-acetyl-aleuritolicacid, 3-O-acetyl-erythrodiol andmethyl-3,4,5-trihydroxybenzoate(methylgallate)	Leaves and stem bark	Hexane,chloroform, ethyl acetate, ethanol ,methanol and aqueous	Noundou et al.,[20]
Flavonoids, cardiac glycosides, anthraquinones, polyphenols, triterpenes, steroids, saponins and tannins	Bark	Aqueous, methanol, acetone and hexane	Gatsing et al.,[18]
Tannins and flavonoids	Leaves	Ethanol	Agbor et al.,[38]
Flavonoids (hyperoside and quercitrin, quercitrin) and tannin	Leaves	Aqueous decoction and methanol	Manga et al.,[49]
Ellagic acid	Leaves	Chloroformic, ether and ethanol	Banzouzi et al.,[50]

Citation: Blaise MWM, Damien NK, Patience ML, et al. A mini-review on ethnomedical uses, chemical constituents, pharmacological activities and toxicological study of *Alchornea cordifolia* (Schum & Thonn) Muell. Arg. *Pharm Pharmacol Int J.* 2022;10(4):139–147. DOI: 10.15406/ppij.2022.10.00376

Table Continued...

Compound	Part used	Extract	References
Alkaloids, flavonoids, saponins and tannins	Leaves	Methanol	Osadebe et al.,[52]
Flavonoids, tannins and alkaloids	Leaves	Aqueous	Effo et al.,[60]
Quercetin, myricetin-3-glucopyranoside, myricetin-3-rhamnopyranoside, proanthocyanidin A2	Leaves	Aqueous and ethyl acetate	Kouakou-Siransy et al.,[61]
N1, N2-diisopentenyl guanidine and N1,N2,N3-triisopentenyl guanidine	Root bark	Aqueous, chloroform and ethyl acetate	Manga et al.,[62]
Polyphenol and total flavonoids	Leaves	Ethanol	Adépo et al.,[63]
Terpenoids, steroid, glycosides, flavonoids, tannins, saponins, alkaloid, anthraquinone, coumarins and emodin	Leaves	Methanol	Komolafe et al.,[32]
Tannin, saponin, flavonoid, cardiac glycoside and anthraquinone	Leaves	Ethanol	George et al.,[53]
Alkaloids, anthocyanins, anthraquinones, coumarins, flavonoids, phenols, saponins, steroids, tannins and terpenoids	Leaves	Aqueous	Adeneye et al.,[42]
Terpenes, sterols, flavonoids, tannins, carbohydrates, glycosides, saponins and traces of alkaloid	Leaves	Methanol	Osadebe & Okoye[34]
Gallic acid, protocatechuic acid, quercetin, quercetin arabmose, galactose glycosides, triisopentenyl guanidine	Leaves	Methanol	Lamikanra et al.,[19]
Tannins and flavonoids	Leaves	Aqueous	Nga et al.,[35]

Toxicological studies

The subchronic toxicity of a total aqueous extract of leaves of *Alchornea cordifolia* was assessed for 28 and 60 days in rats. The final result concluded that the total aqueous extract of *Alchornea cordifolia* is not toxic by once-a-day administration. The daily treatment with *A. cordifolia* did not significantly alter the body weight of the animals, neither did it affect the vital organs. Thus, kidney, heart and liver function were not affected by administration of *A. cordifolia* and are not toxic at the drug doses of 100 mg/kg bw, 200 mg/kg bw and 400 mg/kg bw in rats.[55]

Ansah et al.,[56] evaluated the effect of ethanolic extract of *A. cordifolia* on cells and blood chemistry, histology and relative weight of some organs in mice. It was concluded that the treatment of rats with the extract of *Alchornea cordifolia* in doses ranging from 250-2000 mg/kg daily for a period of two weeks did not significantly affect the weight of vital organs, neither the blood cells nor the renal function. The histological section of the liver and kidney for the dose reaching 1000 mg/kg was normal compared to that of the vehicle-treated controls. However, for mice treated with the dose of 2000 mg/kg, the liver sections of the mice showed some damage to the liver.

A study was carried out to evaluate the effects of methanolic extract of *A. cordifolia* leaf on some reproductive and hematological parameters of male rats. The toxicological results of the extract at the dose of 1600 mg/kg showed some non-significant alterations in white blood cells, while there was a significant decrease in the number of erythrocytes, blood volume, hemoglobin concentration and hematometric indices. Doses of 200 and 400 mg/kg caused a significant increase in testicular weight, sperm count and motility, and serum testosterone levels.[26]

Umukoro & Aladeokin,[51] assessed the anti-stress and anticonvulsant activities of the aqueous leaf extract of *Alchornea cordifolia* in mice for 24 h after treatment. The result of acute toxicity conducted in mice showed that the extract was well tolerated by the animals, because there was no death observed at oral doses of 500-4000 mg/kg.

Gatsing et al.,[18] evaluated the antibacterial activities of four extracts (aqueous, methanol, acetone and hexane) of *Alchornea cordifolia* against *Salmonella typhi*, *Salmonella paratyphi* A and *Salmonella paratyphi* B, using the agar diffusion and broth dilution methods. The main results showed the high activity of aqueous, methanol and acetone extracts against *S. typhi* with respective diameters of 24, 23 and 25 mm as inhibition zone diameters, secondly, 24, 24 and 25 mm respectively as inhibition zone diameters against *S. paratyphi* A and finally, 24, 24 and 26 mm respectively as inhibition zone diameters against *S. paratyphi* B. While there was no activity of hexane extract on the three bacterial strains used.

Ezeokeke et al.,[57] investigated the sub-acute toxicity of aqueous and ethanolic leaf extract of *Alchornea cordifolia* in Swiss albino rats. The authors concluded that the doses ranging from 0.125 to 0.75 g/kg administered daily to mice for a period of two weeks did not significantly affect relative organ weights, blood composition, or renal function. Histological analyses of the liver and kidneys at doses up to 0.5 g/kg were normal and identical to those obtained with vehicle-treated controls. However, cloudy swelling of hepatocytes with vascular degeneration was observed in liver sections of animals after treatment with ethanolic extract of *A. cordifolia* leaves at the dose of 0.75 g/kg.

Pharmacological potential of crude extracts, fractions, and essential oils

Antimicrobial activity

Lamikanra et al.,[19] tested the antibacterial activities of methanolic extracts of *A. cordifolia* leaves. The results reported the highest activity of gallic acid, protocatechuic acid and triisopentenyl guanidine. The aqueous ethanol extract (50%) of Alchornea cordifolia (Schum and Thonn) Muell. Arg. leaf was assessed for activity against 74 microbial strains (aerobic, facultative and anaerobic bacteria as well as fungi). A higher activity of the extract on gram-positive bacteria and yeasts was noticed with concentrations against these pathogenic organisms below 5 mg/mL.[58]

Adeshina et al.,[30] carried out an antimicrobial study of the ethyl acetate extract of Alchornea cordifolia leaf. Results demonstrated that all the fractions possessed antimicrobial effects against the test organisms. In addition, the MIC (minimum inhibitory concentration) and the MBC (minimum bactericidal concentration) of the extract against the test microbial strains ranged between 0.625-10 mg/mL.

Ebenyi et al.,[37] reported antibacterial activity of *Alchornea cordifolia* aqueous and ethylacetate leaves extracts. The final results of this study showed that *A. cordifolia* aqueous and ethylacetate leaves extracts were high inhibitory effects; it was concluded that the activity was bacteriostatic on some organisms and bacteriocidal on others.

A study was carried out to investigate the antibacterial activity of the methanol and chloroform extracts from *A. cordifolia* leaves. The result concluded that the concentrations of 50 mg/mL from methanol extract possessed a high antibacterial effect on the main strains tested, while only the concentration of 200 mg/mL from chloroform extracts showed high activity against the pathogens tested.[44]

Adeshina et al.,[43] investigated the antimicrobial activity of the aqueous and ethyl acetate sub-fractions of *A. cordifolia* leaf against the standard microorganisms (Pseudomonas aeruginosa ATCC 10145, Staphylococcus aureus ATCC 12600, Escherichia coli ATCC 11775, and Candida albicans ATCC 18804). The results demonstrated that both fractions of the methanol extract, ethyl acetate and residual aqueous fractions, exhibited antimicrobial activity against all standard pathogens. Additionally, the ethyl acetate fraction showed the highest effect against Staphylococcus aureus (ATCC 12600) with a zone of inhibition of 27 mm, MIC (Minimum Inhibitory Concentration) of 1.25 mg/ml and MBC (Minimum Bactericidal Concentration) of 2.5mg/ml.

Ethanolic and aqueous extracts of leaves from tree plants (*Alchornea cordifolia*, *Boerhavia diffusa* and *Bridellia micrantha*) were reported for antibacterial activity against some strains (*H. pylori, S. typhi, S. enteritidis, S. flexneri* and *E. coli* (EHEC). Results showed that both ethanolic and aqueous extracts inhibited the growth of all the microorganisms tested. However, the minimal inhibitory concentration (MIC) was found to fall between 15.6 and 31.25 mg/mL. In addition, it was demonstrated that the extracts were bacteriocidal at concentrations ranging between 31.25 and 250 mg/mL.[31]

Kigigha & Atuzie[14] assessed the antibacterial activity of ethanol and expressed extracts of the leaves of *A. cordifolia* using *E. coli* and *S. aureus* as test organisms. The ethanol extract had the highest inhibitory zone against E. coli in all tests, ranging from 53.4 4.8 to 30.4 2.8 mm, followed by the expressed extract. Concerning the activity against S. aureus, it was the expressed extract that exhibited the higher inhibitory zone, ranging from 12.6±4.8 to 6.3±1.8 mm.

Okwu & Ukanwa[46] isolated 5-methyl 4'-propenoxy anthocyanidines 7-O-β-D-diglucopyranoside from the ethanolic extract of the leaves of *A. cordifolia* and evaluated its antibacterial activity on some bacterial strains. The results demonstrated that this compound successfully inhibited *P. aerguinosa*, *E. coli*, *P. mirabilis*, *K. pueumonia* and *S. aureus*.

Ajali[47] tested the antibacterial efficiency of stem bark from petroleum ether, acetone, ethanol, and methanol extracts of *A. cordifolia* on standard strains. It was concluded that all tested extracts of *A. cordifolia* stem bark exhibited antimicrobial activities, but only the petroleum ether extract did not show any good effects. Ebi[64] carried out tests on the antibacterial proprieties of leaf, stem, and root bark extracts of *A. cordifolia*. The study concluded that fractions containing phenolics and terpenoids, showed significant activity against *P. aeruginosa*, *B. subtilis*, and *E. coli*.

A study was conducted to determine the antimicrobial activity of methanol leaf extract of M. arboreus, aqueous and ethanol leaf extracts of *A. cordifolia*, two medicinal plants. Results concluded that all extracts from both plants exhibited antimicrobial effects against standard strains. In particular, ethanol leaf extracts of *A. cordifolia* gave appreciable antimicrobial properties against *S. aureus*, B. *subtilis, E. coli, P. aeruginosa*, and *C. albicans* with MICs of 3.0; 4.0; 6.0; 4.0 and 4.0 mg/mL, respectively, while aqueous showed MICs of 2.5; 3.0; 10.0; 4.0, and 3.0 mg/mL, respectively. The IC50 of aqueous and ethanolic *A. cordifolia* leaf were 0.79 and 0.78 µg/mL, respectively.[65]

Djimeli et al.,[33] assessed the antimicrobial activity of an aqueous extract of *A. cordifolia* leaf against *E. coli*. The conclusion suggested that aqueous extract possessed bacteriostatic activity with an MIC value of 1500 µg/ml. additionally, it was noticed that the dose-dependent efficiency of the extract was orally administrated at 232, 112 and 58 g/kg. The infection was eradicated after 13 days of treatment.

Antidiabetic activity

Thomford et al.,[21] carried out the antidiabetic effects of ethanolic leaf extract of Alchornea cordifolia using the dexamethasone-induced diabetic rat model. The final results showed that two doses of ethanolic leaf extract [(250 mg/kg, p.o.; (5.35 0.95 mmol/L) and 500 mg/kg, p.o.; (5.98 1.12 mmol/l)] demonstrated good activity by preventing an increase in fasting blood glucose level.

Antidiarrhoeal Activity

Agbor et al.,[38] evaluated the antidiarrhoeal propriety of an ethanolic extract from Alchornea cordifolia leaf against castor oil induced diarrhea in mice, using morphine as the standard reference drug. The finding demonstrated that the dose of 800 mg/kg was the most effective in rats and blocked the production of diarrhea after intraluminal administration. The anti-diarrhoeal activity of aqueous and ethanol bark extract of *Alchornea cordifolia* on castor oil-induced diarrhoeal; gastrointestinal motility; and enteropooling was conducted. It was found that both extracts have anti-diarrhoeal effects in a dose-dependent fashion at 200 mg/kg and 400 mg/kg.[48]

Anti-inflammatory activity

Manga et al.,[49] evaluated the *In vivo* anti-inflammatory activity of aqueous decoction and methanol leaf extracts of Alchornea cordifolia to reduce Croton oil-induced oedema in the mouse ear, after topical application. In addition, four bio-assays guided liquid-liquid fractionation (water insoluble, hexane, ethyl acetate and water) of methanol extract provided four different active fractions. The results showed that methanol leaf extract (dose-dependent) suppressed the Croton oil-induced ear oedema in mice (ID_{50} <500µg/cm^2). Only the hexane fraction showed a very high effect with 42% inhibition at 0.7µg/cm^2 while the other fractions were less active.

The anti-inflammatory properties of crude methanolic extract of Alchornea cordifolia leaves and the five fractions were assessed using rats. The authors concluded that the LD_{50} value of the aqueous extract was 1131.4 mg/kg while the methanolic extract at a dose of 50mg/kg exhibited a significant anti-inflammatory effect. In addition, the dose of 100mg/kg of terpenoid fraction and the tannin-containing multi-component fraction showed the best activity, with a percentage inhibition of oedema value of 87.69 each.[52]

Antioxidant activity

Kolawole et al.,[66] tested the *In vivo* antioxidant activity and glutathione S-Transferase inhibitory effect of ethanolic leaf extract of *Alchornea cordifolia* in acetaminophen-induced liver injury. The final results suggested that the ethanolic extract highly decreased the level of hepatic glutathione S-transferase nevertheless it generated (dose dependently) an important rise in the levels of glutathione S-transferases in the presence of the toxicant.

Effo et al.,[60] conducted an in vitro antioxidant effect of an aqueous extract of *A. cordifolia* leaves by using a 1,1-diphenyl-2-picrylhydrazyl (DPPH) free radical scavenging assay and by measuring the iron reduction capacity. The results concluded that aqueous extract alone did not alter transaminases, isoniazid while the combination of

isoniazid and rifampicin caused an elevation of transaminase enzymes (ALT and AST) by over 48% while aqueous extract of *A. cordifolia* at the concentration of 800 mg/kg decreased AST and ALT levels by over 45%. Finally, AEAC administrated at concentrations ranging from 200 mg/kg to 400 mg/kg reduced ALT levels by more than 40%.

A study was carried out to test the antioxidant capacity of the chloroform, methanol, and petroleum ether leaf extracts of A. cordifolia. The IC_{50} values for methanol, chloroform, and petroleum ether extracts in the DPPH and H_2O_2 assays were 35.22, 94.77, and 93.02 ppm, and 272.0, 626.5, and 898.O_4 ppm, respectively, in the DPPH radical and H_2O_2 assays. The Total Total antioxydant Activity (gAAE/100 g) for chloroform, petroleum ether and methanol extracts were 25.85, 40.0 and 40.08 g, respectively.[67]

Antiplasmodial activity

Ayisi et al.,[68] conducted *In vitro* study to assess the selectivity of action of chloroquine, *Alchornea cordifolia* (fruit), Ficus polita, and other antimalarial drugs by a tetrazolium-based colorimetric selective assay. This study used *Plasmodium falciparum*-strain-3D7-infected (1% parasitemia) and uninfected cultures. It was concluded that the aqueous extracts from the fruits of *Alchornea cordifolia* were very effective against *P. falciparum* strain 3D7 with IC_{50} values of 4.9µg/mL and selective index (SI) values of >69.4µg/mL by comparison with chloroquine (EC_{50} values of 0.025µg/mL and SI values of >2,000µg/mL).

Banzouzi et al.,[50] evaluated the antiplasmodial activity of chloroformic, ether, and ethanolic extracts of leaves of *A. cordifolia*. The authors observed a moderate activity of ethanolic extract against *Plasmodium falciparum* while chloroformic and ether extracts were inactive.

Antisickling activity

An *In vitro* study was carried out to assess the antisickling activity of aqueous extracts of three Congolese plants (*A. senegalensis*, *V. unguiculata* and *A. cordifolia*). It was concluded that the three plants possess an interesting capacity to prevent the sickling and hemolysis of red blood cells.[69]

Mpiana et al.,[70] evaluated the antisickling activity of aqueous and diethyl ether extracts of anthocyanins from two Congolese medicinal plants: *A. cordifolia* and *C. retusa* using Emmel's test. Additionally, thin layer chromatography (TLC) helped to prepare with methanol two different fractions (Rf: 0.76; 0.68) for A. cordifolia. The antisickling test showed the highest activity for the second fraction (Rf: 0.68) isolated from *A. cordifolia*.

Anti-stress activity

Umukoro and Aladeokin[51] conducted a study to investigate the anti-stress and anticonvulsant activities of the aqueous leaf extract of *A. cordifolia* in mice. After oral treatment (100-400 mg/kg), the authors noticed good anti-stress/anti-fatigue activity. Extracts decrease the duration of immobility significantly.

Antiviral activity

Aqueous extracts of *O. gratissimum*, *F. polita*, *C. anisata*, *A. cordifolia*, and *E. drupifera* were tested for antiviral activity in vitro. The effects were compared with AZT on HIV-1 and HIV-2 replication and cytopathicity. The results showed that the seeds of *A. cordifolia* had high antiviral indices (90) against HIV-1 strain HTLVIIIB cytopathicity but did not have any active against HIV-2 strain GH1 in comparison with AZT.[68]

Noundou et al.,[29] assessed the in vitro and in silico anti-HIV-1 integrase capacity of methylgallate from methanolic extract of *A. cordifolia* stem bark. The authors concluded that all the isolated compounds from A. cordifolia methanolic crude extract (3-O-acetyl-aleuritolic acid, methylgallate, stigmasterol) and the crude methanolic extract showed good effect against HIV-1 IN with the IC_{50} of the crude extract of 8.5 ng/ml. In addition, the IC_{50} values of methylgallate, stigmasterol, and 3-O-acetyl aleuritolic acid were found to be 3.7, 20.5 and 83.7 nM, respectively.

Reproductive activity

Njila et al.,[17] evaluated the effect of the methanolic extract of *A. cordifolia* leaves on the sexual behavior of senescent and sexually inexperienced rats. The results showed that 14 days after the treatment, the extract significantly increased libido and a good improvement of sexual parameters. In addition, the extract also increased the duration of coitus by significantly increasing the ejaculation latency and the average mating interval. The treatment with the extract also increased the fertility and implantation numbers in female rats mated with males.

Antipyretic and Analgesic activity

A study was carried out to investigate the analgesic and antipyretic activities of aqueous, ethanolic and dichloromethane extracts of two plants which are *Q. africana* (bark) and *A. cordifolia* (leaves and fruits). It was demonstrated that all *A. cordifolia* extracts showed the highest antipyretic and analgesic activities at doses of 400 and 800 mg/kg per os.[24]

Antiamoebic activity

Tona et al.,[71] tested the in vitro antiamoebic activity of forty-five (45) Congolese medicinal plant extracts. Which plants include *A. cordifolia*. The final results showed that extract from *A. cordifolia* root bark was among the most active (MIC<100µg/ml) against the Entamoeba histolytica strain.

Anthelminthic activity

Akoto et al.,[67] evaluated anthelminthic activity of chloroform, methanol, and petroleum ether leaf extracts of *A. cordifolia*. It was concluded that the extracts were higher anthelminthic effects in comparison of albendazole-treated helminths.

Healing property

Agyare et al.,[65] evaluated the healing activity of methanol leaf extract of *M. arboreus*, aqueous and ethanol leaf extracts of *A. cordifolia*, two medicinal plants. The final finding suggested that all extracts from both plants exhibited higher wound healing ability with better wound closure ($p<0.05$) on day 1 and day 9 ($p<0.001$) in comparison with untreated wounds. In addition, a histological survey demonstrated an improvement in wound tissue proliferation, fibrosis, and re-epithelization compared with the untreated wound tissues.

Lymphoproliferative effects

This study was carried out to investigate the in vitro immunostimulant activities of two flavonoid-rich fractions [methanol extract into ethylacetate fractions (EAC) and acetone soluble fractions (AAC)] of *A. cordifolia* leaves extract. In the conclusion, it was demonstrated that the concentration close to 10-250µg/ml from both fractions (EAC and AAC) raised the proliferation of splenocytes and thymocytes cultures in comparison with the mitogenic property of standard mitogens [lipopolysaccharide LPS (10 µg/ml) and concanavalin A, ConA (2 µg/ml)].[25]

Immunostimulatory and adjuvant properties

Nworu et al.,[72] evaluated the in vitro immunostimulatory and adjuvant properties of AcF1, a flavonoids-rich fraction of *A. cordifolia*. The results were very encouraging. The adjuvant AcF1 significantly ($P<0.05$) elevated the level of OVA-specific antibody titres in the sera of immunised mice in comparison with the control group immunized with OVA alone.

Antidepressant-like effect

The antidepressant-like property of hydroethanolic extract of *A. cordifolia* in the forced swimming test was examined. Results showed a dose dependent (200 and 400 mg/kg, p.o.) and significant ($P<0.001$) antidepressant-like effect of the extract. In addition, the combination of subeffective doses of imipramine (5mg/kg, p.o.) or fluoxetine (5mg/kg, p.o.), with hydroethanolic extract (25 mg/kg, p.o.) induces a synergistic antidepressant-like effect in the forced swimming test.[73]

Effect against *Babesia duncani* disease

A. cordifolia was included amongst herbal medicines which possess very good in vitro inhibitory activity in the treatement of human babesiosis caused by *B. duncani* with 54% inhibition capacity.[74]

Effect against hemorrhoidal disease

Nga et al.,[35] assessed the anti-hemorrhoidal property of aqueous extracts from two African medicinal plants (M. indica and A. cordifolia). The concentrations of 500 mg/kg and 1000 mg/kg exhibited anti-inflammatory activity and inhibited some mediators (histamine, 5-hydroxytryptamine, kinins, and prostaglandins) which cause inflammation.

Entomotoxicant effect

Koomson & Oppong[16] investigated the entomotoxicant effect of leaf powder of *A. cordifolia* on *Sitophilus zeamais* the maize storage pest. Results confirmed that the powder was toxic to the insect ($P<0.05$) at the concentration of 5.0g by causing very high mortality of 93% after 21 days. In addition, the repellent effect on insects (97%) was also observed at the same concentration.

Conclusion

This mini-review is a compilation of the various properties of the plant *Alchornea cordifolia*. The various traditional uses, phytochemistry, pharmacology and toxicology of this plant are briefly presented. The research has elucidated several interesting bioactive compounds that have been found to treat various human and animal diseases. Future research should lead researchers to further investigate the antihelminthic activity of some compounds of this plant on Okapi helminths in order to formulate a phytomedicine that will allow the conservation of this emblematic animal threatened with extinction.

Acknowledgments

None.

Conflicts of interest

Authors declare that there is no conflict of interest.

References

1. Mpiana PT, Ngbolua KN, Mudogo V, et al. The Potential Effectiveness of Medicinal Plants used for the Treatment of Sickle Cell Disease in the Democratic Republic of Congo Folk Medicine: A Review. In: *Progress in Traditional and Folk Herbal Medicine*. Daya Publishng House; 2012. 12 p.
2. Kasali FM, Mahano AO, Nyakabwa DS, et al. Ethnopharmacological Survey of Medicinal Plants Used against Malaria in Bukavu City (D. R. Congo). *European Journal of Medicinal Plants*. 2014;4(1):29–44.
3. Alagbe JO, Adegbite MB. Heamatologfical and Serum Biochemical Indices of Starter Broiler Chicks Fed Aqueous Extract of Balanites Aegyptiaca and Alchornea Cordifolia Bark Mixture. *International Journal of Biological, Physical and Chemical Studies*. 2019;1(1):8–15.
4. Mbembo BM, Ashande CM, Asamboa SL, et al. A Mini-review on the Phytochemistry and Pharmacobiology of Azadirachta indica A. Juss. (Meliaceae): Towards future research directions. *Journal of Complementary and Alternative Medical Research*. 2021;15(2):1–21.
5. Ipona EN, Inkoto CL, Bongo GN, et al. Ethno-Botanical Survey and Ecological Study of Medicinal Plants Traditionally Used Against Erectile Dysfunction in Democratic Republic of the Congo. *Bioscience and Bioengineering*. 2018;4(4):85–91.
6. Gupta SC, Prasad S, Tyagi AK, et al. Neem (Azadirachta indica): An Indian traditional panacea with modern molecular basis. *Phytomedicine*. 2017;34:14–20.
7. WHO. *Traditional medicine: growing needs and potential*. World Health Organization; 2002. 64 p.
8. Mpianaa PT, Ngboluab KN, Tshibangua DST, et al. Identification of potential inhibitors of SARS-CoV-2 main protease from Aloe vera compounds: A molecular docking study. *Chemical Physics Letters*. 2020;754:137751.
9. Katiyar, C Gupta A, Kanjilal S, et al. Drug discovery from plant sources: An integrated approach. *Ayu*. 2015;33(1):10–19.
10. Balunas MJ, Kinghorn AD. Drug discovery from medicinal plants: Minireview. *Life Sciences*. 2005;78(5):431–441.
11. Zampini IC, Cuello C, Alberto MR. Antimicrobial activity of selected plant species from the Argentine puna against sensitive and multiresistant bacteria. *Journal of Ethnopharmacology*. 2009;124(3):499–505.
12. Ayisi NK, Appiah-Opong R, Gyan B, et al. Plasmodium falciparum: Assessment of Selectivity of Action of Chloroquine, Alchornea cordifolia, Ficus polita, and Other Drugs by a Tetrazolium-Based Colorimetric Assay. *Malaria Research and Treatment*. 2011;2011:816250.
13. Kouakou K, Igor AS, Yapi A, et al. Immunomodulator activity of polysaccharides isolated from Alchornea cordifolia. *J Ethnopharmacol*. 2013;146(1):232–242.
14. Kigigha LT, Atuzie MN. Assessment of traditional medicinal application of Alchornea cordifolia. *Afr J Biotechnol*. 2012;11(8):2083–2086.
15. Nodu MB, Okpeku M, Abezi AE. Heamatological Characteristics of Young Rabbits fed a mixture of Alchornea cordifolia/Pawpaw leaf meal. *IOSR Journal of Agriculture and Veterinary Science*. 2014;7(1):92–96.
16. Koomson CK, Oppong EK. Entomotoxicant potential of Christmas bush, Alchornea cordifolia (Schum. & Thonn.) leaves powder in the control of maize weevil, Sitophilus zeamais Motschulsky (Coleoptera: Curculionidae) infesting stored maize. *Journal of Entomology and Zoology Studies*. 2018;6(2):2649–2654.
17. Njila MIN, Meng GY, Ebrahimi M, et al. Effect of methanolic extract of Alchornea cordifolia leaves on the sexual behavior of senescent and sexually inexperienced rats. *The Journal of Phytopharmacology*. 2018;7(6):471–476.
18. Gatsing D, Moudji ST, Kuiate JR, et al. In vitro Antibacterial Activity of Alchornea cordifolia bark Extract against Salmonella Species Causing Typhoid Fevers. *Ethiop Pharm J*. 2008;26(2):83–94.
19. Lamikanra A, Ogundaini AO, Ogungbamila FO. Antibacterial Constituents of Alchornea cordifolia Leaves. *Phytotherapy Research*. 1990;4(5):198–200.

20. Noundou XS, Krause RWM, Van Vuuren SF, et al. Antibacterial effects of Alchornea cordifolia (Schumach. and Thonn.) Müll. Arg extracts and compounds on gastrointestinal, skin, respiratory and urinary tract pathogens. *Journal of Ethnopharmacology*. 2016;179:76–82.

21. Thomford AK, Thomford KP, Ayertey F, et al. The Ethanolic Leaf Extract of Alchornea cordifolia (Schum. & Thonn.) Muell. Arg Inhibits the Development of Dyslipidaemia and Hyperglycaemia in Dexamethasone-Induced Diabetic Rats. *Journal of Applied Pharmaceutical Science*. 2015;5(9):52–55.

22. Mambe FT, Voukeng IK, Beng VP, et al. Antibacterial activities of methanol extracts from Alchornea cordifolia and four other Cameroonian plants against MDR phenotypes. *J Taibah Univ Medic Sci*. 2016;11(2):121–127.

23. Arhoghro EM, Ikeh CH, Eboh AS, et al. World Journal of Pharmaceutical Research. 2015;4(5):1–12.

24. Nsonde NGF, Kimpouni V, Dianzitoukoulou MLD, et al. Evaluation of Antipyretic and Analgesic Effects of Alchornea cordifolia Schum. & Thonn. (Euphorbiaceae) and Quassia africana Baill (Simaroubaceae). *International Journal of Sciences*. 2020;9(1):1–7.

25. Nworu CS, Temchura V, Okoye FBC, et al. Activation of murine lymphocytes and modulation of macrophage functions by fractions of Alchornea cordifolia (Euphorbiaceae) leaf extract. *Immunopharmacol Immunotoxicol*. 2010a;32(1):28–36.

26. Ajibade TO, Olayemi FO. Reproductive and toxic effects of methanol extract of Alchornea cordifolia leaf in male rats. *Andrologia*. 2014;47(9):1034–1040.

27. Ngbolua KN, Asimonyio AJ, Ndrodza N, et al. Valeur nutritive et teneur en acide cyanhydrique de huit espèces végétales consommées par Okapia johnstoni (Mammalia: Giraffidae) en République Démocratique du Congo. *International Journal of Innovation and Scientific Research*. 2016;23:419–427.

28. Ngbolua KN, Behundo MY, Mbembo BM, et al. Micro-graphic Profiling and Phytochemical Analysis of Some Plants Consumed by Okapia johnstoni (Giraffidae: Mammalia) in Democratic Republic of the Congo. *Journal of Biomedical and Life Sciences*. 2021;1(1):38–50.

29. Noundou XS, Musyoka TM, Moses V, et al. Anti-HIV-1 integrase potency of methylgallate from Alchornea cordifolia using in vitro and in silico approaches. *Scientific Reports*. 2019;9(1):4718.

30. Adeshina GO, Onaolapo JA, Ehinmidu JO, et al. Phytochemical and antimicrobial studies of the ethyl acetate extract of Alchornea cordifolia leaf found in Abuja, Nigeria. *J Med Plant Res*. 2010;4(8):649–658.

31. Adeleye AI, Omonigbehin AE, Stella S, et al. Antibacterial activity of extracts of Alchornea cordifolia (Schum and Thonn) Mull.Arg., Boerhavia diffusa (L) and Bridellia micranthaI (Hoscht) Baill. Used in traditional medicine in Nigeria on Helicobacter pylori and four diarrhoeagenic bacterial pathogens. *Afr J Biotechnol*. 2008;7(20):3761–3764.

32. Komolafe KA, Adeoti OM, Olaoye OJ, et al. Oral Toxicity Assessment and In vitro Antimicrobial Profile of Methanolic Leaf Extract of Alchornea Cordifolia on Albino Rats. *Ecology and Evolutionary Biology*. 2020;5(2):22–28.

33. Djimeli MN, Fodouop SPC, Njateng GSS, et al. Antibacterial activities and toxicological study of the aqueous extract from leaves of Alchornea cordifolia (Euphorbiaceae). *BMC Complementary and Alternative Medicine*. 2017;17(1):349.

34. Osadebe PO, Okoye FBC. Anti-inflammatory effects of crude methanolic extract and fractions of Alchornea cordifolia leaves. *Journal of Ethnopharmacology*. 2003;89(1):19–24.

35. Nga EN, Yinyang J, Bidias EB, et al. Étude phytochimique et pharmacologique d'Alchornea cordifolia (Schum. & Thonn.) Mull. Arg. et de Mangifera indica dans le traitement traditionnel de la maladie hémorroïdaire. *Journal of Applied Biosciences*. 2017;109:10649–10661.

36. Lengbiye ME, Ngbolua KN, Messi LM, et al. In vitro Evaluation of the Anti-scavenging and Anthelmintic Activities of Artocarpus heterophyllus LAM Leaves (Moraceae) in the Democratic Republic of Congo. *International Journal of Biomedical Engineering and Clinical Science*. 2019;5:14–22.

37. Ebenyi LN, Nwakaeze AE, Moses IB, et al. Antibacterial activity of Alchornea cordifolia leaves found in Ebonyi state, Nigeria. *IJAPBC*. 2017;6(1):46–51.

38. Agbor GA, Talla L, Ngogang YJ. The Antidiarrhoeal Activity of Alchornea cordifolia Leaf Extract. *Phytother Res*. 2004;18(11):873–876.

39. Boniface PK, Ferreira SB, Kaiser CR. Recent trends in phytochemistry, ethnobotany and pharmacological significance of Alchornea cordifolia (Schumach. & Thonn.) Muell. Arg. *Journal of Ethnopharmacology*. 2016;191:216–244.

40. Moshi MJ, Otieno DF, Weisheit A. Ethnomedicine of the Kagera Region, north-western Tanzania. Part 3: plants used in traditional medicine in Kikuku village, Muleba District. *J Ethnobiol Ethnomed*. 2012;8:14.

41. Sudeep T, Shailendra R. *Extraction technologies for medicinal and aromatic plants. Chapter 5: Decoction and hot continuous extraction techniques*. United Nations Industrial Development Organization and the International Centre for Science and High Technology; 2008. 266 p.

42. Adeneye AA, Oreagba AI, Ishola IO, et al. Evaluation of the anti-arthritic activity of the hydroethanolic leaf extract of alchornea cordifolia in rats. *Afr J Tradit Complement Altern Med*. 2014;11(2):402–410.

43. Adeshina GO, Kunle OF, Onaolapo JA, et al. Antimicrobial Activity of the Aqueous and Ethyl Acetate Sub-Fractions of Alchornea cordifolia Leaf. *European Journal of Medicinal Plants*. 2012;2(1):31–41.

44. Okoye EL, Uba BO, Uhobo PC, et al. Evaluation of the Antibacterial Activity of Methanol and Chloroform Extracts of Alchornea cordifolia Leaves. *Journal of Scientific Research & Reports*. 2014;3(1):255–262.

45. Eliakim-ikechukwu CF, Obri AI. Histological changes in the pancreas following administration of ethanolic extract of alchornea cordifolia leaf in alloxan- induced diabetic wistar rats. *Nigerian Journal of Physiological Sciences*. 2009;24(2):153–155.

46. Okwu DE, Ukanwa N. Isolation, Characterization and Antibacterial Activity Screening of Anthocyanidine Glycosides from Alchornea Cordifolia (Schumach. and Thonn.) Mull. Arg. Leaves. *Journal of Chemistry*. 2010;7(1):41–48.

47. Ajali U. Antibacterial activity of Alchornea cordifolia stem bark. *Fitoterapia*. 2000;71(4):436–438.

48. Emudainohwo OTJ, Moke EG, Ejebe ED, et al. An investigation into the anti-diarrhoeal effects of aqueous and ethanol stem bark extracts of Alchornea cordifolia in wistar rats. *J Pharmacogn Phytochem*. 2015;3(6):183–187.

49. Manga HM, Brkic D, Marie DEP, et al. In vivo anti-inflammatory activity of Alchornea cordifolia (Schumach. & Thonn.) Müll. Arg. (Euphorbiaceae). *Journal of Ethnopharmacology*. 2004;92(2-3):209–214.

50. Banzouzi JT, Prado R, Menan H, et al. In vitro antiplasmodial activity of extracts of Alchornea cordifolia and identification of an active constituent: ellagic acid. *Journal of Ethnopharmacology*. 2002;81(3):399–401.

51. Umukoro S, Aladeokin AC. Evaluation of the anti-stress and anticonvulsant activities of leaf extract of Alchornea cordifolia in mice. *Journal of Ethnopharmacology*. 2010;127(3):768–770.

52. Osadebe PO, Okoye FBC, Uzor PF, et al. Phytochemical analysis, hepatoprotective and antioxidant activity of Alchornea cordifolia methanol leaf extract on carbon tetrachloride-induced hepatic damage in rats. *Asian Pacific Journal of Tropical Medicine*. 2012;5(4):289–293.

53. George NJ, Obot IB, Ikot AN, et al. Phytochemical and Antimicrobial Properties of Leaves of Alchonea Cordifolia. *Journal of Chemistry*. 2010;7(3):1071–1079.

54. Muanza DN, Kim BW, Euler KL, et al. Antibacterial and Antifungal Activities of Nine Medicinal Plants from Zaire. *Int J Pharmacog*. 1994;32(4):337–345.

55. Gnahoué G, Koné A, Kouadio KJ, et al. Assessment of the acute, subacute and Subchronic toxicity of a total aqueous extract of leaves of Alchornea cordifolia (Schumach and Thonn) Müll Arg (Euphorbiaceae) on rats Wistar. *Journal of Pharmacognosy and Phytochemistry*. 2021;10(1):1609–1614.

56. Ansah C, Oppong E, Woode E, et al. Toxicity studies on alchornea cordifolia leaf extract in mice. *Journal of Science and Technology*. 2009;29(1):1–16.

57. Ezeokeke EE, Ene AC, Igwe CU. Sub-Acute Toxicity Studies of Alchornea cordifolia Leaf Extract in Swiss Albino Rats. *Anal Bioanal Tech*. 2017;8:353.

58. Okeke IN, Ogundaini AO, Ogungbamila FO, et al. Antimicrobial Spectrum of Alchornea cordifolia Leaf Extract. *Phytother Res*. 1999;13(1):67–69.

59. Essien EE, Newby JS, Walker TM, et al. Characterization and Antimicrobial Activity of Volatile Constituents from Fresh Fruits of Alchornea cordifolia and Canthium subcordatum. *Medicines*. 2016;3(1):1.

60. Effo KE, Kouakou SL, Irié-N'Guessan G, et al. Antioxidant Activity and Hepatoprotective Effect of an Aqueous Extract of Alchornea cordifolia Leaves. *Pharmacology & Pharmacy*. 2017;8(11):369–380.

61. Kouakou-Siransy G, Sahpaz G, Nguessan GI, et al. Effects of Alchornea cordifolia on elastase and superoxide anion produced by human neutrophils. *Pharmaceutical Biology*. 2010;48(2):128–133.

62. Manga HM, Chapon D, Hoet S, et al. N1,N2,N3-Trisisopentenyl Guanidine and N1,N2-Diisopentenyl Guanidine, Two Cytotoxic Alkaloids from Alchornea cordifolia (Schumach.& Thonn.) Müll. Arg. (Euphorbiaceae) Root Barks. *Natural Product Communications*. 2006;1(12):1097–1100.

63. Adépo AJB, Manda P, Ngbé VJ, et al. Study of aflatoxicosis reduction: effect of Alchornea cordifolia on biomarkers in an aflatoxin B1 exposed rats. *Drug and Chemical Toxicology*. 2019;42(3):243–251.

64. Ebi GC. Antimicrobial activities of *Alchornea cordifolia*. *Fitoterapia*. 2001;72(1):69–72.

65. Agyare C, Owusu-Ansah A, Ossei PPS, et al. Wound Healing and Anti-Infective Properties of Myrianthus arboreus and Alchornea cordifolia. *Med Chem*. 2014;4(7):533–539.

66. Olaleye MT, Kolawole AO, Ajele JO. Antioxidant Properties and Glutathione STransferases Inhibitory Activity of Alchornea cordifolia Leaf Extract in Acetaminophen-Induced Liver Injury. *Iranian Journal of Pharmacology & Therapeutics*. 2007;6(1):63–66.

67. Akoto CO, Acheampong A, Boakye YD, et al. In vitro anthelminthic, antimicrobial and antioxidant activities and FTIR analysis of extracts of Alchornea cordifolia leaves. *Journal of Pharmacognosy and Phytochemistry*. 2019;8(4):2432–2442.

68. Ayisi NK, Nyadedzor C. Comparative in vitro effects of AZT and extracts of Ocimum gratissimum, Ficus polita, Clausena anisata, Alchornea cordifolia, and Elaeophorbia drupifera against HIV-1 and HIV-2 infections. *Antiviral Research*. 2003;58(1):25–33.

69. Kitadi JM, Inkoto CL, Lengbiye EM, et al. Mineral Content and Antisickling Activity of Annona senegalensis, Alchornea cordifolia and Vigna unguiculata Used in the Management of Sickle Cell Disease in the Kwilu Province (Congo, DR). *International Blood Research & Reviews*. 2020;11(3):18–27.

70. Mpiana PT, Mudogo V, Nyamangombe L, et al. Antisickling activity and photodegradation effect of anthocyanins extracts from Alchornea cordifolia (Schumach & Thonn) and Crotalaria retusa. *Ann Afr Med*. 2009;2(4):224–311.

71. Tona L, Kambu K, Ngimbi N, et al. Antiamoebic and phytochemical screening of some Congolese medicinal plants. *Journal of Ethnopharmacology*. 1998;61(1):57–65.

72. Nworu CS, Esimone CO, Tenbusch M, et al. Adjuvant properties of AcF1, an immunostimulant fraction of Alchornea cordifolia extract. *Immunological Investigations*. 2010b;39(2):132–158.

73. Ishola IO, Agbaje EO, Akinleye MO, et al. Antidepressant-like effect of the hydroethanolic leaf extract of Alchornea cordifolia (Schumach. &Thonn.) Mull. Arg. (Euphorbiaceae) in mice: Involvement of monoaminergic system. *Journal of Ethnopharmacology*. 2014;158(Pt A):364–372.

74. Zhang Y, Alvarez-Manzo H, Leone J, et al. Botanical Medicines Cryptolepis sanguinolenta, Artemisia annua, Scutellaria baicalensis, Polygonum cuspidatum, and Alchornea cordifolia Demonstrate Inhibitory Activity against Babesia duncani. *Front Cell Infect Microbiol*. 2021;11:624745.