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Research Article

Studies of Phyto-compounds with Antibacterial Properties from Stem Bark of *Combretum lamprocarpum* (Diels)

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ABSTRACT
Combretum lamprocarpum (*C. lamprocarpum*) stem bark was investigated in an attempt to identify chemical substances of medicinal value to enable scientific validation of the plant in the treatment of diseases caused by pathogenic microorganisms. The plant's stem bark, after collection, identification, Air-drying and pulverization, was subjected to cold extraction with n-hexane, dichloromethane (DCM), ethyl acetate and methanol successively in that order. The extracts obtained were subjected to phytochemical screening, thin-layer chromatography (TLC) and antimicrobial studies using standard procedures. The preliminary phytochemical screening of the crude extracts revealed the presence of flavonoids, tannins, glycosides, steroids, triterpenoids, anthraquinones, and alkaloids. The TLC of the extracts showed eight, five, three and two prominent bands in the n-hexane, DCM, ethyl acetate and methanol extracts, respectively. The antimicrobial effects of the crude extracts were tested against eight microorganisms, namely: *Methicillin-resistant Staphylococcus aureus, Staphylococcus aureus, Streptococcus pyogenes, Corynebacterium ulcerans, Escherichia coli, Proteus vulgaris, Proteus mirabilis,* and *Pseudomonas aeruginosa*. The antimicrobial studies indicated that the extracts possess significant activity against *Methicillin-resistant Staphylococcus aureus, Corynebacterium ulcerans, Escherichia coli* and *Pseudomonas aeruginosa* (with zones of inhibition ranging from 22mm to 28mm and MIC ranges: 2.5-40mg/ml). The presence of the phytochemical constituents with similar and/or distinct therapeutic activities, coupled with the result of the antibacterial assay, indicated that the plant stem bark could be used in the treatment of the ailments acclaimed in ethno-medicine.

Keywords: Antimicrobial; *Combretum lamprocarpum;* Phytochemical; Phyto-compounds; Stem bark

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INTRODUCTION

Natural products, especially plants have been used for the treatment of variety of diseases for thousands of years (Kizito *et al.*, 2020). Traditional medicine is the oldest method of curing diseases and infections; various plants have been used in different parts of the world to treat diseases and infections (Bantho *et al* 2023). Terrestrial plants have been used as medicine in different countries, from ancient times and an impressive number of modern drugs have been developed from them (Latif, 2025). Many of these indigenous medicinal plants are used as spices and food plants; they are also sometimes added to foods for medicinal purposes. Furter more, medicinal plants are believed to be an important source of new chemical substances with potential therapeutic effects (Fazeli *et al.,* 2022). The occurrence of bioactive plant components mainly called phytochemical has been considered of fundamental nutritional importance in the prevention of many diseases such as cancer, cardiovascular disease and diabetes (Davis & Chois, 2024). It has been discovered

that regular utilization of fruits, vegetables, herbs and spices has been associated with health benefits of human and animals. But not until recent, these valuable compounds (phytochemicals) were discovered to possess a wide range of biological activity (Fazeli *et al.,* 2022). Phytochemical studies of medicinal plants that are common in northern Nigeria will go a long way in providing a cheaper way of treating diseases such as jaundice, intestinal helminthiasis, wounds, malaria, venereal diseases, epilepsy, diarrhea, haemarroid, cancer, asthma and fever afflicting substantial number of communities in the region (Theodoridis *et al*., (2023). Phytochemicals are biologically active, naturally occurring chemical compounds found in plants, which provide healthcare benefits for humans as medicine and nutrients. Enormous work has been done in the past and revealed that these phytochemicals play an important role in the routine healthcare systems worldwide (Prasathkumar *et al.,* 2021).The major classes of phytochemical compounds like terpenoids, alkaloids, phenolics, tannins, saponins and steroids have potential to prevent humans and act as anti-oxidant, anti-microbial, anti-inflammatory, anti-cancerous, detoxifying agent, immunity-potentiating, wound healing activity and neuropharmacological agent. Each class of these functional agents consists of a wide range of chemicals with different potency and some of these phytochemicals are found to be multifunctional (Jamshidi *et al*., 2018). Plants serve humans as a natural source for treatment and therapies from ancient time. Medicinal herbs have gain attention because of its wide used and less side effects (Head *et al*., 2018). Consequently, the exploration of phytochemicals from indigenous medicinal plants has become essential in the search for novel antimicrobial agents. *Combretum lamprocarpum* (Diels), a plant traditionally used in parts of northern Nigeria, remains underexplored despite its ethnomedicinal relevance. Therefore, this study aims to investigate the phytochemical constituents and antimicrobial potential of stem bark extracts of *Combretum lamprocarpum* collected from Dutsin-Ma, Katsina State, with a view to scientifically validating its traditional use and contributing to the development of plant-based antibacterial therapies

MATERIALS AND METHOD

Collection and Identification of Plant Material

The stem bark of *Combretum lamprocarpum* was collected from Dutsin-Ma Local Government Area of Katsina State, Nigeria in December, 2019. The plant was identified and authenticated in the Department of Biological Sciences, Ahmadu Bello University Zaria, Nigeria.

Extraction of Plant Material

The powdered sample (1.2kg) was soaked into 2 dm^3 of n-hexane and allowed to stand for 48 hours with shaking at regular intervals (using Cold maceration method) and repeated three times. The residue (marc) was similarly macerated with dichloromethane (2 dm3), ethyl acetate (2 dm3) and methanol (2 dm^3) in this order.

Phytochemical Screening

The method described by Fawehinmi *et al*. (2022) was used for qualitative phytochemical screening of extracts of *Combretum lamprocarpum* stem bark. Saponins, tannins, anthraquinones, glycosides, alkaloids, flavonoids, terpenoids and steroids were the secondary metabolites screened.

Thin-Layer Chromatography (TLC)

Thin-layer chromatography was carried out using TLC pre coated sheets by one-way ascending technique. The TLC was carried out to ascertain the number of components in each crude extract. A little quantity of each of the extracts was dissolved in dichloromethane to form a solution. The extract was then spotted on TLC plate using capillary tube and allowed to dry. After drying, the plate was developed in an air tight chromatographic tank using perceived solvent system. The developed chromatograms were air dried and visualized; under normal day light using ultra violet light (254nm & 366nm).

Antibacterial Activity

The antibacterial activities of dichloromethane, ethyl acetate methanol and the isolate of the plant's extracts were determined using some pathogens microbes. The microbes were obtained from the department of medical microbiology ABU Zaria.

About 0.4g of the extract was weighed and dissolved in 10ml of DMSO to obtain a concentration of 40mg/ml. Diffusion method was the method used for screening the extracts, Muller Hinton agar was the medium used as the growth media for the microbes. The medium was prepared according to the manufacturer instruction sterilized at 121^0C for 15minutes, poured into the sterile Petri dishes and was allowed to cool and solidify. The medium was

seeded with 0.1ml of the standard inoculum of the test microbe (Wilson *et al*., 2024). The inoculum was spread evenly over the surface of the media by the used of sterile swab. By the use of a standard sterile cork borer of 6mm in diameter a well was cut at the center of each inoculated media. 0.1ml of solution of the extracts of the concentration of 40mg/ml was then introduced into the well on the inoculated medium.

Incubation was made at 37^0C for 24hrs, after which the plates of the medium were observed for the zone of inhibition of growth, the zone was measured with a transparent ruler and the result recorded in millimeter.

Minimum Inhibitory Concentration

Broth dilution technique was used in determining the minimum inhibitory concentration (Monawer *et al*., 2023). Mŭeller-Hinton broth was prepared, 10ml was dispensed into test tubes and were sterilized at 121^0C for 15mins, the broths were allowed to coolturbidity standard scale number 0.5 prepared to give turbid solution. Normal saline was prepared, 10m was dispensed into sterile test tube and the test microbe was inoculated and incubated at 37^0C for 6hrs. Dilution of the test microbe was done in the normal saline until the turbidity marched that of scale by visual comparison at this point the test microbe has a concentration of about 1.5x 10^8 cfu/ml. Two-fold serial dilution of the extract was done in the sterile broth to obtain the concentration of 40mg/ml, 20mg/ml, 10mg/ml, 5mg/ml, and 2.5g/ml. Having obtained the different concentration of the extract in the sterile broth, 0.1ml of the test microbe in the normal saline was then inoculated into the different concentrations, incubation was made at 37^0C for 24hrs after which the test tubes of the broth were observed for turbidity (growth), the lowest concentration of the extract in the sterile broth which shows no turbidity was recorded as the minimum inhibition concentration (Marquardt *et al*., 2020).

Minimum bactericidal concentration

Minimum bactericidal concentration was carried out to determine whether the test microbes were killed or only their growth was inhibited. Mueller Hinton agar was prepared and sterilized at 121^0C for 15 minutes, poured into sterile Petri dishes and were allowed to cool and solidly. The contents of the MIC in the serial dilutions were then sub cultured onto the prepared medium, incubation was made at 37^0C for 24hrs, after which the plates of the medium were observed for colony growth, MBC was the plates with lowest concentration of the extract without colony growth (Renata *et al.,* 2022).

RESULTS

Phytochemical screening of *Combretum lamprocarpum* extracts showed solvent-dependent distribution of secondary metabolites (Table 1). Saponins were absent in all extracts, while glycosides were detected only in the methanol extract. Alkaloids were present in n-hexane and dichloromethane extracts but absent in ethyl acetate and methanol extracts. Anthraquinones were detected in n-hexane, dichloromethane, and ethyl acetate extracts, while steroids and terpenes were present in all extracts. Flavonoids occurred in n-hexane, dichloromethane, and ethyl acetate extracts, whereas tannins were detected only in n-hexane and methanol extracts.

TLC analysis of the n-hexane extract revealed eight components with Rf values ranging from 0.10 to 0.62 (Table 2; Plate 1). The dichloromethane extract showed five components with Rf values between 0.14 and 0.86 (Table 3; Plate 2). The ethyl acetate extract exhibited three components with Rf values of 0.10–0.82 (Table 4; Plate 3), while the methanol extract produced two components with Rf values of 0.51 and 0.77 (Table 5; Plate 4). The isolated compound from the ethyl acetate extract showed a single TLC spot with an Rf value of 0.53, indicating purity (Table 6; Plate 5).

Antimicrobial activity results showed zones of inhibition ranging from 20–28 mm against *Methicillin-resistant Staphylococcus aureus*, *Staphylococcus aureus*, *Corynebacterium ulcerans*, *Escherichia coli*, and *Pseudomonas aeruginosa* (Table 7). No inhibition was observed against *Streptococcus pyogenes*, *Proteus vulgaris*, and *Proteus mirabilis*. MIC values were recorded at 10 mg/ml for susceptible organisms (Table 8), while MBC values occurred at 10–20 mg/ml (Table 9).

Table 1: Phytochemical Constituents of *Combretum lamprocarpum* extracts

Test Compounds	n-hexane Extract	DCM Extract	Ethyl acetate Extract	Methanol Extract
Saponins	-	-	-	-
Glycosides	-	-	-	+
Alkaloids	+	+	-	-
Anthraquinones	+	+	+	-
Steroids	+	+	+	+
Terpenes	+	+	+	+
Flavonoids	+	+	+	-
Tannins	+	-	-	+

Keys: + = Present, - = Absent

Plate 1: TLC Profile of the crude extract of n-hexane

Table 2: Retention factor of n-Haxane crude extract.

Components	Distance traveled by component (cm)	Distance traveled by solvent system (cm)	Retention Factor (Rf)
H_1	0.45	4.5	0.10
H_2	0.90	4.5	0.20
H_3	1.25	4.5	0.27
H_4	1.50	4.5	0.33
H_5	1.80	4.5	0.40
H_6	2.00	4.5	0.44
H_7	2.50	4.5	0.55
H_8	2.85	4.5	0.62

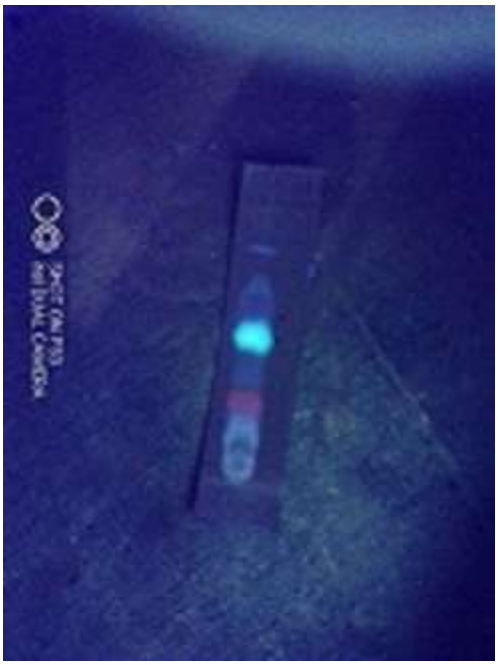

Plate 2: TLC profile of the crude extract of DCM

Table 3: Retention factor of DCM Extract

Components	Distance traveled by component (cm)	Distance traveled by solvent system (cm)	Retention Factor (Rf)
D_1	0.70	5.0	0.14
D_2	1.05	5.0	0.21
D_3	2.62	5.0	0.52
D_4	3.50	5.0	0.70
D_5	4.30	5.0	0.86

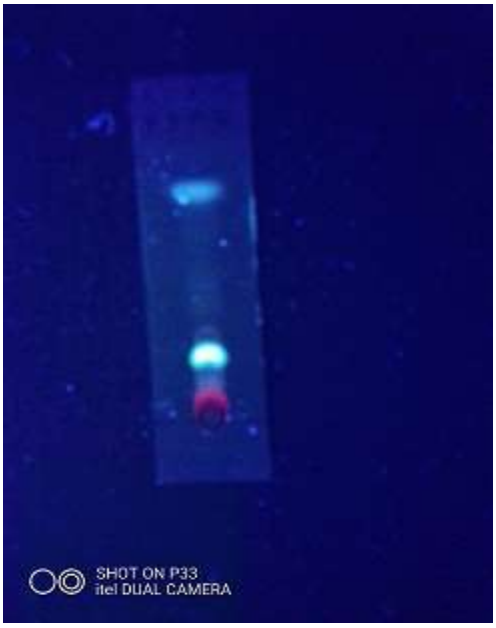

Plate 3: TLC Profile of the Crude Extract of DCM

Table 4: Retention factor of DCM Extract

Components	Distance traveled by component (cm)	Distance traveled by solvent system (cm)	Retention Factor (Rf)
E_1	0.50	5.0	0.10
E_2	1.05	5.0	0.21
E_3	4.10	5.0	0.82

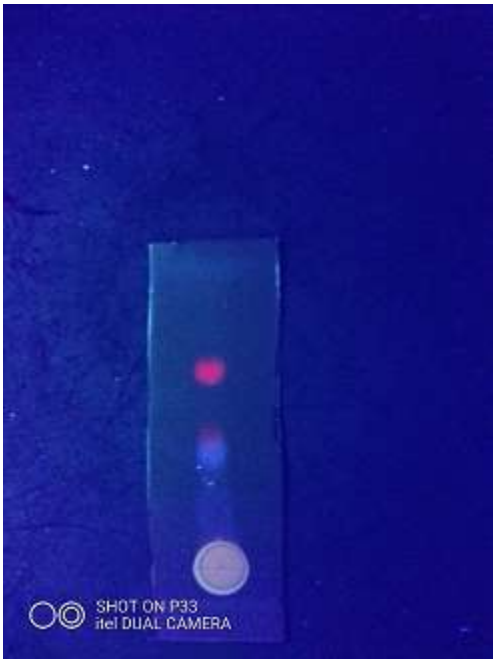

Plate 3: TLC profile of the crude extract of methanol

Table 5: Retention factor of DCM extract

Components	Distance traveled by component (cm)	Distance traveled by solvent system (cm)	Retention Factor (Rf)
M_1	2.30	4.50	0.51
M_2	3.50	4.50	0.77

Plate 5: TLC Profile of the Plant's isolate (Isolated from ethyl acetate extract)

Table 6: Retention factor of the Plant's isolate (Isolated from ethyl acetate extract)

Component	Distance traveled by component (cm)	Distance traveled by solvent system (cm)	Retention Factor (Rf)
Isolate	2.4	4.50	0.53

Table 7: Zone of Inhibition of the Extracts against Tested Microorganisms

Test Organism	DCM Extract	Ethyl acetate Extract	Methanol Extract
Methicillin Resist Staph aureus	22	24	26
Staphylococus aurues	24	23	26
Streptococus pyogenes	0	0	0
Corynebacterium ulecrans	21	24	27
Escherichia coli	20	22	24
Proteus vulgaris	0	0	0
Proteus mirabilis	0	0	0
Pseudomonas aeruginosa	23	25	28

Table 8: Minimum inhibition concentration of the extracts

Test Organism	DCM Extract	Ethyl acetate Extract	Methanol Extract
Methicillin Resist Staph aureus	**40**	**40**	**40**
Staphylococus aureus	**40**	**20**	**20**
Streptococus pyogenes	**ND**	**ND**	**ND**
Corynebacterium ulecrans	**20**	**40**	**40**
Escherichia coli	**20**	**20**	**40**
Proteus vulgaris	**20**	**ND**	**ND**
Proteus mirabilis	**ND**	**ND**	**ND**
Pseudomonas aeruginosa	**40**	**20**	**20**

Key: ND= Not detected

Table 9: Minimum Bactericidal Concentration of the extracts

Test Organism	DCM Extract	Ethyl acetate Extract	Methanol Extract
Methicillin Resist Staph aureus	40	40	40
Staphylococus aureus	40	20	20
Streptococus pyogenes	ND	ND	ND
Corynebacterium ulecrans	20	40	40
Escherichia coli	20	20	40
Proteus vulgaris	20	ND	ND
Proteus mirabilis	ND	ND	ND
Pseudomonas aeruginosa	40	20	20

Key: ND= Not detected

DISCUSSUION

Phytochemical screening of the *n*-hexane, dichloromethane, ethyl acetate, and methanol extracts of the stem bark of *Combretum lamprocarpum* revealed the presence of several biologically important secondary metabolites, including alkaloids, anthraquinones, flavonoids, tannins, glycosides, steroids, and triterpenes. These classes of phytochemicals are well documented for their antimicrobial potential, acting through mechanisms such as membrane disruption, enzyme inhibition, and interference with microbial metabolic pathways (Gambo and Isyaku, 2025). The detection of these compounds provides scientific justification for the traditional use of *C. lamprocarpum* in ethnomedicine for the treatment of infectious diseases.

Thin-layer chromatography (TLC) analysis was employed to assess the chemical complexity of the extracts and guide further purification. A solvent system consisting of 10% ethyl acetate in *n*-hexane was found to be most suitable for the *n*-hexane, dichloromethane, ethyl acetate extracts and the isolate, while 15% ethyl acetate in *n*-hexane was optimal for the methanolic extract. Silica gel-coated aluminum plates served as the stationary phase, enabling effective separation of the phytochemical constituents. The TLC profiles revealed eight prominent bands for the *n*-hexane extract, five for dichloromethane, three for ethyl acetate, two for methanol, and a single band for the isolate. These findings indicate varying degrees of compound complexity across the extracts and demonstrate that the constituents are amenable to separation by column chromatography.

The antibacterial activity of the dichloromethane, ethyl acetate, methanolic extracts, and the isolate showed appreciable inhibitory effects against selected bacterial strains. The zones of inhibition ranged from 21 to 28 mm, with the methanolic extract exhibiting the highest activity (24–28 mm). Specifically, the dichloromethane extract showed inhibition zones of 21–24 mm, ethyl acetate 22–25 mm, methanol 24–28 mm, and the isolate 21–25 mm. The extracts and isolate were active against methicillin-resistant *Staphylococcus aureus*, *Staphylococcus aureus*, *Corynebacterium ulcerans*, *Escherichia coli*, and *Pseudomonas aeruginosa*, while no activity was observed against *Streptococcus pyogenes*, *Proteus vulgaris*, and *Proteus mirabilis*, except in the case of the isolate.

According to Johnson and Case (1995), a zone of inhibition equal to or greater than 16 mm is indicative of microbial susceptibility. Based on this criterion, all active extracts of *C. lamprocarpum* can be classified as possessing significant antibacterial activity. The superior activity observed in the methanolic extract may be attributed to its ability to extract more polar bioactive compounds, such as flavonoids, tannins, and alkaloids, which are known for their strong antimicrobial effects.

Minimum inhibitory concentration (MIC) analysis further confirmed the antibacterial efficacy of the extracts and isolate, with MIC values ranging from 2.5 to 40 mg/mL. MIC determination is a critical parameter for assessing the potency of antimicrobial agents (Anarado *et al*., 2021). The relatively low MIC values obtained for some extracts suggest strong antibacterial potential. Overall, the observed antimicrobial activity of the stem bark extracts correlates well with the presence of pharmacologically active phytochemicals such as steroids, flavonoids, alkaloids, terpenoids, and tannins, which have been widely reported to exhibit antimicrobial properties (Silén *et al*., 2023). These

results collectively support the ethnomedicinal relevance of *C. lamprocarpum*.

CONCLUSION

This study demonstrated that the stem bark of *Combretum lamprocarpum* contains a diverse array of bioactive phytochemical constituents. The TLC profiles revealed multiple components across the four solvent extracts, indicating chemical diversity and suitability for further purification. Antibacterial evaluation showed notable activity against selected pathogenic microorganisms, with zones of inhibition ranging from 21 to 28 mm and MIC values between 2.5 and 40 mg/mL. The observed antibacterial effects, coupled with the presence of pharmacologically relevant phytochemicals, provide strong scientific support for the traditional use of *C. lamprocarpum* in the treatment of infectious diseases. These findings suggest that the stem bark of *C. lamprocarpum* is a promising source of antimicrobial agents and warrants further investigation for isolation and characterization of its active compounds.

REFERENCES

Anarado, C. E., Ajiwe, V. I. E., Obumselu, O. F., & Anarado, C. J. O. (2021). Anti-inflammatory and Antimicrobial Screening of Leaf Extracts of Combretum platypterum (Welw) Hutch & Dalziel. *Journal of Pharmaceutical Research International*, 39–61. https://doi.org/10.9734/JPRI/2021/v33i52A33556.

Bantho, S., Naidoo, Y., Hassan, Y., & Singh, M. (2023). South African Journal of Botany A review on the secretory structures, bioactive compounds and biological activities of selected Combretum species. *South African Journal of Botany*, *158*, 18–30. https://doi.org/10.1016/j.sajb.2023.04.038.

Davis, C. C., & Choisy, P. (2024). Medicinal plants meet modern biodiversity science. *Current Biology*, *34*(4), R158–R173. https://doi.org/10.1016/j.cub.2023.12.038.

Fawehinmi, A. B., Hassan Lawal, E. U. Chimezie, and A. T. Ola-Adedoyin. 2022. "Quantitative and Qualitative Phytochemical Screening and Anti-Microbial Activities of Argemone Mexicana Linn". *Journal of Pharmaceutical Research International*, 34 (54B):33-45. https://doi.org/10.9734/jpri/2022/v34i54B7241.

Fazeli-nasab, B., Valizadeh, M., & Beigomi, M. (2022). Evaluation of Antioxidant and Antimicrobial Activity of Some Medicinal Plant Extracts on Escherichia coli Isolated from Poultry Feces. *Journal of Medicinal Plants and By-products,* 265-275. https://doi.org/10.22092/jmpb.2021.353243.1319.

Gambo, Z. B., & Isiyaku, A. (2025). Efficacy of Combretum Lamprocarpum Leaf Extracts as Control on Alternaria porri Causing Purple Blotch of Onion in Adamawa State*, Research Journal of Pure Science and Technology,* 82–95. https://doi.org/10.56201/rjpst.vol.8.no11.2025.pg82.95.

Head, C., Bamola, N., Verma, P., Negi, C., Head, C., & Pradesh, U. (2018). A Review on Some Traditional Medicinal Plants. *International journal of life science and scientific research,* 1 550–1556. https://doi.org/10.21276/ijlssr.2018.4.1.7.

Hutch, C. B., Combretaceae, D., Mba, T., Obinna, O., Ginikachukwu, U., & Micheal, C. (2022). Quantitative Phytochemical Analysis and Antidiarrhoeal Activity of Methanol Leaf Extract. *World Journal of Pharmaceutical Research11*(1), 1607–1622. https://doi.org/10.20959/wjpr20221-22469.

Jamshidi-kia, F., Lorigooini, Z., & Amini-khoei, H. (2018). Medicinal plants *:* Past history and future perspective: A review. *Journal of herbmed pharmacology*, *7*(1), 1–7. https://doi.org/10.15171/jhp.2018.01.

Kizito, Ibrahim Gadaka, Bello, Isaac Asuseyi., Ayo, Racheal Grace, & Isyaku, I. (2020). Phytochemical Screening and Antibacterial Studies of the Leaf Extract of Combretum Lamprocarpum Diels (Combretaceae). *FUDMA Journal of Sciences*, *4*(1), 85–88. https://www.fjs.fudutsinma.edu.ng/index.php/fjs/article/view/21.

Latif, R. (2025). Medicinal plants and human health : a comprehensive review of bioactive compounds, therapeutic effects, and applications. In *Phytochemistry Reviews* (Vol. 7). Springer Netherlands. https://doi.org/10.1007/s11101-025-10194-7.

Marquardt, P., Seide, R., Vissiennon, C., Schubert, A., Birkemeyer, C., Ahyi, V., & Fester, K. (2020). Activity of Combretum Collinum Fresen Leaves Extracts from Benin. *Molecules* 1–18.

Monawer, A. T., Mohammed, I., & Mammani, A. (2023). Antibacterial Activity of Ethanolic extracts of

Plantago major leaves against Pseudomonas aeruginosa from burn infections.*J Infect Dev Ctries* 17(2):276-280. https://doi.org/10.3855/jidc.17576.

Onocha, P. A., Audu, E. O., & Ekundayo, O. (2005). Phytochemical and Antimicrobial Properties of Extracts of Combretum racemosu. *Molecules*, 97–101.

Prasathkumar, M., Anisha, S., Dhrisya, C., Becky, R., & Sadhasivam, S. (2021). Phytomedicine Plus Therapeutic and pharmacological efficacy of selective Indian medicinal plants – A review. *Phytomedicine Plus*, *1*(2), 100029. https://doi.org/10.1016/j.phyplu.2021.100029.

Renata, L.,_azara de Araujo, C., Lilibeth Carvalho de Pinho, Fabiane Oliveira Farias, Luciana Igarashi-Mafra, Marcos R. M. (2022). *Crinum* L. species as a potential source of alkaloids: Extraction methods and relevance on medicinal and pharmacological, South African Journal of Botany 151, 720_734.

Silén, H.; Salih, E.Y.A.; Mgbeahuruike, E.E.; Fyhrqvist, P. (2023). Ethnopharmacology, Antimicrobial Potency, and Phytochemistry of African Combretum and Pteleopsis Species (Combretaceae): A Review. *Antibiotics*, 12, 264. https://doi.org/10.3390/12020264.

Theodoridis, S., Drakou, E. G., Hickler, T., Thines, M., & Nogues-bravo, D. (2023). Personal View Evaluating natural medicinal resources and their exposure to global change. *The Lancet Planetary Health*, *7*(2), e155–e163. https://doi.org/10.1016/S2542-5196 (22)00317-5.

Wilson, D; Shagal, M. H; Christopher, K; Suleiman, H. (2024). Phytochemicals and Antimicrobial Activity of Crude Extracts of Fresh Leaves and Stem Bark of Faidherbia albida. *J. Appl. Sci. Environ. Manage*. 28 (10B Supplementary) 3471-3476.