



Comparative Phytochemical and *In Vitro* Antimicrobial Activities of Four Nigerian Medicinal Plants

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Abstract

Medicinal plants play significant role in healthcare delivery system as it have been utilized in the treatment and prevention of several diseases. Despite their importance, these plants are seldom handled within an organized and regulated sector; however, there is little regard to their future sustainability. This research was aimed at validating the phytochemical contents and *in vitro* antimicrobial effects of the extracts of the rootbark of *Hamatostaphis barteri*, stembark of *Milicia excelsa*, rootbark of *Parkia biglobosa* and aerial part of *Polygonum senegalensis* using standard methods. The plants were found to contain variably: alkaloids, anthraquinone, cardiac glycoside, flavonoid, saponins, tannins and terpenoids. Antimicrobial activities were assayed on *Bacillus cereus*, *Bacillus subtilis*, *Staphylococcus aureus*, *Streptococcus pyogenes*, *Escherichia coli*, *Klebsiella pneumonia*, *Pseudomonas aeruginosa*, *Shigella dysenteriae*, *Aspergillus niger* and *Candida albicans*. *Hamatostaphis barteri* was resistant to most of the organisms except against *Klebsiella pneumoniae* with 10.00±0.00 mm. The extracts of *Milicia excelsa*, *Parkia biglobosa* and *Polygonum senegalensis* respectively inhibit with highest activity the growth of: *Bacillus subtilis* (21.33±0.58, 18.00±0.00, 19.67±0.58 mm) and *Klebsiella pneumonia* (20.00±0.00, 10.00±0.00, 18.67±1.15 mm). *Milicia excelsa* exhibited 20.00±0.00 mm against *Candida albicans*. The highest MBC/MIC was shown by *Milicia excelsa* against *Bacillus subtilis* and *Staphylococcus aureus* at 25.00/12.50 mg/mL while the lowest MBC/MIC of 50.00/25.00 mg/mL were expressed by *Milicia excelsa*, *Parkia biglobosa* and *Polygonum senegalensis* respectively against *Candida albicans*, *Bacillus subtilis* and *Pseudomonas aeruginosa*. Therefore, *Milicia excelsa* is the most highly active broad-spectrum extract followed by *Polygonum senegalensis* and *Parkia biglobosa*. Therefore, these activities against the test microorganism indicated that the extracts from most of these medicinal plants have a scientific backing in their use in the African Traditional medicine owing to their effects against various microbial related infections.

Introduction

Natural products from plants, animals and minerals are the basis for treating human diseases since human existence. Natural product is a chemical compound or substance produced by living organisms including plants, animals, and microorganisms. (Cutler and Cutler, 2000). Presently, the demand and acceptance of medicinal plants are increasingly progressing (Cutler and Cutler, 2000).

African Traditional Medicine is among the oldest, and perhaps the most assorted of all therapeutic systems. Africa is considered to be the cradle of mankind with a rich biological and cultural diversity marked by regional differences in healing practice (Gurib-Fakin, 2006; Gurib-Fakin and Mahomoodally, 2013). The traditional healer typically diagnosed and treats the psychological basis of all illness before prescribing medicines, particularly medicinal plants to treat the symptoms (Gurib-Fakin *et al.*, 2006). The African continent has a long history with the use of plants for medicinal purposes; in some of its countries, up to 90% of the population relies on medicinal plants as a source of drugs (Neuwinger, 1996). Herbal drugs are prescribed widely because of their effectiveness, less side effects and relatively low cost (Venkatesh *et al.*, 2003). Therefore, investigation of plants for their pharmacological values has become very necessary and more important (Suba *et al.*, 2004). Recently there has been increasing quest in the investigation of different extracts obtained from medicinal plants as potential source of new antimicrobial agents (Bonja and Farrokhi, 2004). In recent years, the use of information about traditional medicinal plants research has again received substantial interest; but not

until the 19th Century that humans began to isolate the active principles of medicinal plants (Pezzuto, 1997). Such medicinal plants include part(s) of: *Hamatostaphis barteri* Hook F., *Milicia excelsa* (Welw.) C. C. Berg., *Parkia biglobosa* (Jacq.) R. Br. Ex. G. Don. and *Polygonum senegalensis* Meisn. among other numerous to mention

Haematostaphis barteri Hook F. belongs to the family Anacardiaceae (Bokhari and Ahmed, 1979). *Haematostaphis barteri* is called *Blood plum* in English, *Jinin kafiri* in Hausa and *Tursha* in Babur language (Bokhari and Ahmed, 1979). The tree is widely distributed in most parts of Nigeria. The fruit of *H. barteri* can be used in producing drugs for the treatment of sickle cell, toothache, pile while the flower can be used topically as drug for skin disease (Bokhari and Ahmed, 1979). Diseases treated with *H. barteri* include cold (62.5% of the interviewees), malaria (26.25%), snake bite (7.5%), diarrhoea (2.5%) and child growth (2.5%). It is used to a smaller extent as laxative (1.25%) or to treat anaemia (1.25%). (Biaou *et al.*, 2017). The plant is used variously in Northern Nigeria in the management of ailments such as cancer (Kubmarawa *et al.*, 2007), stomach ache, and vomiting (Rabo and Sanusi, 2001, Ezekiel *et al.*, 2023), anaemia and haemorrhoid. Different ethnic groups in Ghana use the leaves and bark infusion of *H. barteri* in the treatment of malaria, hepatitis and sleeping sickness (Boampong *et al.*, 2015, Ezekiel *et al.*, 2023). Similarly, Wurochekke *et al.* (2014) reported the use of stem bark extract of the same plant in the management of trypanosomiasis. There were no much documented literatures on the antimicrobial activities from the parts

under study, hence the purpose for this research

Milicia excelsa is synonymous to *Azadirachta excelsa*, although the synonym is rarely used in scientific literature (Iswanto *et al.*, 2010), belongs to the family Meliaceae (Iswanto *et al.*, 2010, Jones *et al.*, 2011, Liu *et al.*, 2021, Ramanan *et al.*, 2024). It is generally called *rock-elm* in English, Yoruba and Hausa people called it *loko* (Odugoye 2015). The plant is known to Igbos as *oji* while Idoma speakers refer to it as *uloko* (Onuwa and Udobata, 2010). Its bark, root, leaves and latex are used to prepare ethnomedicines for the treatment of cough, fever, backache, toothache, abdominal pain, oedema, venereal diseases, hepatitis, liver diseases and hemostasis (Ndencho, 2009); and also possesses anti-fungal activities (Onuorah, 2000). To date, very few reports are available on the antimicrobial efficacy of the rootbark extracts of the plant *Milicia excelsa*.

Parkia biglobosa is a dicotyledonous angiosperm belonging the family Fabaceae.. Locally called African locust bean in English; *runo* in Kanuri; *dorawa* in Hausa, *ogiriokpi* in Igbo, *narghi* by Fulani people, it is known as *iru* in Yoruba, and *Nonna* among Babur Bura speaking group (USDA, 2017, Lompo *et al.*, 2018, Enoch *et al.*, 2025). The tree may grow to heights of up to 20 m and is found throughout West, Central, and East Africa (Lompo *et al.*, 2018, Enoch *et al.*, 2025). The plant has been used for centuries in traditional medicine to treat a variety of conditions including anemia, constipation, diarrhea, and fever (Olowokere *et al.*, 2018, Enoch *et al.*, 2025). In West Africa, the barks, roots, leaves, flowers, fruits and seeds are commonly used in traditional medicine to treat wide array of complaints. The roots have been reported to be used to treat

wound infections in Burkina Faso (Heuze *et al.*, 2018). *P. biglobosa* promotes good sight, reduces hypertension and diseases (like stroke and diabetes), served a lot of medicinal uses and treatments like Malaria, wounds, dysentery, rheumatism, headache, pain, fungal infection, tonic, anti-diarrhoea, female sterility, skin infection, leprosy, blennorrhoea, Schistosoma infection, sores, ulcers, mumps, antiemetic, severe colic, snake bites, diabetes, palpitation eye lotion, toothache, burns, fever, haemorrhoids, constipation, anorexia, bronchitis, whooping cough, amenorrhoea, skin eruption, abscess, stomach ache, yellow fever, conjunctivitis, Sedative, diuretic, purgative, tension, mouth ulcers, wasp and bee sting, bronchitis and pneumonia (Shao, 2002, Ayanrinde *et al.*, 2023). Even though, there were reports on the activities of the plant, but they were scanty and more so, the species studied varied across the sample's place of collection, method of extraction, solvents of extraction and period of sampling. Therefore, much need to explore the extracts against these microbes with the view to finding extract with best activity.

Polygonum senegalensis is a perennial herb of the family Polygonaceae (Akoegninou *et al.*, 2006). It is locally called *Rimin kuda* in Hausa and *Njaragiya* in Kanuri. The whole plant decoction is used as a remedy for colic pain, pneumonia and the boiled paste is applied in cuts and wounds (Koche *et al.*, 2008). Moreover, they are considered as traditional medicines to treat disorders; like dyspepsia, haemorrhoids, diarrhoea and itchy skin (Khatun *et al.*, 2015). Numerous research have been undertaking on some parts of the plant, however, there is little literature on the antimicrobial studies of entire aerial part of the plant especially against the test microorganism under study

This study was therefore, aimed to validate the phytochemical contents and report the *in vitro* antimicrobial activities of the parts

of these plants as a succor against diarrhoea, dysentery, wound infections among others.



(a). *Haematostaphis barteri*



(b). *Milicia excelsa*



(c). *Parkia biglobosa*



(d). *Polygonum senegalensis*

Figure 1. Aerial view of: (a). *Haematostaphis barteri* tree (b). *Milicia excelsa* tree (c). *Parkia biglobosa* tree (d). *Polygonum senegalensis* (Photo Credit: Researchers, 2018).

Materials and Methods

Sample Collection and Identification

All the plant samples were collected in December, 2018. The rootbark of *Haematostaphis barteri* was collected from Ghuma village, Hawul L.G.A., Borno State; the stembark of *Milicia excelsa* was collected from Okokolo village, Agatu L.G.A., Benue State; the rootbark of *Parkia biglobosa* was collected from Degubi village, Nangere L.G.A., Yobe State; while the aerial part of *Polygonum senegalensis* was collected from Zabarmari village, Jere L.G.A., Borno State, Nigeria. The plant samples were individually identified and authenticated by a Taxonomist from the Department of Botany, Faculty of Life Sciences, University of Maiduguri, Nigeria, where the voucher specimen numbers: 18.CH020, 16.CH.03, 17.CH020 and 15.CH02 were respectively deposited. The plant materials were air-dried independently under shade until complete dryness and later pulverized into coarse powder using wooden mortar and pestle.

Extraction of Plant Material

Two hundred and fifty grams (250 g) each of the ground plant materials were independently extracted with 80% methanol using maceration technique for 72 hours. Briefly, each plant material was placed in a transparent corked 3 L container followed by the addition of the solvent (total of 1500 mL was used) and intermittently shaken for about 5 minutes. The content was then allowed to stand for 24 hours in the first instance and then decanted. This procedure was repeated until 72 hours for all the samples. The solution were then individually filtered using Whatman No. 1 filter paper. The choice of

methanol as solvent of extraction was supported by Lin *et al.*, (1999) and Parekh *et al.*, (2006); who reported that methanol is a better solvent to be considered more for the extraction of antimicrobial substance from medicinal plants compared to other solvents such as water, ethanol and hexane. The combined methanol extract of each sample was independently filtered using Whatman No. 1 and concentrated to dryness under reduced pressure using rotary evaporator with model number: RE-52A. Upon complete dryness each of the extract coded respectively as HBME (*Haematostaphis barteri* Methanol Extract), MEME (*Milicia excelsa* Methanol Extract), PBME (*Parkia biglobosa* Methanol Extract) and PSME (*Polygonum senegalensis* Methanol Extract) and later kept in a desiccator until required for qualitative phytochemical screening and *in vitro* antimicrobial susceptibility studies.

Phytochemical Evaluation

Qualitative phytochemical evaluations of the secondary metabolites present in the extracts of HBME, MEME, PBME and PSME were evaluated using standard procedures as described (Brain and Tuner, 1975; Vishnoi, 1979; Silva *et al.*, 1998; Evans, 2009; Hatil *et al.*, 2015).

Antimicrobial Studies

Test Microorganisms

A total of ten (10) microorganisms were used in this study: *Bacillus cereus*, *Bacillus subtilis*, *Staphylococcus aureus* and *Streptococcus pyogenes* (Gram positive); *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Shigella dysenteriae* (Gram positive), while *Aspergillus niger* and *Candida albicans* were fungal strains. The microorganisms were sourced from faecal and wound samples obtained from the Department of

Veterinary Medicine, University of Maiduguri. The microorganisms were isolated, characterized using various identification techniques such as biochemical test, staining technique, viability test, morphological examinations etc. and then stored on agar slant until use.

Preparation of the Culture Media

The nutrient agar (NA) and sabouraud dextrose agar (SDA) were the media employed for bacterial and fungal culture assay. The NA media was prepared by dissolving 28 g of the nutrient agar powder in 1000 mL of distill water, while 30 g of SDA was dissolved in 1000 mL of distill water. They were sterilized at 121 °C for 15 minutes in an autoclave and subsequently allowed to cool to about 45-50 °C and poured on the petri dish and allowed to gel (Lennette *et al.*, 1968).

Disc Diffusion Technique

The Disc diffusion method was used in this study as described by Vollekova *et al.* (2001), as modified by Usman *et al.* (2005). The test was carried out using a stock concentration of 400 mg/mL, 200 mg/mL, and 100 mg/mL by dissolving 4 g, 2 g, and 1 g of the crude extract in 10 mL of 80% methanol respectively. Three holes were bored (6 mm) in each plate using sterile cork-borer. The isolated organisms were introduced into the petri dish differently as labeled using poured plate method. About 0.2 mL each of the extract solution was inoculated across the well and incubated overnight at 37 °C for 24 hours for the bacteria and 37 °C for 2-3 days for fungal strains. At the end of the incubation period, diameter zones of inhibition were measured in millimeter (mm) by transparent meter rule and was recorded as Mean±SE.

Determination of Minimum Inhibitory Concentration (MIC)

Minimum inhibitory concentration (MIC) was determined using the nutrient agar broth dilution technique as described by (Vollekova *et al.*, 2001; Usman *et al.*, 2005; Usman *et al.*, 2018). The MIC was determined for the microorganisms that were initially susceptible to each of the crude extract under study. The stock extract concentration of 100 mg/mL was made by dissolving 1 g of each of the active extract in 10 mL of 80% methanol and the working concentration prepared by two-fold serial dilution technique that range from 6.25 mg/mL to 100.00 mg/mL using nutrient broth and later incubated with 0.2 mL of suspension of the organisms. After 24 hours incubation at 37 °C, the test tubes were then observed for turbidity; the concentration of the test tube with no turbidity was noted and recorded as MIC (Usman *et al.*, 2005; Usman *et al.*, 2018).

Determination of Minimum Bactericidal Concentration (MBC)

The minimum bactericidal concentration was determined from broth dilution test resulting from the MIC tube by inoculating the content of each test tube on a nutrient agar plate. The plates were then incubated at 37 °C for 24 hrs. The lowest concentration of the extract which showed no growth was noted and recorded as the minimum bactericidal concentration (Vollekova *et al.*, 2001; Usman *et al.*, 2005; Usman *et al.*, 2018).

Results

The weight, percentage yield, colour and texture of the extracts of the rootbark of *Hamatostaphis barteri*, stembark of *Milicia excelsa*, rootbark of *Parkia biglobosa* and aerial part of *Polygonum senegalensis* were respectively: 40.0 g [16.0%] (reddish-brown amorphous powder), 22.5 g [9.0%]

(brown gummy mass), 38.3 g [15.3%] (dark-brown mass) and 30.0 g [12.0%] (dark-green paste). The results of the phytochemical screening of the extracts from the rootbark of *Hamatostaphis barteri*, stembark of *Milicia excelsa*, rootbark of *Parkia biglobosa* and aerial part of *Polygonum senegalensis* is presented in Table 1 below. Figures 2a,b,c shows results of susceptibility effects on some pathogenic microbes on the extracts of rootbark of

Hamatostaphis barteri, stembark of *Milicia excelsa*, rootbark of *Parkia biglobosa* and aerial part of *Polygonum senegalensis* at 80, 40 and 20 mg/hole. The results of the minimum inhibitory and minimum bactericidal concentrations of the extracts of stembark of *Milicia excelsa*, rootbark of *Parkia biglobosa* and aerial part of *Polygonum senegalensis* against susceptible microorganisms are presented in Table 2 below.

Table 1. Phytochemical content of the extracts of the methanol rootbark of *Hamatostaphis barteri*, stembark of *Milicia excelsa*, rootbark of *Parkia biglobosa* and aerial part of *Polygonum senegalensis*

S/No.	Phytochemicals	Test	<i>Hamatostaphis barteri</i>	<i>Milicia excelsa</i>	<i>Parkia biglobosa</i>	<i>Polygonum senegalensis</i>	
1.	Alkaloids	Dragendorff's Test	-	+	+	-	
		Mayer's Test	-	+	+	-	
		Wagner's Test	-	-	-	-	
2.	Anthraquinones	Free Anthraquinones	Borntrager's Test	-	-	-	-
		Combined Anthraquinones	Borntrager's Test	+	+	+	-
		Cardiac glycosides	Keller-Killiani Test	+	+	+	+
4.	Flavonoids	Shinoda's Test	+	+	+	+	
		Ferric chloride (Braymer's Test)	+	+	+	-	
		NaOH Test	-	-	-	+	
		Lead acetate Test	+	-	+	+	
5.	Saponins	Frothing Test	+	+	+	+	
		Fehling's Test	+	-	+	+	
6.	Tannins	Ferric chloride (Braymer's Test)	+	-	+	+	
		Lead acetate Test	+	-	-	-	
7.	Terpenoids	Liebermann-Burchard;s Test	+	+	+	+	

Key: + = Present, - = Absent

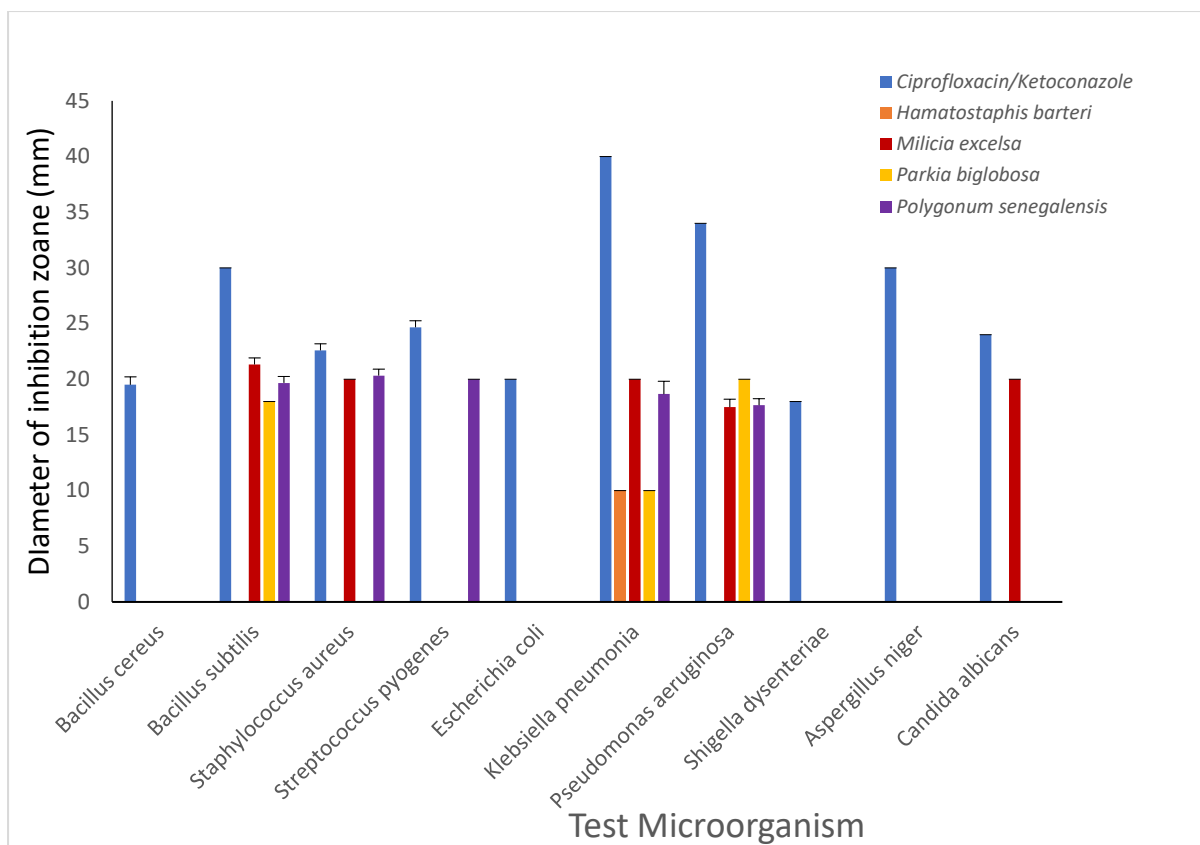


Figure 2a. Antimicrobial activities of the extracts of the methanol rootbark of *Hamatostaphis barteri*, stembark of *Milicia excelsa*, rootbark of *Parkia biglobosa* and aerial part of *Polygonum senegalensis* at 80 mg/hole

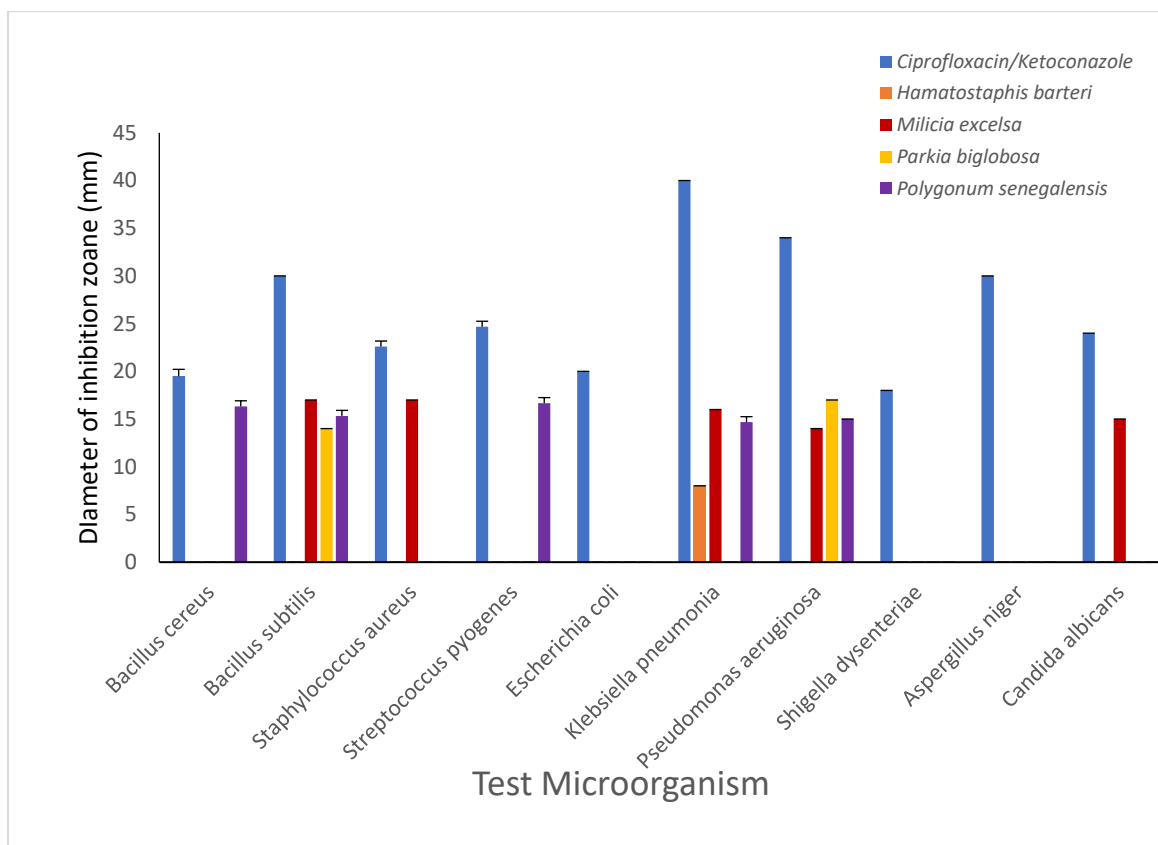


Figure 2b. Antimicrobial activities of the extracts of the methanol rootbark of *Hamatostaphis barteri*, stembark of *Milicia excelsa*, rootbark of *Parkia biglobosa* and aerial part of *Polygonum senegalensis* at 40 mg/hole

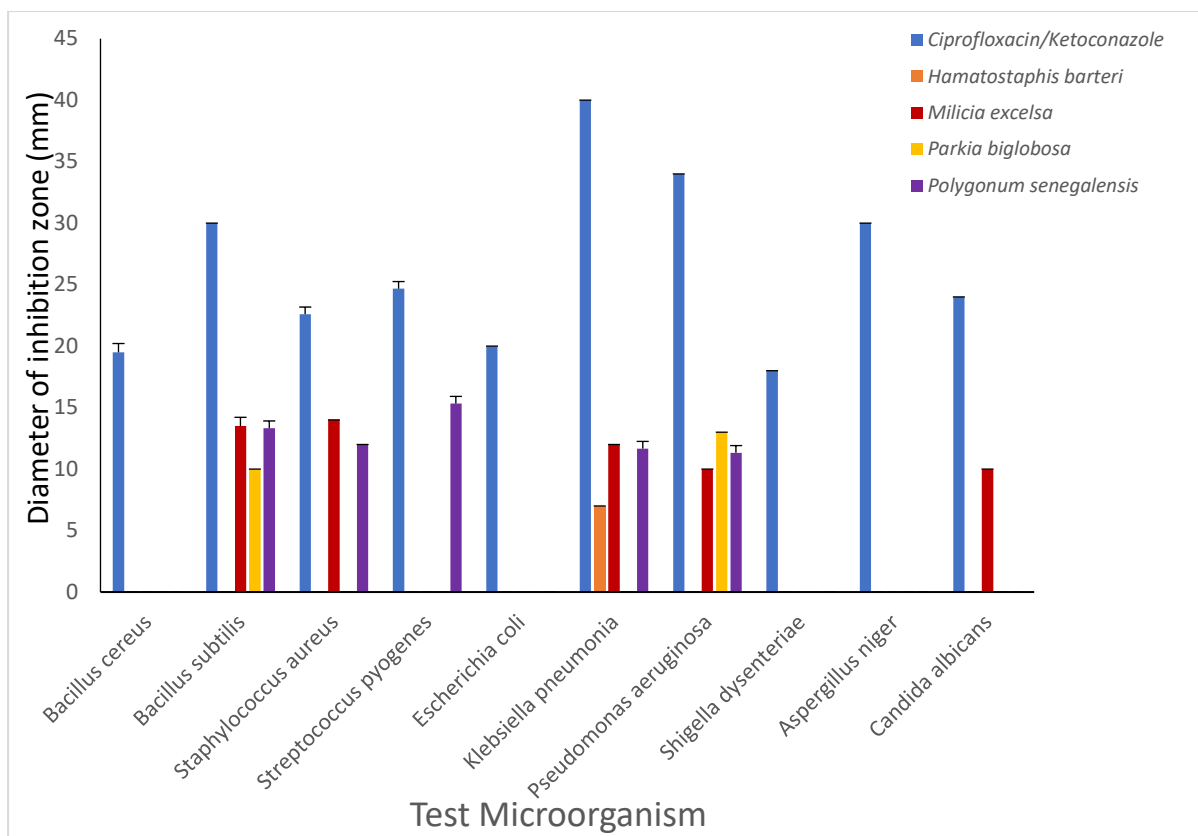


Figure 2c. Antimicrobial activities of the extracts of the methanol rootbark of *Hamatostaphis barteri*, stembark of *Milicia excelsa*, rootbark of *Parkia biglobosa* and aerial part of *Polygonum senegalensis* at 20 mg/hole

Table 2. Minimum Inhibitory and Minimum Bactericidal Concentrations of the methanol extracts of stembark of *Milicia excelsa*, rootbark of *Parkia biglobosa* and aerial part of *Polygonum senegalensis* against susceptible microorganisms

S/No.	Microorganism	Extract	Concentrations (mg/mL)				
			100.00	50.00	25.00	12.50	6.25
1.	<i>Bacillus subtilis</i>	<i>Milicia excelsa</i>	-	-	MBC	MIC	+
		<i>Parkia biglobosa</i>	-	MBC	MIC	+	+
		<i>Polygonum senegalensis</i>	-	-	MBC	MIC	+
2.	<i>Staphylococcus aureus</i>	<i>Milicia excelsa</i>	-	-	MBC	MIC	+
		<i>Polygonum senegalensis</i>	-	MBC	MIC	+	+
3.	<i>Klebsiella pneumoniae</i>	<i>Milicia excelsa</i>	-	MBC	MIC	+	+
		<i>Polygonum senegalensis</i>	-	-	MIC/MBC	+	+
4.	<i>Pseudomonas aeruginosa</i>	<i>Milicia excelsa</i>	-	MBC	MIC	+	+
		<i>Parkia biglobosa</i>	-	-	MIC/MBC	+	+
		<i>Polygonum senegalensis</i>	-	MBC	MIC	+	+
5.	<i>Candida albicans</i>	<i>Milicia excelsa</i>	-	MBC	MIC	+	+

Key: + = growth - = no growth

Discussion

The preliminary phytochemical investigations of the crude methanol extracts of *Haematostaphis barteri* (rootbark), *Milicia excelsa* (stembark), *Parkia biglobosa* (rootbark) and *Polygonum senegalensis* (aerial part) are presented in Table 1. The results revealed the presence of bioactive compounds like alkaloids, anthraquinones, cardiac glycoside, flavonoids, saponins and terpenoids. *Haematostaphis barteri* rootbark extract contained most of the constituents except alkaloids which was absent. However, the phytochemical results presented by Tadzabia *et al.* (2013), on the stembark and leaf extracts were that alkaloids was present. The phytochemical constituents observed in *M. excelsa* are similar to those reported by (Udegbunam *et al.*, 2013), except for tannins which was present but absent in our findings. The variation observed with that of Udegbunam and co-workers could possibly be due to the part used, age of the plant, humidity, climate, soil conditions, geographical location, time of harvesting and the method of extraction (Shagal *et al.*, 2009). Although, all the secondary metabolites mentioned above were present in *P. biglobosa*; yet, it wasn't active against most of the organisms tested; while anthraquinones and alkaloids were absent in *P. senegalensis*; similar to the earlier work conducted in Egypt by Abdel-Gawad and El-Zait (1982).

These secondary metabolites have been reported by several authors to be responsible for pharmacological and biological effects both *in vitro* and *in vitro* exhibited by plant extract (Hassan *et al.*, 2004; Usman *et al.*, 2005; Usman *et al.*, 2018). Flavonoid, terpenoid and alkaloid are known to have antimicrobial properties

against some pathogenic bacteria due to its ability to complex with extracellular, soluble protein and to complex with bacteria cell wall protein (Cowan 1999; Usman *et al.*, 2007; Musa *et al.*, 2008; Usman *et al.*, 2018). Flavonoids have been known to be biosynthesized in plant in response to many microbial infestations (Dixon *et al.*, 1983; Al-Bayati and Al-Mola, 2008). Based on the above references, it can therefore be asserted that the flavonoids, alkaloids and saponins and other metabolites present in the extracts especially *M. excelsa* and *P. senegalensis* could have related mode of actions. Moreover, it has been stated earlier that the phytocompounds present in plant extracts are responsible for curative activity against several pathogens and therefore could explain their use in traditional medicine for the treatment of many different illnesses related to microbes (Hassan *et al.*, 2004; Usman *et al.*, 2005; Usman *et al.*, 2018).

The *in vitro* antimicrobial susceptibility test against some Gram positive, Gram negative organisms and fungal species are presented in Figures 2a,b,c. There was virtually resistance by the organisms at all concentrations of *H. barteri*; this could **probably be** due to low concentrations of the bioactive components at the studied concentrations in the extract. The highest activity (21.33 ± 0.58 mm) was exhibited against Gram positive bacteria- *B. subtilis*, at the highest concentration of 80 mg/hole, which was expressed by *M. excelsa* followed by *P. senegalensis* with diameter of inhibition zone of (20.00 ± 0.58 mm) against *S. aureus*; the highest activities on Gram negative bacteria was 20.00 ± 0.00 mm against *K. pneumonia* and *P. aeruginosa* respectively expressed by *M. excelsa* and *P. biglobosa*, However, *M. excelsa* was the only extract that showed

inhibition against *C. albicans*. The resistances posed by fungal strains on other extracts could not be unrelated with the complex nature of fungal cell wall which makes penetration of drug and other chemotherapeutic agents extremely difficult (Campbell, 1999). This presentation shows that the extracts are generally more active against Gram positive compared to Gram negative stains with extractive from *M. excelsa* being the most broad-spectrum and acted concentration-dependently in line with several reports in the literature.

The lowest MBC/MIC values of the active extracts stood largely between 50.0/25.0 mg/mL while highest MBC/MIC was around 25.0/12.5 mg/mL. The highest MBC/MIC was shown by *Milicia excelsa* against *Bacillus subtilis* and *Staphylococcus aureus*. this trend confirmed that *M. excelsa* is the most active of all the extracts investigated. Therefore, *Milicia excelsa* methanol stembark extract showed the best activity comparatively.

Generally, the extracts were observed to be more active against bacteria than fungi. Despite some low susceptibility pattern shown by the extracts on most organisms

References

- Abdel-Gawad MM and El-Zait SA (1982). Flavonoids of *Polygonum senegalensis* growing in Egypt, Medicinal Chemistry Department, Theodor Bilharz Institute, Nat. Res. Centre Cairo Dokki Egypt, 239-240.
- Akoegninou A, Vander Burg W and Vander Maesen LJ (2006). Flore analytique du Bénin, Baekhuys Publisher p. 600.
- Al-Bayati FA and Al-Mola HF (2008). "Antibacterial and antifungal activities of different parts of *Tribulus*

under study, it could be surmised that the extracts have considerable activity as was suggested much earlier, that plant extractive with diameters of inhibition zone ≥ 10 mm are considered active (Zwadyk *et al.*, 1972; Usman *et al.*, 2005; Usman *et al.*, 2018). Furthermore, Hiremath *et al.* (2012), reported that, zones of inhibition (mm) ≤ 08 , 09-11, 12-15, 16-18, and ≥ 19 were respectively considered as inactive, weakly active, moderately active, highly active and highest active.

Conclusion

Based on our findings, it can be concluded that *Melia excelsa* extract was highly active against Gram positive, Gram negative bacteria and fungal species while *Polygonum senegalensis* and *Parkia biglobosa* extract were shown to be active only towards Gram positive and Gram negative bacteria. However, there was no activity shown expressed by the extract of *Hamatostaphis barteri* against all the test microorganism. The traditional use of *Hamatostaphis barteri* as medicine against microbial-related infections have no scientific support. Therefore, this study will serve as a foresight for research against the test microorganism by the extracts from the plants studied.

terrestris L. Growing in Iraq". *Journal of Zhejiang Universal Science*, **B.9(2)**: 151-159.

- Ayanrinde FA, Oyewole SO, Ayanrinde OA and Ayewole AL (2023). "Importance of *Parkia biglobosa* (African locust beans) to the women livelihoods in Ibarapa North and Ibarapa Central Local Government Areas of Oyo State, Nigeria". *Journal of Applied Science Environmental Management*. **27(9)**: 2097-2100.

- Biaou SSH, Moutouama JK, Dan BSC, Amahow OI, Moutouama FT and Natta AK (2017). "Uses of *Haematostaphis barteri* Hook. F. among the Waaba and Bètammariè in North-Benin and impact on the species vulnerability". *International Journal of Biodiversity and Conservation* **9(5)**: 146-157.
- Boampong JN, Karikari, AA and Elvis O. (2015). "In vivo antiplasmodial and in vitro antioxidant properties of stem bark extracts of *Haematostaphis barteri*". *Asian Journal of Tropical Biomedicine*, **5(6)**: 446 – 450.
- Bokhari MH and Ahmed MJ (1979). Food Plants in Borno State Nigeria. University Press, Maiduguri, Nigeria. pp.20-21.
- Bonja C and Farrokhi K (2004). The Bactericidal Activities of *Amoxicillin* with Other Antimicrobial Agent. *J. Antimicrob. Chemother.*, **3**: 273.
- Brain KR and Turner TD (1975). The Practical Evaluation of Phytopharmaceuticals. *Wright Science Technica*. Bristol. pp. 140-144, 152-154.
- Campbell CS, Judd, WS, Kellogg EA, Steven PF and Donoghue MJ (1999). Plant Systematic, A Phylogenetic Approach. Sunderland, M.A. *Sinaver Associates, Inc.* pp. 1-620.
- Cowan M (1999). "Plant products as antimicrobial agents". *Clinical Microbiology Reviews*, **12(4)**: 564-582.
- Cutler S and Cutler HG (2000). Biologically Active Natural Products: Pharmaceuticals. *CRC Press*. p. 5.
- Dixon R, Dey P and Lamb C (1983). Phytoalexin: Enzymology and Molecular Biology". *Adv. in Enzymol.*, **55**:1-69.
- Enoch OC, Chigozie LI, Nwangwu SC, Ibeabuchi CG, Ikechukwu UK, Ogochukwu AR, Chukwuebuka EV, Victoria, AI and Oruaro AF (2025). Estimation of the nutritional values of African locust bean *Parkia biglobosa*. *Science Asia* **1(1)**: 01-15.
- Evans, C.W. (2009). Trease and Evans Pharmacognosy. 15th Edition. Saunders Company Limited, London. pp. 572-585.
- Ezekiel, JS., Adamu HM, Chindo IY, Garba IH and Tadzabia K (2023). "Separation of antioxidant compounds from the stem bark extracts of *Haematostaphis Barteri* Hook F. (Anacardiaceae) using chromatographic techniques". *FUDMA J. Sci.*, **7(5)**: 50-53.
- Gurib-Fakin A (2006). "Medicinal plants, traditions of yesterday and drugs of tomorrow". *Molecular Aspects of Medicine*, **27(1)**:1-93.
- Gurib-Fakin A, Kotowaroo MI, Mahmoodaly MF and Subratty AH (2006). "Screening of traditional antidiabetic medicinal plants of Mauritius for possible *alpha amylase* inhibitory effect in vitro". *Phytotherapy Research*, **20(3)**: 228-31.
- Gurib-Fakin A and Mahmoodaly MF (2013). African Flora as Potential Sources of Medical Plants. Towards the Chemotherapy of Major Parasitic and other Infectious Disease is view. *Jordan J. Bio. Sci.*, **6**: 77-84.
- Hassan MA, Oyewale AO, Amupitan JO, Abdullahi MS and Okonkwo EM (2004). "Preliminary phytochemical and antibacterial investigation of crude extract of the rootbark of *Deterium microcarpum*". *Journal of*

- Chemical Society of Nigeria*, **29(1)**: 36-49.
- Hatil H, El-Kamali A and Ahmed AE (2015). "Preliminary phytochemical screening of 27 plants species use in ethnoveterinary in Khartoum State, Sudan". *Journal of Advances in Life Science*, **5(2)**: 48-52.
- Heuze V, Thiollet H, Tran G, Edouard N and Lebas F (2018). African Locust Bean (*Parkia biglobosa* and *Parkia filicoidea*). Feedipedia, a programme by INRA, CIRAD, AFZ and FAO.
- Hiremath DM, Hiremath SC and Yadawe MA (2012). "Study of antibacterial activities of indole derivatives". *Research Journal of Pharmaceutical, Biological and Chemical Science*, **3(1)**: 969.
- Iswanto, AH, Febrianto F, Wahyudi I, Hwang W-J, Lee S-H, Kwon, J-H Kwon, S-M, Kim N-H and Kondo T. (2010). Effect of pre-treatment techniques on physical, mechanical and durability properties of oriented strand board made from Sentang wood (*Melia excelsa* Jack). *J. Fac. Agric. Kyushu Univ.* **55**, 371–377.
- Jones AMP, Ragone D, Tavana NG, Bernotas DW and Murch SJ (2011). Beyond the Bounty, Breadfruit (*Artocarpus altilis*) for Food Security and Novel Foods in the 21st Century. *Ethnobot. Res. & Appl.* **9**: 129-149.
- Khatun A, Imam MZ and Rana MS (2015). "Antinociceptive effect of methanol extract of leaves of *Persicaria hydropiper* in mice". *BMC Complementary and Alternative Medicine*, **15(1)**: 63.
- Koche DK, Shirsat RP, Syed-Imran M, NafeesZingare AK and Donode KA (2008). "Ethnomedicinal survey of Nagzira wild life sanctuary, district Gondia (M.S.) India-Part II". *Ethnomedical Leaflets*, **1(8)**: 532-537.
- Kubmarawa D, Ajoku GA, Nwerem NM and Okorie DA. (2007). "Preliminary phytochemical and antimicrobial screening of 50 medicinal plants from Nigeria". *African Journal of Biotechnology*, **6(14)**: 1690-1696.
- Lennette EH, Balows AL, Hauslerjr WJ and Shadonmy HJ (1968). *Medios de Cultivo. International Manul De Microbiologia Clinica*, 3rd Edn, Buenos Aires: Editorial Medicapan Americana.
- Lin J, Opuku AR, Geheeb-Keller M, Hutchings AD, Terblanche SE and Jager AK (1999). Preliminary Screening of Some Traditional Zulu Medicinal Plants for Anti-Inflammatory and Antibacterial Activities. *J. Ethnopharmacol.*, **68**: 267-274.
- Liu, W-Q, Xu, S-L, Fu, Q-Y, Quan C and Jin J.-H (2021). Late Oligocene *Melia* (Meliaceae) from the Nanning Basin of South China and it's biogeographical implication. *J. Palaeogeog.* **10**, 16
- Lompo, D., B. Vinceti, H. Konrad, H. Gaisberger and T. Geburek, 2018. Phylogeography of African locust bean (*Parkia biglobosa*) reveals genetic divergence and spatially structured populations in West and Central Africa. *J. Hered.*, **109**: 811-824.
- Musa AM, Abbas G, Aliyu AB, Abdullahi MS and Akpulu IN (2008). "Phytochemical and antimicrobial screening of *Indigofera confertagillert* (Papilionacea)". *Medicinal plants*, **2(2)**:74-78.
- Ndencho, E.N. (2009). "Herbarium and resources for the development of *ethnopharmacology* in mount Cameroon region". *African Journal of Pharmacy and Pharmacology*, **3(3)**: 78-86.

- Neuwinger HD (1996). African Ethnology, Poison and Drugs. *Chapman and Hall, GMBH, Germany*. p. 343.
- Odugoye M (2015). The Sons of Gods and the daughter of Men: An afro-asiatic Interpretation of Genesis 1-11 wipf and Stock Publisher.
- Olowokere JA, Onen AI, Odineze MC, B'aga ID and J.N. Akoji JA (2018). Extraction and characterization of oil from African locust bean (*Parkia biglobosa*) seed. *Asian J. Appl. Chem. Res.*, **2**.10.9734/ajacr/2018/v2i229677 .
- Onuorah EO. (2000). The wood preservative potential of heartwood extract of *Milicia excelsa* and *Erytrophyleum suaveolens*". *Journal of Bio-Resources. Technology*, **75(2)**: 171-173.
- Onuwa A and Udobata R (2010). A Handbook of African Religion and Culture. *Dorrance Publishing*.
- Parekh J, Karathia N and Chanda S (2006). "Screening of some traditionally used medicinal plants for potential antimicrobial activity". *Turkish Journal of Biology*, **29**: 203-210.
- Pezzuto JM (1997). Plants-Derived Anti-Cancer Agents, Biochemical Pharmacology. *Int. J. Pharm.* **53**:121-133.
- Rabo, E. T. and Sanusi, S. S. (2001). An Inventory of Medicinal Plants of Nigeria Savannah, Jos: Leviathan Books. pp. 21- 24.
- Ramanan, SS, Arunachalam A, Uttam Kumar Sahoo UK and Upadhyaya K. (2024). Exploring Research Trends and Priorities of Genus *Melia*. *Sci. Reports*. **14**:6265.
- Shagal G, Ramathan SMN, Ismail S and Mansor SM (2009). "Phytochemical and antimicrobial activity of *swietenia mahagoni* crude methanol seed extract". *Journal of Tropical Biomedicine*, **26(3)**: 274-279.
- Shao, M (2002). *Parkia biglobosa*. Changes in Resources Allocated in Kandiga, Ghana. Master Thesis, Michigan Technologist University, United State of America.
- Silva LG, Lee IS and Kinghorn DA (1998): Special problem with the extraction of plants. In: Natural Products Isolation, Ed. Cannell RJP. (Humana Press Inc. 999, Riverview Drive, Suite 208, Totowa, New Jersey, USA). pp. 343-364.
- Suba V, Murugesan T, Rao RB, Ghosh L, Pal M, Mandal SC and Saha BP (2004). "Antidiabetic potential of *Barleria lupulina* extract in rats". *Journal of Phytomedicine*, **75(1)**: 1-4.
- Tadzabia K, Maina HM, Maitera ON and Ezekiel JS (2013). Evaluation of Phytochemical and Elemental Contents of *Haematostaphis barberi* Leaves and Stembark in Hong Local Government Area of Adamawa State, Nigeria. *J. Chem. & Pharmaceut. Res.* **5**: 150-156.
- Udegbunam SO, Nnaji TO, Udegbunam RL, Okafor JC and Agbo L (2013). "Evaluation of herbal ointment formulation of *Millica excelsa* (Welw.) C.C. Berg. for wound healing". *African Journal of Biotechnology*, **12(21)**: 3351-3359.
- USDA (2017). GRIN-Germplasm Resources Information Network. National Germplasm Resources Laboratory, *Bettsville Maryland*. U.S.A.
- Usman H, Haruna AK, Akpulu IN, Iiyas M, Ahmadu AA and Musa YM (2005). "Phytochemical and antimicrobial

screenings of the leaf extracts of (*Celtis integrifolia* Lam)". *Journal of Tropical Bioscience*, **5(2)**: 72-76.

Usman H and Osuji JC (2007). "Phytochemical and *in vitro* antimicrobial assay of the leaf extract of *Newbouldia laevis*". *African Journal of Traditional, Complementary and Alternative Medicines*, **4(4)**: 476-480.

Usman H, Kaigama AU, Ibisagba OO, Fulata AM and Ahmed IA (2018). "Phytoconstituents Evaluation and Antimicrobial Efficacy of the Crude Flavonoids and Saponins Rootbark Extracts of *Terminalia avicennioides* and *Ficus polita*". *Journal of Herbmed Pharmacology*, **7(2)**: 106-111.

Venkatesh S, Reddy GD, Reddy BM, Ramesh M and Rao AVNA (2003). Anti-hyperglycemic activity of *Caralluma attenuata*. *Fitoterapia*, **74(3)**: 274–279.

Volleková A, Kòst'álovà D and Sochorová R (2001). Isoquinoline Alkaloids from *Mahonia aquifolium* Stembark is Active Against *Malassezia spp.* *Folia Microbiol.*, **46**: 107-111.

Vishnoi NR (1979). Advanced Practical Chemistry. *Yikas Publication House, PVT Ltd.*, Ghaziabad-India. pp. 447-449.

Wurochekke, A., Usman, B. H., Yusuf, H. B. and Mahmoud, S. J. (2014) "*In vitro* trypanocidal activity of aqueous stem bark extract of *Haematostaphis barteri* against *Trypanosoma congolense* and *Trypanosoma brucei brucei*". *Scholars Academic Journal of Pharmacy*, **3(1)**: 38-42.

Zwadyk P (1972). Enteriobacteriaceae in Zinsser Microbiology. 20th Ed. *George Thiene Verlag*, Stuttgart. pp. 20-32.