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MINERAL, PHYTOCHEMICAL, AND ANTIMICROBIAL SCREENING OF *Pterocarpus erinaceus* (*stem bark and leave*) EXTRACTS.

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ABSTRACT

Pterocarpus erinaceus Poir. (Fabaceae), widely known as African rosewood or bar-wood, is a potential tree of high ethnomedicinal and economic significance across West Africa. This study presents a comprehensive experimental analysis focused on phytochemical screening, antimicrobial activity, and essential mineral composition of *P. erinaceus* stem bark and leaves collected from Pitchi area, Bida Niger State, Nigeria. The phytochemical screening revealed the presence of alkaloids, flavonoids, tannins, saponins, phenols, steroids, glycosides, and terpenoids, with the highest concentration generally observed in the stem bark. Agar well diffusion assays demonstrated significant inhibitory effects against Gram-positive *(Staphylococcus aureus)* and Gram-negative *(Escherichia coli, Pseudomonas aeruginosa)* bacteria, as well as the fungal pathogen Candida albicans. Mineral analysis by atomic absorption spectrophotometry indicated substantial quantities of calcium, potassium, magnesium, and iron. These results confirm the traditional uses of *P. erinaceus* for treatment of various infectious and inflammatory disorders with potentials as a source of bio-active compounds and nutritional supplements. Recommendations are provided for further research on isolation of bio-active constituents, toxicological assessment, and conservation measures to ensure sustainable utilization.

Keywords: *Pterocarpus erinaceus*, phytochemistry, antimicrobial, mineral analysis, Niger-state, ethnopharmacology

INTRODUCTION

Bio-active compounds from medicinal plants plays a central role in primary healthcare across many villages, providing local accessible and culturally relevant therapeutic resources. In Africa today traditional remedies for different infectious diseases are derived from trees and shrubs, traditional remedies derived from trees and shrubs are widely used for the management of infectious diseases, fever, gastrointestinal conditions, and wounds (WHO, 2013). *Pterocarpus erinaceus*, widely known as African rosewood in English, and maijini in Hausa language. *Pterocarpus erinaceus* is a same medium-siezed tree distributed across west Africa savanna area. The species of the plant are good sources of timber, resin (kino) with great pharmaceutical potentials. Traditionally, the bark, leave and root are usually decocted for the treatment different infectious diseases, malaria, cough wounds diarrhea and inflammatory complications (Burkill, 2008; Adetutu et al., 2012). In Niger state, the botanical potentials of *Pterocarpus erinaceus* include, treatments of febrile and microbial illnesses (Ibrahim et al., 2014). The scientific research on phytochemical composition and biological activities reveal the presence of alkaloids, flavonoids, steriod, phenol, saponins, and terpenoids compounds, these metabolites are associated antioxidant, antimicrobial, and anti-inflammatory potentials (Akinmoladun et al., 2016; Ibrahim et al., 2014). The comprehensive experimental findings that combine the phytochemical, antimicrobial, mineral, and proximate analysis of P.*erinaceus* in Niger state geographical location remains limited. Furthermore, some part of the plant species is challenged by severe exploitation pressures caused by timber extraction and firewood collection, causing environmental degradation assessment (IUCN, 2020). Thus, this research work is quest to determine the potential experimental assessment of *P. erinaceus* collected from geographical location of the *Pitchi* area of *Bida,* Niger state, this research work will be focusing on phytochemical constituents, essential mineral, and antimicrobial properties to justify the traditional claims and suggest the conservation and utilization strategies.

Aim: To evaluate the phytochemical, antimicrobial and mineral composition of *Pterocarpus erinaceus* collected from Pichi area of Bida, Niger State, Nigeria.

Objectives: To carry out qualitative phytochemical screening of the stem bark and leaf extracts of *P. erinaceus*, to determine the antimicrobial activity of the extracts against selected bacterial and fungal pathogens using agar well diffusion, to quantify essential minerals (***Ca, K, Na, Mg, Fe, Zn, Cu, Mn***) in plant samples using atomic absorption spectrophotometry and to compare the experimental findings with existing literature and discuss the implications for it pharmaceutical importance and conservative utilization.

Figure 1: The picture of *Ptericurpus Erinaceus*

MATERIALS AND METHODS

The plant samples of the *Pterocarpus erinaceus* (stem bark and leaves) were collected from the trees located at **Pichi** area in Bida, Niger State (coordinates approx. 9.08°N, 6.01°E) between January and March 2025. Voucher specimens were prepared and deposited from the her-barium garden of the Department of Biological Sciences, Federal Polytechnic Bida. The plant was authenticated by a taxonomist Mallam Sule.

Preparation-of-plant-materials: The samples (stem-bark and leaves) collected were washed with distilled water to remove the impurities, air-dried under the laboratory room temperature at ambient temperature of (25 to 30^{O}C) for two weeks. The dried samples were pulverized using a mechanical grinder. The samples were extracted using two solvents, methanol, and ethyl acetate. For each extract, 100g of the powdered sample was macerated in 1 L of solvent for 72 h with occasional shacking for proper dissolution. The filtrates were obtained from the solution using filter paper and concentrated using rotatory evaporator to obtained the desired crude extract. The weight of the yielded extracts was recorded and stored.

P**hytochemical-screening:** Phytochemical screening of the sample extracts were conducted using the standard procedures stated by Harborne (2008) and Trease & Evans (2002). These tests included Mayer's and Dragendorff's reagents for alkaloids, Shinoda test for flavonoids, ferric chloride test for phenols and tannins, frothing test for saponins, Salkowski test for terpenoids and Liebermann–Burchard test for steroids. Observations were recorded as abundant (+++), -moderate (++), -trace (+)-and-absent (-).

Antimicrobial-assays: In the antimicrobial screening the pathogens used include, clinical isolate strain of *Pseudomonas aeruginosa* (ATCC 27853), *Staphylococcus aureus* (ATCC 25923), *Candida albicans* (ATCC 90028), *Escherichia coli* (ATCC 25922), and *Aspergillus niger*. The microorganisms were cultured on two agars, nutrient (bacterial) and sabouraud dextrose (fungi), this were incubated under appropriate conditions. Mueller-Hinton agar plates for agar well diffusion was incubated with standardized microbial suspensions of 0.5 McFarland standard, ~1.5 × 10^8 CFU/ml). The well (6 mm diameter) of each extract was bored and filled with 50µL at various concentration of 100mg/ml, 200mg/ml and 400mg/ml. The positive controls used were ciprofloxacin

(10µg/ml) and ketoconazole (10 µg/ml), solvent controls were also incubated. Each plate was incubated with at 37^{O}C for 24hrs for (bacteria) and 48hrs for (fungi). The zone of inhibitory concentration was measured in mm (mean±SD n=3).

Minimum inhibitory concentration (MIC): The minimum inhibitory concentration for each sample was determined using broth micro-dilution in 96-well plates using CLCI standard guidelines. Two-fold serial dilutions for each extract were prepared (range 0.125–64 mg/ml) in Mueller–Hinton broth (for bacteria) and RPMI 1640 (for fungi). The least concentration with no visible growth after incubation was recorded as the MIC.

Mineral-analysis: Mineral analysis of the plant samples was carried out by wet digestion using nitric acid and perchloric acid (3:1 v/v). The wet digestion was made to standard volume of distilled water and analyzed using atomic absorption spectroscopy (AAS) to determine the presence of Ca, K, Na, Mg, Fe, Zn, Mn and Cu. Standard solutions were used to generate the-calibration-curves-with-quality-control-included.

The experimental analysis was all performed in triplicate, while data were interpreted as means ± standard deviation. One-way analysis of variance (ANOVA) is used for statistical comparison where necessary. Statistically significant was determined using Tukey's post hoc test; $p< 0.05$.

RESULTS

Percentage-of-Extract-yield: The crude extracts yield varies with the differences in polarities of the solvents and the concentration of bio-active compounds present in the selected part of the plant (Stem bark and leave). The methanolic extraction of stem bark yield 22.4% (w/w) while leaf extraction yields 9.8% (w/w). Ethyl acetate yields were 12.7% (bark) and 10.4% (leaf) respectively. The stem bark consistently produced higher yields of crude extract compared to the leaves.

Table 1: Phytochemical constituents of *Pterocarpus erinaceus* extracts (qualitative)

Phytochemical	Stem Bark (Methanol)	Stem Bark (Ethyl acetate)	Leaves (Mathanol)	Leaves (Ethyl acetate)
Alkaloids	+	+	++	+
Flavonoids	+	++	+	+
Tannins	+	+	+	+
Saponins	+	-	+	+
Phenols	+	+	++	-
Steroids	+	-	+	-
Glycosides	+	+	+	-
Terpenoids	+	+	+	+

Keys: +++ = abundant - = absent; + = trace; ++ = moderate

Table 2: Antimicrobial activity of *P. erinaceus* extracts (zone of inhibition in mm)

Organism	Bark MeOH 100 mg/ml	Bark MeOH 200 mg/ml	Bark MeOH 400 mg/ml	Leaf MeOH 400 mg/ml	Control (Cip/Ket 10 µg/ml)
Staphylococcus aureus	12.4 ± 0.5	14.3 ± 0.6	18.5 ± 0.6	15.1 ± 0.4	22.3 ± 0.6
Escherichia coli	10.0 ± 0.3	12.8 ± 0.5	17.1 ± 0.6	13.7 ± 0.3	21.8 ± 0.5
Pseudomonas aeruginosa	7.4 ± 0.2	11.1 ± 0.3	12.4 ± 0.5	9.2 ± 0.3	18.6 ± 0.4
Candida albicans	10.4 ± 0.3	13.2 ± 0.4	16.0 ± 0.4	12.4 ± 0.2	21.5 ± 0.5
Aspergillus niger	8.5 ± 0.2	9.2 ± 0.3	11.4 ± 0.3	8.8 ± 0.2	19.1 ± 0.4

Minimum Inhibitory Concentration (MIC): The minimum inhibitory concentration of the stem bark MeOH ranges from 7.4–18.5 mg/ml at different concentrations of 100mg/ml, 200mg/ml, and 400mg/ml depending on the organism. The lowest MIC observed is *Aspergillus Niger*. While leaf extract shows higher minimum inhibitory concentration-than-the-stembark-extract.

Table 3: Mineral composition of *P. erinaceus* (mg/100 g dry weight)

Mineral	Stem Bark	Leaves	FAO/WHO RDI (Adult)
Calcium (Ca)	255.6 ± 2.1	315.5 ± 2.5	1000 mg
Potassium (K)	318.8 ± 3.2	422.4 ± 2.8	3500 mg
Sodium (Na)	83.5 ± 1.4	70.3 ± 1.1	1500 mg
Magnesium (Mg)	112.5 ± 1.8	157.2 ± 2.1	400 mg
Iron (Fe)	16.2 ± 0.6	21.6 ± 0.7	8–18 mg
Zinc (Zn)	5.6 ± 0.2	7.3 ± 0.3	11 mg
Copper (Cu)	1.4± 0.1	1.7 ± 0.1	0.9 mg
Manganese (Mn)	2.2 ± 0.1	2.9 ± 0.1	2.3 mg

DISCUSSION

The phytochemical screening results shows that *P. erinaceus* is highly ric in secondary metabolites which confirm it widely spread antimicrobial and antioxidant potential.The presence of tannins and flavonoids in the stem bark of the plant is similar to the previous research reports by (Ibrahim et al., 2014; Akinmoladun et al., 2016). These constituents are associated with free radical scavenging and microbial growth inhibition. The presence of high alkaloids, detected from in bark extracts, are often responsible for antiplasmodial and analgesic actions according to Hostettmann & Marston, 2015. Saponins and terpenoids, presence at moderate levels, may reduce the membrane-disrupting effects on microbes leading to observed antimicrobial activity. The agar well diffusion assays confirmed that stem-bark extracts exerted stronger activity than leaves against both Gram-positive and Gram-negative bacteria. Highest zones of inhibition against *S. aureus* and *E. coli* at 400 mg/ml suggests the presence of potential constituents for developing systemic antimicrobial agents by further purification and toxicity studies. These results align with Adeoye et al. (2015) and Ibrahim et al. (2014), who reported broad-spectrum antimicrobial effects of *P. erinaceus* bark extracts. Notably, *P. aeruginosa* displayed relative resistance, a pattern commonly observed due to its intrinsic presence of bio-active-compounds-(Poole,2004).

The highest minimum inhibitory concentration data (MIC 18.5 mg/ml for *S. aureus*) justify the bio-active potentials of the bark extract of P.*erinaceus*. this is consistent with the high level of active constituents present. The mineral analysis shows that *Ptericurpus erinaceus* contains appreciable levels of Ca, K, Mg and Fe. The iron content (16.2–21.6 mg/100 g) may contribute to the traditional treatment of anemia-related conditions. The presence of tannin and saponin also show significant anti-nutritional activities (Gibson et al., 2000). The physiological functions with electrolytic balance and enzymatic activities are supported by the presence of magnesium and potassium and manganese. This research findings are widely consistent with prior studies by Akinmoladun et al. (2016). The presence of phenolic compound is associated with significant antioxidant and antimalarial properties. Ibrahim et al. (2014) documented similar phytochemical profiles and antimicrobial activities. Variations in quantitative values likely reflect differences in geographic origin, seasonal collection, extraction methods, and analytical protocols (De Calisto et al., 2017).

CONCLUSION

The experimental research work on *Pterocarpus erinaceus* has justify it ethnomedicinal properties claimed by the tradomedical practitionals. The leave and stem bark confirmed high presence of phytochemical compounds, displays broad-spectrum of antimicrobial activities and large concentration of essential minerals. These findings support it continued use as medicine in the treatment of infectious diseases, inflammatory conditions and nutritional purposes.

RECOMMENDATION

Further research on this plant should focus on the purification/isolation of pure bio-active constituents, toxicological assessment, and conservation measures to ensure sustainable utilization.

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