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Antimicrobial and Antioxidant Properties of *Hedranthera barteri* Leaf and Root Extracts

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Authors' contributions

This work was carried out in collaboration between both authors. Authors OEO and MSO designed and analysed the research. Author OEO interpreted and prepared the manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

Plants have been a good source of alternative therapy, due to the increasing use of plants for therapeutic purposes, there is a need to evaluate their medicinal constituents. This study assessed the phytochemical potential, antioxidant, and antimicrobial proprieties of *Hedranthera barteri* extracts. Qualitative and quantitative procedures were used to evaluate the phytochemical constituents. 2,2-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) and 2,2-diphenyl-1-picryl/hydrazine (DPPH) was use to assay for radical scavenging properties of *Hedranthera barteri* extracts. The scavenging activities of nitric oxide (NO) radical, and its total reducing capacity methods, were used to analyze the antioxidant potentials of *Hedranthera barteri* extracts. Serial dilution and disc diffusion methods were used to assess the minimum inhibitory concentration and antimicrobial activity of *Hedranthera barteri* extracts. The result of this study revealed that extracts of *Hedranthera barteri* possess abundant phytochemical constituents as well as high antioxidant

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potential. The data also showed that the root and leaf extracts of *Hedranthera barteri* possess very strong antibacterial potential against *Staphylococcus spp, Streptococcus spp, Neisseria spp, Escherichia coli, Pseudomonas spp,* and *Enterobacter spp*. The root extract had an inhibition zone of 11.00±1.00 to 22.00±1.00 mm while the leaf extract inhibition zone was 8.00±1.00 to 18.67±1.53 mm. This study disclosed the antimicrobial and antioxidant properties of *Hedranthera barteri* extracts. For further studies, we will explore the characterization of bioactive constituents, a critical step forward to determine the potential therapeutics of these extracts.

Keywords: Hedranthera barteri; antioxidant; secondary metabolite; antimicrobial.

1. INTRODUCTION

"For ages, plants have been used for medicinal purposes and have been an important part of human tradition and culture. World Health Organization (WHO) reported that about 80% of the world's population relies on traditional or alternative medicine for their primary health care" [1]. Several benefits, such as treating some diseases, have been associated with traditional medicinal plants. Because of inadequate income, unavailability of modern health facilities, ignorance, and poor communication among individuals worldwide, particularly in Africa, still use traditional medicines for therapeutic purposes. Reports of plants used against various illnesses may be documented in areas where the plant's use is of great importance [2]. Bacteria have the genetic ability to transmit and have resistance to therapeutic agents such as drugs. One of the ways to prevent antibiotic resistance is through the use of natural compounds as alternative to synthetic antimicrobial agents [3]. According to Zahid et al. [4], antimicrobials extract from plants have enormous therapeutic potential, which are more effective compared to synthetic components in the treatment of infectious diseases. In addition, these natural components have the advantage of not exhibiting many side effects, which are often observed with synthetic antimicrobial drugs.

There have been several research works on the uses of medicinal plants and plant parts that have afforded models for 25-50% of drugs made in the western world [5]. The importance of plant-derived drugs includes their safety, therapeutic benefits, and affordability [6].

Hedranthera barteri (Hook.F) Pichon, belongs to the family of Apocynaceae. It is a shrub that is found in the dump situation of Ghana, Western Cameroon, North and South Nigeria, and Zaire (Congo Brazzaville) [7]. The shrub grows up to 2m high. The flowers are large, tubular, and white with a fragrant scent. The plants have been reported to be effective in preventing miscarriage [7]. This plant has been described as effective against gonorrhea. It is also used as a vermifuge and the leaf is used in the management of painful tumors [8]. The leaf decoction is used to treat dizziness by the Igbos of South-Eastern Nigeria. It is used in the treatment of convulsion. Several reports [9,10] have described the anxiolytic, antimicrobial, antinociceptive, anti-inflammatory, and antidepressant activity of the plant. In addition, antioxidant and antiulcer activities of the root have also been reported.

This study aims to determine the antimicrobial and antioxidant activity, and phytochemical composition of root and leaf extracts of *Hedranthera barteri*.

2. METHODS

The root and leaves of *Hedranthera barteri* were harvested at Alihame, Agbor, Delta state Nigeria. The plant was identified by Prof Obadoni, a Professor of botany, Ambrose Ali University Ekpoma, Edo State. The root and leaves were collected, chopped into smaller sizes, and washed to remove all foliar contaminants. Both the root and leaves were allowed to sundry. After drying, plant materials were blended into fine powder. 250g of the powdered plant materials was macerated into 1200ml of 96% ethanol for 48 hours and stirred at intervals. After which, the extracts were filtered using a muslin cloth. The extracts were concentrated using a rotary vacuum evaporator (Re-52A, lab science, England), at 37°C.

3. PHYTOCHEMICAL SCREENING

Qualitative and quantitative phytochemical analysis was used to evaluate the presence of secondary metabolites such as flavonoids, phenols, tannins, saponins, anthraquinones, cardiac glycosides, cyanogenic glycosides, and alkaloids in the extracts using standard procedures:

3.1 Test for Proteins

3.1.1 Million test

0.2ml of the ethanol extracts was mixed with 2ml of million's reagent, and a white precipitate was observed, which turn red on gentle heating, indicating protein presence [11].

3.2 Test for Carbohydrates

3.2.1 Fehling's test

2ml of Fehling A and Fehling B reagents were mixed, and 2ml of the mixture was allowed to react with 0.2ml of the extracts and gently heated. The presence of brick red precipitate at the test tube bottom indicates the presence of reducing sugar [11].

3.2.2 Iodine test

0.2ml of the crude extracts was allowed to react with 2ml of iodine solution. The presence of purple or dark blue precipitate indicates carbohydrate presence [11].

3.3 Test for Phenols and Tannins

0.2ml of crude extracts reacted with a 2% solution of $FeCl_3$. The precipitate of blue-green colour indicates the presence of tannins and phenols [12].

3.4 Test for Flavonoids

3.4.1 Shinoda test

Magnesium ribbon fragments were allowed to react with 0.2ml of the crude extracts, and concentrated hydrochloric acid was added dropwise. Appearances of pink, scarlet precipitate indicate flavonoid's presence [12].

3.4.2 Alkaline reagent test

0.2ml of extracts was mixed with 2ml of 2% of NaOH. A yellow precipitate was formed, which, on the addition of dilute acid in drops, turned colourless, indicating flavonoid's presence [12].

3.5 Test for Triterpenoids

Extracts of 10mg was dissolved in 1ml of chloroform followed by the addition of 1ml of acetic anhydride, after which 2ml of concentrated H_2SO_4 was added. Formation of a reddish-violet precipitate indicates triterpenoids presence [12].

3.6 Test for Phlobatannins

2ml of 1% HCl was mixed to 2ml of each extract. The mixture was boiled. The presence of red precipitate indicates phlobatannins presence [13].

3.7 Test for Saponins

Extracts of 0.2ml were mixed with 5ml of distilling water and shaken vigorously. The development of stable foam indicates saponin's presence [12].

3.8 Test for Glycosides

3.8.1 Liebermann's test

Extracts of 0.2ml were mixed with 2ml of chloroform followed by the addition of 2ml of acetic acid. The reacting mixture was cooled and mixed with concentrated H_2SO_4. The precipitate formed changes to blue to green from violet, which indicates the steroidal nucleus, which is the glycone portion of the glycoside [13].

3.8.2 Keller- Kiljani test

Extracts of 0.2ml were mixed with glacial acetic containing 1-2 drops of 2% of $FeCl_3$ solution. The reacting mixture was allowed to react with 2ml of concentrated H_2SO_4. Brown ring formation at the interphase indicates cardiac glycosides presence [13].

3.9 Test for Steroids

0.2ml of the extract was allowed to react with chloroform and concentrated H_2SO_4. Formation of red precipitate at the lower chloroform layer indicating steroids presence [14].

3.10 Test for Terpenoids

Extract of 0.2ml was mixed with 2ml of chloroform and allowed to evaporate to dryness. To this, 2ml of concentrated H_2SO_4 was added and heated for 2 minutes. The presence of greyish precipitate indicates terpenoids' presence [14].

3.11 Test for Alkaloids

Extracts of 0.2ml were mixed with 2ml of 1%HCl and allowed to heat. Mayer's and Wagner's reagents were added to the reacting solution. The presence of turbidity indicates alkaloids presence [12].

3.12 Estimation of Total Phenolic Content (TPC)

The total phenolic content of the plant extracts was estimated by mixing 500 µl of diluted Folins-phenol reagent (1:1 ratio with water) with the appropriate dilution of plant extracts, and 2.5 ml of 20% sodium carbonate was added, to the reacting solution. The reacting solution was shaken and incubated in the dark for 40 minutes for colour development. After incubating, absorbance was read at 725nm using a UV spectrophotometer (Jenaway, Germany). The plant extracts TPC was expressed as mg of gallic acid equivalent (mg GAE/g extract) using a standard curve [15].

3.13 Estimation of Total Saponin Content (TSC)

Total saponins determination involves mixing 250 µl of vanillin reagent (800 mg of vanillin in 10 ml of 99.5% ethanol) with the appropriate extract dilution. 2.5 ml of 72% sulfuric acid was added and mixed well. The reacting solution was kept in the water bath at 60 °C for 10 minutes and then the reacting solution was cooled in ice-cold water, and absorbance was spectrophotometrically read at 544nm. The value was expressed as quinine equivalent (mg QU/g extract) [16].

3.14 Estimation of Total Flavonoid Content (TFC)

Total flavonoids were estimated by treating appropriate dilution of the extracts with 0.1 ml of 10% aluminum chloride and 0.1 ml of 1 M sodium acetate and left to stand for 30minutes and absorbance was read at 415nm using. The TFC in the extracts was determined using quercetin as standard (mg QE/g extract) [17].

3.15 Estimation of Total Tannin Content (TTC)

The total tannin content of the extracts was estimated according to the method reported by Polshettiwar et al. [18]. 100 µl of extracts and standard solution of tannic acid was taken and made up to 1 ml with distilled water, then 0.5 ml of Follin-Denis reagent with 1 ml of Na_2CO_3 solution was added to the reacting solution. The volume of the reacting solution was made up to 10 ml with distilled water and absorbance was spectrophotometrically measured at 700nm. The total tannin content was expressed as tannic acid equivalent (mg TAN/g extract).

3.16 Antioxidant Assay

3.16.1 Determination of DPPH (2,2 diphenyl-1-picry/hydrazine) free radical scavenging ability

Different concentrations of plant extracts were added to equal volumes of methanolic solution of DPPH. The reacting mixtures were allowed to react at room temperature in the dark for 30 minutes and absorbance was read at 517nm. A lower absorbance value indicates higher radical scavenging activity. DPPH radical scavenging activity was calculated using DPPH scavenging effect (% inhibition) [16].

DPPH radical scavenging activity (%)

$$= \frac{A_0 - A_1}{A_0} x100$$

Where A0 is absorbance of control and A1 is absorbance of sample extract.

3.16.2 Determination of ABTS (2,2-azino-bis (3-ethylbenzthiazoline-6-sulphonic acid)) radical scavenging ability

ABTS scavenging activity of the extracts were determined by method reported by Re et al. [19]. The stock solution which consisted of 7mM ABTS solution and 2.4mM potassium persulfate (1:1) was allowed to react in the dark for 16 hours at room temperature. The radical generated wasQ mixed with methanol to obtain an absorbance of 0.702±0.001 unit at 734nm. Exactly 2ml of the resulting solution was added to the extracts or vitamin C and absorbance was measured at 734nm after 7minutes. The percentage scavenging ability was calculated using the formula

ABTS radical scavenging activity (%)

$$= \frac{\text{Abs control - Abs sample}}{\text{Abs control}} \text{x100}$$

Where Abs control is absorbance of control and Abs sample is absorbance of sample extract.

3.17 Determination of Nitric Oxide Radical Scavenging Ability

A volume of 0.5 mL of 10 mM sodium nitroprusside in phosphate-buffered saline was

mixed with 1 mL of the different concentrations of the ethanol extracts (100−1000 μg/mL) and incubated at 25°C for 180 mins. The extract was mixed with an equal volume of freshly prepared Griess reagent. Control samples without the extracts but with an equal volume of buffer were prepared in a similar manner as was done for the test samples. The colour tubes contained ethanol extracts at the same concentrations with no sodium nitroprusside. The absorbance was measured at 546 nm. Ascorbic acid was used as the positive control [15].

Nitric oxide radical scavenging ability (%)

$$= \frac{\text{Abs control - Abs sample}}{\text{Abs control}} \text{x}100$$

Where Abs control is absorbance of control and Abs sample is absorbance of sample extract.

3.18 Isolation, Identification, and Antimicrobial Assay

The following microorganisms, *Staphylococcus spp., Streptococcus spp., Neisseria spp., Escherichia coli, Pseudomonas spp.,* and *Enterobacter spp.,* were cultured and identified, using appropriate media and reagents.

3.18.1 Isolation of microorganism

The collected samples were inoculated into the various agars and incubated at 37°C for 24 hours. After 24 hours subcultures were carried out on the plates with growths using the nutrient agar, which was incubated at 37°C for 24 hours. The colonies in the various plates were picked and subjected to gram staining and a series of biochemical tests for identification.

3.18.2 Identification of microorganism

Biochemical tests such as gram stain test, motility test, catalase test, oxidase test, citrate test, indole test, and triple sugar ion (TSI) test were carried out, using the method reported by Cheese Brough, [20] on the colonies of the microorganisms for proper identification.

3.19 Antimicrobial Assay

The disc diffusion method was used. Each of the organisms was stricken uniformly on the surface of the solidified nutrient media. The disc was made from Whitman's No1 filter paper using a paper puncher, and the sterile disc was soaked in the extracts. Extracts of the concentrated disc were placed on the Petri-dishes containing the nutrient agar and the test organism using sterile forceps. The Petri dishes were incubated for 24 hours at 37°C. The control was done using a sensitivity disc containing the following antibiotics: Gentamycin 10ug, Taravid 30ug, and Zinnacef 20ug. The Petri dishes were incubated at 37°C for 24 hours. The Petri dishes were observed for growth inhibition zone, and inhibition zones were measured in millimeters.

3.19.1 Minimum inhibitory concentration (MIC)

Minimum inhibitory concentration is the concentration with the lowest inhibition of microorganisms. The serial dilution method was used to determine MIC. The inoculated bacteria were prepared from 24hours of broth culture and standardized suspensions were adjusted to 0.5 Mc Farland turbidity standard. Four different test tubes were sterilized and placed on a rack, 10ml of already prepared nutrient broth was added to each test tube and 2ml of the extract was added to the first test tube swirled properly. 0.1ml of the standard inoculums prepared earlier was collected with a pipette and dropped into each test tube which was then sealed properly to prevent loss by evaporation and incubated at 37°C for 24 hours. The presence or absence of growth was then observed. The concentration with no growth was recorded as minimum inhibitory concentration (MIC).

Statistical analysis of the research work was carried out using Graph Pad Prism 8.0.

4. RESULTS

Table 1. Phytochemical constituents of ethanol root and leaf extracts of *Hedranthera barteri*

Test	Root	Leaf
Reducing Sugars	-	-
Proteins	+	-
Carbohydrates	-	-
Phenols & Tannins	+	+
Flavonoids	+	+
Triterpenoids	+	-
Phlobatannins	+	-
Saponins	+	+
Cardiac Glycosides	+	+
Steroids	+	+
Terpenoids	-	-
Alkaloids	+	+

Key: (+) positive means present of constituent and (-) negative means absent of constituent

Table 2. Quantitative phytochemical content of ethanol extract of the root and leaf of *Hedranthera barteri*

Plant part	TPC (mg/GAE/g)	TFC (mg/QUE/g)	TSC (mg/QE/g)	TTC (mg/TAN/g)	TAC (mg/QUN/g)	% yield
Leaf	185.70±2.7	213.00±2.62	131.90±1.49	50.81±2.22	170.90±2.23	36.67
Root	151.60±2.03	201.60±2.23	117.42±1.80	35.12±1.45	144.80±2.10	30

TPC – total phenolic content, TFC – total flavonoid content, TSC – total saponins content, TTC – total tannin content, TAC – total alkaloids content, Values are expressed as mean ± standard deviation (n=3)

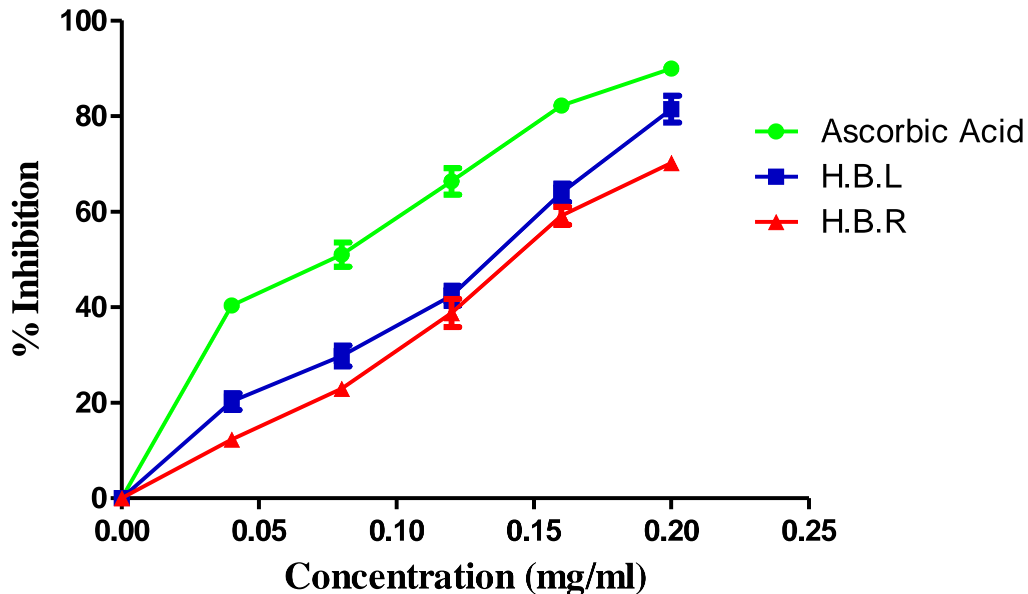

Fig. 1. Nitric oxide activity of the *H. Barteri* leaf and root extracts. H.B.L for leaf extract and H.B.R for root extract

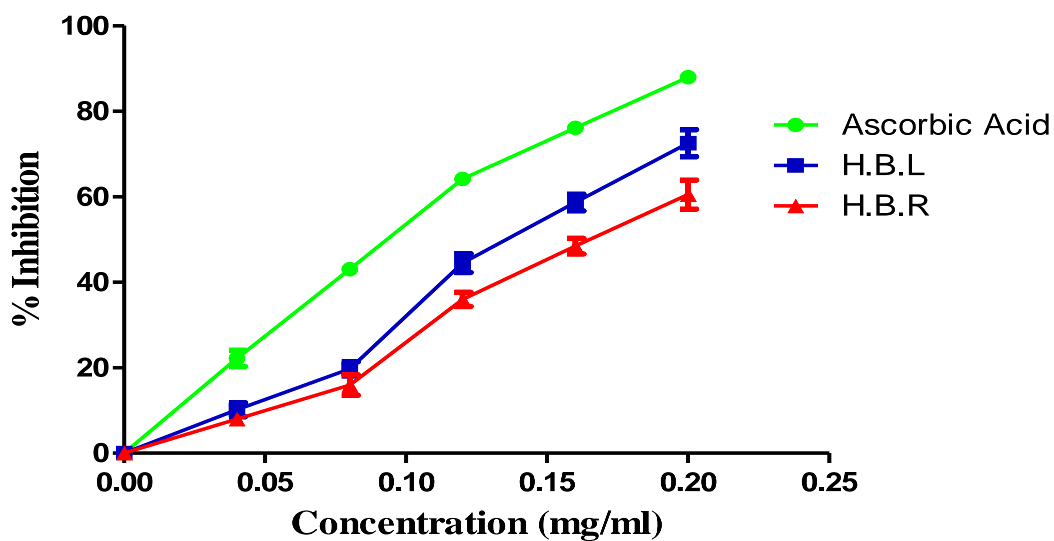

Fig. 2. ABTS activity of the analyzed *H. Barteri* leaf and root extracts plant extracts. H.B.L for leaf extract and H.B.R for root extract

Table 3. Biochemical investigation of microorganisms

Catalase	Oxidase	Citrate	Motility	Gram stain	Shape	Indole test	Gas bubble	Lactose	Hydrogen sulfide	Crack	Microorganism
+	-	+	-	+	Cocci chain	+	+	+	-	+	*Streptococcus spp.*
+	-	+	+	+	Cocci	+	-	+	-	+	*Staphylococcus spp.*
+	+	-	-	-	Cocci	+	+	+	-	+	*Neisseria spp.*
+	+	+	+	-	Rod	-	+	+	-	+	*Pseudomonas spp.*
+	-	+	+	-	Rod	+	+	-	+	+	*Escherichia coli*
+	-	-	+	-	Rod	-	-	+	-	+	*Enterobacter spp.*

Key: (+) Positive means present of biochemical indicator, (-) Negative means absent of biochemical indicator

Table 4. Minimum inhibitory concentration (MIC) of ethanol extracts of *Hedranthera barteri* root (R) and leaves (L) on the microorganism

Microorganism	Concentration of extracts (mg/dl)							
	500		250		125		62.5	
	R	L	R	L	R	L	R	L
Streptococcus spp.	-	-	-	-	-	+	+	+
Staphylococcus spp.	-	-	-	-	+	-	+	+
Neisseria spp.	-	-	+	-	+	-	+	+
Pseudomonas spp.	-	-	-	-	-	-	+	+
Escherichia coli	-	-	-	-	+	+	+	+
Enterobacter spp.	-	-	-	-	-	-	+	+

Key: (+) Positive means present of microorganism; (-) Negative means absent of microorganism

Table 5. Minimum inhibitory concentration (MIC) of ethanol extract of *Hedranthera barteri* root on the microorganism

Microorganism	Concentration of extracts			
	500mg/dl	250mg/dl	125mg/dl	62.5mg/dl
Streptococcus spp.	-	-	-	+
Staphylococcus spp.	-	-	+	+
Neisseria spp.	-	+	+	+
Pseudomonas spp.	-	-	-	+
Escherichia coli	-	-	+	+
Enterobacter spp.	-	-	-	+

Key: (+) Positive means present of microorganism; (-) Negative means absent of microorganism

Table 6. Minimum inhibitory concentration (MIC) of ethanol extracts of *Hedranthera barteri* leaves on the microorganism

Microorganism	Concentration of extracts			
	500mg/dl	250mg/dl	125mg/dl	62.5mg/dl
Streptococcus spp	-	-	+	+
Staphylococcus spp	-	-	-	+
Neisseria spp	-	-	-	+
Pseudomonas spp	-	-	-	+
Escherichia coli spp	-	-	+	+
Enterobacterspp	-	-	-	+

Key: (+) Positive means present of microorganism; (-) Negative means absent of microorganism

Table 7. Effect of ethanol extracts of *Hedranthera barteri* leaves, root, and the standard antibiotic on tested microorganisms

Microorganism	Inhibition zone (mm)				
	Leaf	Root	Gentamycin	Tarivid	Zinnacef
Streptococcus spp.	18.67±1.53	22.00±1.00	8.66±0.58	13.00±1.00	8.66±0.58
Staphylococcus spp.	11.67±1.56	14.00±1.53	8.67±1.16	11.33±1.53	9.67±1.16
Neisseria spp.	9.67±1.53	12.67±1.55	10.33±6.57	9.67±0.57	6.33±1.15
Pseudomonas spp.	8.00±1.00	21.68±1.67	6.33±1.15	7.00±1.00	8.00±1.00
Escherichia coli	12.67±1.58	11.33±0.58	12.33±0.58	13.33±1.53	12.33±0.58
Enterobacter spp.	14.33±1.16	11.00±1.00	10.33±1.14	8.67±0.58	5.66±0.58

Values represent mean ± standard deviation (n=3)

Table 8. IC_{50} values for the inhibitory effect of *Hedranthera barteri* root and leaf extracts on DPPH, ABTS, and nitric oxide activity

Assays	Ascorbic acid	IC_{50} (mg/ml)	
		Leaf	Root
DPPH	0.098±0.002	0.117±0.004	0.143±0.007
ABTS	0.105±0.002	0.141±0.006	0.171±0.009
NITRIC OXIDE	0.098±0.03	0.127±0.004	0.145±0.005

Values represent mean ± standard deviation (n=3)

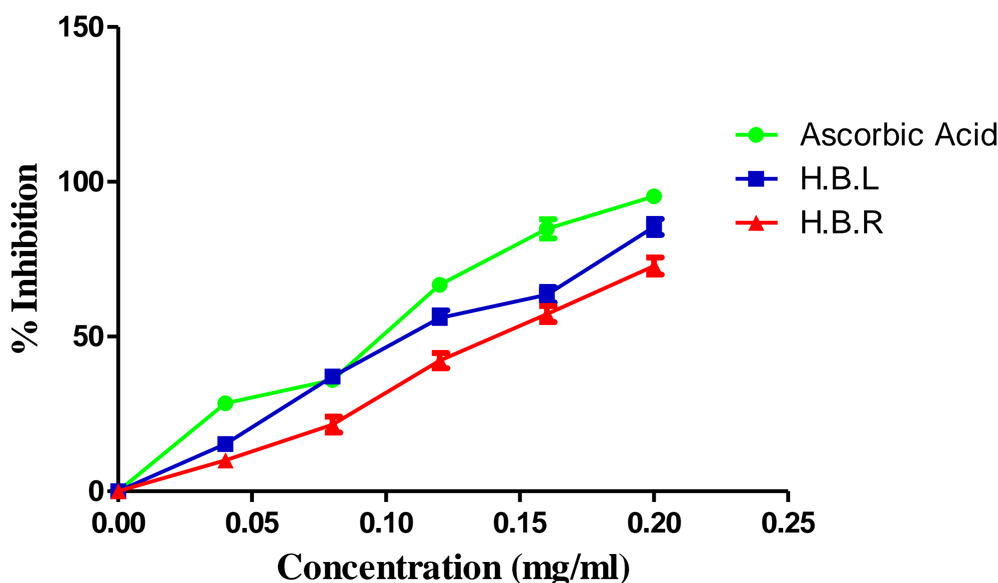

Fig. 3. DPPH activity of the investigated *H. Barteri* leaf and root extracts. H.B.L for leaf extract and H.B.R for root extract

5. DISCUSSION

The phytochemical analysis of ethanol extracts of *Hedranthera Barteri* (H.B) root and leaves revealed the presence of proteins, phenols and tannins, flavonoids, triterpenoids, saponins, phlobatannins, cardiac glycosides, steroids, and alkaloids, as shown in Table 1. The presence of these phytochemical components has also been reported by previous investigations [9]. Research has attributed the medicinal activities of plants to the presence of several phytochemical components [21,22]. Saponins have been reported to be useful in managing inflammation [23,24]. Flavonoids have also been described to exhibit useful properties which include anti-inflammatory, antimicrobial, antioxidant, antiallergic, vascular and cytotoxic antitumor activities [25]. The quantitative analysis of the plant extracts revealed that both extracts (leaves and root of H. B) contain abundant secondary metabolites as shown in Table 2. Flavonoid is the most abundant of the phytochemicals present in the extracts. Obtained results in this study confirmed published data of Onasanwo et al. [26].

In vitro analysis of H.B extracts revealed its antioxidant activity in which DPPH, ABTS, and nitric oxide assays were measured in a dose-dependent manner. DPPH is one of the widely used assays to assess antioxidant activity. Plant extracts are known to exert an effect on DPPH due to their ability to donate hydrogen atoms [27]. DPPH is a stable free radical that can accept hydrogen radicals to form a stable diamagnetic molecule [28]. Discolouration of the DPPH reaction from purple to yellow can be attributed to the reaction between the antioxidant molecules and the radicals. Our data showed that the leaf extract had the highest DPPH inhibitory activity with an IC_{50} value of 0.117±0.004 compared to the root extract with an IC_{50} value of 0.143±0.007. The leaf extracts were able to scavenge DPPH due to their polyphenols content, also the result of this assay is in consonance with the work of Onasanwo et al. [26] who worked on the antioxidant activities of *Hedranthera barteri*. It is also known that ABTS can be oxidized by potassium persulfate to create a radical $ABTS^{+}$. The inhibitory test using the ABTS test showed that the H.B leaf extract had the highest ABTS scavenging potential with an IC_{50} value of 0.141±0.006 compared to the root with an IC_{50} value of 0.171±0.009, this can be attributed to the phenol concentration of the extracts because phenolic compounds scavenge free radicals due to their hydroxylgroup. this ABTS result corroborates the research of Onasanwo et al. [26] who worked on the antioxidant activities of *Hedranthera barteri*. This ABTS scavenging ability of the extracts is due to the flavonoids, and tannin. Nitric oxide is a mediator generated by type I and pro-inflammatory macrophages, endothelial cells, and neurons are involved in various biological

processes. The increased production of NO leads to the development of several diseases [29,30]. NO assay corroborates with the work of Onasanwo et al. [26] who worked on the antioxidant activities of *Hedranthera barteri*. In this study, the extracts of H. B. were able to react with oxygen and inhibit the generation of anions. The scavenging activity of these extracts can be attributed to their phenolic composition. It has been reported that the phenolic acid antioxidant activity can be due to the quantity, number, and position of the hydroxyl group in the molecule [31]. Flavonoids have also been reported to possess antioxidant properties due to their hydroxyl/group that act as the reducing agent, metal chelation, and free radical scavengers [32].

Ethanol extracts of *Hedranthera barteri* (H.B) root and leaves inhibited all microorganisms tested. The root extract had an inhibition zone ranging between 11.00±1.00 to 22.00±1.00 mm while the leaf extract possesses an inhibition zone that ranges between 8.00±1.00 to 18.67±1.53 mm. Both extracts were effective in inhibiting gram-positive bacteria more than gram-negative bacteria which corroborates with the similar report of Wei et al. [33]. The difference in the gram-positive and gram-negative sensitivity is due to the difference in their morphological makeup. Gram-negative bacteria possess an outer phospholipid membrane containing lipopolysaccharide components. "While the gram-positive bacteria are susceptible due to their outer peptidoglycan layer which is not an effective permeability barrier" [34,35]. The antimicrobial activity of these extracts can be attributed to their phytochemical constituents. Phenols, flavonoids, and tannins have been reported to possess antimicrobial activity. "Antimicrobial mechanisms of phenolic compounds include permeation and destabilization of the bacterial membrane, which result in the disturbance of electron flow, proton motive force, coagulation, and leakage of its cellular content resulting in a bactericidal effect" [36,37,38]. Also, plants synthesize flavonoids due to microbial attacks, this might be linked to their effectiveness against wide array of microorganisms. This can be attributed to their reaction with soluble extracellular proteins and bacterial cell walls which results in bacteria death [39].

6. CONCLUSION

In conclusion, the result of this study revealed that H.B leaf and root extracts possess high phytochemical content and antioxidant potentials which are responsible for their biological activities. Little or no research work has been carried out to separate and identify the various components of *Hedranthera barteri* secondary metabolites. Further study is recommended aiming for the isolation and identification of *Hedranthera barteri* bioactive compounds for more therapeutic studies.

AVAILABILITY OF DATA AND MATERIALS

The data supporting the findings of this study are available from the corresponding author, upon request.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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