



Phytochemical Analysis and In-vitro Antimicrobial Activity of Methanolic Leaves, Root and Stem Extracts of *Bryophyllum pinnatum*, *Cochlospermum tintorium* and *Erythrina senegalensis*

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Authors' contributions

This work was carried out in collaboration among all authors. Authors LWT, TTL and PAM conceived, designed and executed the experiment. Authors AA and AAA did the statistical analysis. Author PAM drafted the manuscript and all the authors reviewed it. All authors read and approved the final manuscript.

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ABSTRACT

Aim: This Study was design to determine the phytochemical and antimicrobial activities of leaves, roots and stem bark of *Cochlospermum tentorium*, *Bryophyllum pinnatum*, and *Erythrina senegalensis* obtained in Takum Town of Taraba state.

Methods: The leaves, roots and stem bark of *Cochlospermum tentorium*, *Bryophyllum pinnatum*, and *Erythrina senegalensis* were obtained, dried, ground, and extracted using methanol. The antimicrobial activity of the extract at various concentration was tested using agar well diffusion techniques against three human pathogens by measuring zones of inhibition after incubation 24 hours

Results: Phytochemical screening revealed the presence of alkaloids, glycoside, flavonoids, phenols, saponins, tannins and steroids. Flavonoids were however absent in the leaf and stem bark of *Cochlospermum tintorium*, leaf and roots of *Bryophyllum pinnatum*, and leaf and roots of *Erythrina senegalensis*. Phenol and tannins were absent in the roots of *Bryophyllum pinnatum*. The quantitative screening shows that the leaf of *Cochlospermum tintorium* had the highest amount of glycoside (1.55mg/dl) while the roots had the least amount (0.81mg/dl). Stem bark of *Bryophyllum pinnatum* showed the highest amount of tannins (7.51mg/dl) while the leaf had the least (3.54mg/dl). Stem bark of *Cochlospermum tintorium* showed the highest amount of flavonoid (6.54mg/dl) while the leaf had the least (3.66mg/dl). Stem bark of *Cochlospermum tintorium* recorded the highest amount of phenol (4.37mg/dl) while the roots had the least (1.48mg/dl). The stem bark of *Bryophyllum pinnatum* recorded the highest amount of alkaloid (1.30mg/dl) while the leaf recorded the least (0.72mg/dl). Stem bark of *Bryophyllum pinnatum* showed the highest amount of saponins (2.85mg/dl) while the roots showed the least (1.57mg/dg). The methanolic leaf, root and stem bark extract of *Cochlospermum tentorium* had potent antibacterial activity, while *Bryophyllum pinnatum*, and *Erythrina senegalensis* had minimal antibacterial activities against *Escherichia coli*, *Klepsiella pneumoniae* and *staphylococcus aureus*.

Conclusion: This result indicates that the methanolic leaf, root and stem bark extract of *Cochlospermum tentorium* had antimicrobial activity confirming the folklore claim. Thus, making a strong case for the isolation of novel antimicrobial agent from this plant.

Keywords: *Phytochemical; antimicrobial activity; Bryophyllum pinnatum; Cochlospermum tentorium; Erythrina senegalensis.*

1. INTRODUCTION

The emergence of antimicrobial resistance in clinical practice has reduced the efficacy of commonly used antimicrobials resulting in increased therapeutic failure and mortality cases globally with an urgent need for newer, effective and affordable antimicrobial [1,2]. Since the beginning of time, Humans have been in continuous search for ways of relieving common ailments and diseases. This has led to great discoveries on the use of plant (leaves, roots and stem barks, pods and flowers) with medicinal properties for treatment of common diseases [3].

Over the past decades, traditional herbal medicine has immensely gained acceptance with approximately 80% of the world population relying solely on this system as form of treatment [4]. The acceptance of medicinal plants for the treatment of common ailments is attributed to its accessibility, availability, effectiveness and affordability [5]. Additionally, secondary

metabolites from plant origin possess notable activity against a wide range of microbes [6,7]. This has gained acknowledgement by the World Health Organization (WHO), that traditional medicine plays a critical role in the health care system that provides good results to its users [8].

“Given the predominant uses of medicinal plants in traditional medicine, there is an upsurge in research to investigate the active medicinal compounds, efficacy, and safety of such plants” [9]. “The literature suggests that the search for novel therapeutic compounds based on traditional uses and folkloric information about medicinal plants obtained from the community could guide and serve as a potential strategy for the development of new therapeutic compounds. Therefore, there is need for data and high quality-research on medicinal plants to provide stronger scientific evidence and confirm their medicinal uses and safety in traditional medicines” [10].

"*Bryophyllum pinnatum* belongs to the family Crassulaceae commonly known as sprouting leaf. The leaf and leaf juices have been used traditionally as an anti-inflammatory, antipyretic, antimicrobial, antioxidant, antidiabetic, antiulcer and a cough depressant agent" [11]. Its bark are used as astringent, analgesics and are useful in the control of diarrhea and vomitions [12]. *Cochlospermum tinctorium* (Cochlospermaceae) has recently gained attention from the scientific community due to its traditional and wide range medicinal use. The plant has been successfully used to treat malaria, liver diseases, management of burns, ulcers, syphilis, hemorrhoids, intestinal worms, measles and yellow fever [13]. *Erythrina senegalensis* (Fabaceae) leaves, stem bark and roots have been used to treat malaria, gastrointestinal disorders, fever, dizziness, secondary sterility, diarrhea, jaundice, nose bleeding and pains [14], Antibacterial activity [15], Inhibitory activity against HIV-proteases [16], Plasmodium falciparum and hepatoprotective properties [17]. Despite the extensive use of these plants and the traditional claims of their efficacies, There is paucity of information on their pharmacological and antimicrobial activities of these plants from Takum local government area of Taraba state, This study aims to analyse the phytochemical constituents and investigate the antimicrobial activity of *Bryophyllum pinnatum*, *Cochlospermum tinctorium* and *Erythrina senegalensis* methanolic leaf, root and stem bark extracts on some selected clinical isolate using Agar well diffusion method.

2. MATERIALS AND METHODS

2.1 Plant Collection and Identification

Fresh leaves, roots and stem bark of *Bryophyllum pinnatum*, *Cochlospermum tinctorium* and *Erythrina senegalensis* were collected from a local traditional herbarium in Takum local Government area Taraba state, in the month of July 2022 and transported to the department of biological sciences, Modibbo Adamma University, Yola and was identified by a botanist.

2.2 Extraction of Plant Materials

The fresh leaves, roots and stem barks of *Bryophyllum pinnatum*, *Cochlospermum tinctorium* and *Erythrina senegalensis* were washed, chopped into small pieces, air dried under room temperature and grounded into fine

powder with the aid of an electric blender. The powder was packed in sterile airtight ziplock bags and stored in cool, dry shelf, awaiting extraction. The methanolic extracts was prepared by taking 200g of *Bryophyllum pinnatum*, *Cochlospermum tinctorium* and *Erythrina senegalensis* leaves, roots and stem bark powders into an extraction jar, 1000 ml of methanol was added gradually to each jar, then shaken vigorously until a uniform consistency was obtained. The mixtures were stirred continuously using a magnetic stirrer for 72 hours and then filtered. The filtrate was evaporated using a rotary evaporator at an operating temperature of 40° C for 4 hours. The resulting content was then placed into an amber colour bottle, covered with an aluminum foil and then placed on a hot sand bath to get a consistent powder. The methanolic extraction process was repeated to give enough yield for the study.

2.3 Phytochemical Studies

The methanolic leaves, roots and stem bark extracts were qualitatively screened for the presence of saponins [18], Tanins [19], Glycosides [18], Alkaloids using Mayers test, Flavonoids [20], Phenols [19], Steroids [21] and Terpenoids [22].

2.4 Antimicrobial Study

2.4.1 Collection of test organisms

Three bacterial strains *Escherichia coli*, *Klebsiella pneumoniae* and *staphylococcus aureus* were obtained from stock cultures from the Microbiology Laboratory, Department of Microbiology Modibbo Adama University, Yola.

2.4.2 Preparation of culture and antimicrobial sensitivity test

The stock solution was prepared according to the clinical laboratory standards institutes (CLSI). A loopful of pure cultures of each microbe was suspended in 10 ml sterile physiological saline to give a concentration equal to that of 0.5 MacFarland standards. Each test microorganism was spread on aseptically prepared nutrient agar by the use of a sterile swab. Five (5) wells of 8mm in diameter and 10mm depth were made on the agar plates with a sterilized cork borer. 0.1ml of the extracts of varying concentration of 0.5mg/ml, 1.0mg/ml, 1.5mg/ml, 2.0mg/ml, and 2.5mg/ml was pipetted into each of these five holes where 0.5ml of the pure solvent into the

sixth hole served as the negative control. All the plates were allowed to stand on flat bench for an hour for proper disperse into agar before incubation at 37°C for 24hrs. Antimicrobial activity was evaluated by measuring the diameter of the zone of inhibition measured in millimeters (Shagal et al. 2012).

2.5 Statistical Analysis

All experiments were performed in triplicates; data were analyzed using statistical package for social science (SPSS), version 23, and results are provided as mean ± SEM. One-way analysis of variance (ANOVA) and post hoc ANOVA using the Turkey HSD test was used to compare the difference in means among and between groups. Differences (among and between groups) were considered to be statistically significant at $p < 0.05$.

3. RESULTS

3.1 Phytochemical Screening

The Phytoconstituents detected in the methanolic leaf, root and stem barks of *Cochlospermum tintorium*, *Bryophyllum pinnatum* and *Erythrina senegalensis* were Alkaloids, Glycosides, Flavonoids, Phenols, Saponins, Tannins and Steroids. Alkaloid, Glycoside and Steroids as given in Table 1.

According to the results, alkaloids, Glycosides, Saponins and Steroids were present in all leaf, roots and stem bark methanolic extracts of *Cochlospermum tintorium*, *Bryophyllum pinnatum* and *Erythrina senegalensis*, Flavonoids were only detected in the roots extract of *Cochlospermum tentorium* and stem bark extracts of *Bryophyllum pinnatum* and *Erythrina senegalensis*, Phenols and Tannins were detected in all methanolic extracts except the root extract of *Bryophyllum pinnatum*.

3.1.1 Quantitative screening of phytochemical constituents

The results of quantitative analysis of some phytochemicals constituents of the plants in mg/dl is presented in Table 2. The results revealed that, for Glycoside, the leaf of *Cochlospermum tintorium* has the highest yield of 1.553mg/dl while it recorded the least yield of 0.810mg/dl. For Tannins, the stem bark of *Bryophyllum pinnatum* has the highest yield of 7.508mg/dl while its leaves has the least yield of

3.535mg/dl. Roots of *Bryophyllum pinnatum* has the highest yield for Flavonoid which is 6.573mg/dl while the roots of *Cochlospermum tintorium* has the yield of 3.427mg/dl. Stem bark of *Cochlospermum tintorium* has the highest yield of 4.372mg/dl for Phenol while the least yield of 1.482mg/dl was recorded for its roots. The stem bark of *Bryophyllum pinnatum* has the highest yield of 1.300mg/dl for Alkaloid while the leaves of *Erythrina senegalensis* have the least yield of 0.620mg/dl. Stem bark of *Bryophyllum pinnatum* has the highest yield of 2.845mg/dl for Saponins while its roots have the least yield of 1.565mg/dl.

3.2 Antimicrobial Activity

A varying antimicrobial activity of the methanolic extract of the leaves, stem and roots of *Cochlospermum tintorium*, *Bryophyllum pinnatum* and *Erythrina senegalensis* was recorded based on zone of inhibition against the selected bacterial isolates: *Klebsiella pneumoniae*, *Escherichia coli* and *Staphylococcus aureus*. The leaf, roots and stem bark extracts of *Cochlospermum tentorium* exhibited potent activity against *Klebsiella pneumoniae*, *Escherichia coli* and *Staphylococcus aureus* in a dose dependent manner with zones of inhibition ranging from 11.00 ± 0.45 mm – 20.00 ± 0.05 mm when compared to the standard control ciprofloxacin tablets 25 mm, 22 mm and 26 mm respectively. The leaf, roots and stem bark extracts of *Bryophyllum pinnatum* showed minimal antibacterial activity against *Klebsiella pneumoniae*, *Escherichia coli* and *Staphylococcus aureus* with zone of inhibition ranging from 3.00 ± 0.50 mm -12.00 ± 0.40 compared to the standards control ciprofloxacin tablets 25 mm, 22 mm and 26 mm respectively. The leaf and root extracts of *Erythrina senegalensis* had minimal antibacterial activity at all concentrations, while the stem bark had no antibacterial activity against *Klebsiella pneumoniae*. The leaf, root and stem bark extract had minimal inhibitory activity at 2.0 and 2.5 mg/ml when compared to the standard control 22 mm, additionally, no antibacterial activity was seen against *Staphylococcus aureus*.

4. DISCUSSION

The emergence of drug resistant microbial strains has posed a great challenge to global public health [2], Owing to this, there is an urgent need to develop new therapeutic agents which is critical toward the future management of

Table 1. Phytochemical analysis of the methanolic leaf, roots and stem bark extracts of the *Cochlospermum tintorium*, *Bryophyllum pinnatum* and *Erythrina senegalensis*

Qualitative phytochemical analysis of the methanolic extract of the plants							
Plants	Al	Gl	Fl	Ph	Sa	Ta	St
<i>Cochlospermum tintorium</i> leaves	+	+	-	+	+	+	+
<i>Cochlospermum tintorium</i> stem bark	+	+	-	+	+	+	+
<i>Cochlospermum tintorium</i> roots	+	+	+	+	+	+	+
<i>Bryophyllum pinnatum</i> leaves	+	+	-	+	+	+	+
<i>Bryophyllum pinnatum</i> stem bark	+	+	+	+	+	+	+
<i>Bryophyllum pinnatum</i> roots	+	+	-	-	+	-	+
<i>Erythrina senegalensis</i> leaves	+	+	-	+	+	+	+
<i>Erythrina senegalensis</i> stem bark	+	+	+	+	+	+	+
<i>Erythrina senegalensis</i> roots	+	+	-	+	+	+	+

Key; + presence of phytochemical, - absence of phytochemical, Al-Alkaloid, Gl-Glycoside, Fl-Flavonoid, Ph-Phenol, Sa-Saponin, Ta-Tannins, St-Steroid

Table 2. Quantitative screening of phytochemical constituents of methanolic leaf, roots and stem bark extracts of the *Cochlospermum tintorium*, *Bryophyllum pinnatum* and *Erythrina senegalensis* (mg/dl)

Extracts	Glycosides	Tannins	Flavonoid	Phenols	Alkaloids	Saponins
<i>C.tintorium</i> Leaf	1.55 ± 0.003	4.21 ± 0.009	3.66 ± 0.01	3.06 ± 0.006	0.72 ± 0.000	1.86 ± 0.000
<i>C.tintorium</i> Root	0.94 ± 0.005	4.72 ± 0.207	6.54 ± 0.002	4.37 ± 0.002	0.74 ± 0.000	2.08 ± 0.000
<i>C.tintorium</i> Stem bark	0.81 ± 0.003	3.65 ± 0.009	3.43 ± 0.007	1.48 ± 0.002	1.10 ± 0.000	2.41 ± 0.005
<i>B. pinnatum</i> Leaf	1.13 ± 0.003	3.54 ± 0.005	5.13 ± 0.005	2.45 ± 0.005	0.84 ± 0.000	1.91 ± 0.000
<i>B. pinnatum</i> Root	0.87 ± 0.009	7.51 ± 0.008	4.55 ± 0.002	3.40 ± 0.000	1.30 ± 0.000	2.85 ± 0.005
<i>B. pinnatum</i> Stem bark	1.08 ± 0.003	5.91 ± 0.013	6.57 ± 0.003	2.89 ± 0.000	0.82 ± 0.000	1.57 ± 0.005
<i>E.senegalensis</i> Leaf	1.34 ± 0.003	5.56 ± 0.002	5.14 ± 0.005	3.79 ± 0.001	0.62 ± 0.000	2.14 ± 0.000
<i>E.senegalensis</i> Root	1.17 ± 0.004	4.33 ± 0.003	5.41 ± 0.005	1.76 ± 0.005	0.96 ± 0.000	1.62 ± 0.005
<i>E.senegalensis</i> Stem bark	1.05 ± 0.043	5.16 ± 0.009	4.10 ± 0.004	2.46 ± 0.004	1.06 ± 0.000	2.24 ± 0.005

Table 3. Antimicrobial activity of methanolic leave, root and stem bark extract of *Cochlospermum tintorium* on various concentrations using agar well diffusion technique

Microorganism	Concentration (mg/ml)	Leaf Extract (mm)	Root Extract (mm)	Stembark extract (mm)	Control ciprofloxacin tablets (mm)
<i>Klebsiella pneumoniae</i>	0.5	-	6.00 ± 0.50	-	25
	1.0	10.00 ± 0.25	10.00 ± 0.48	-	
	1.5	11.00 ± 0.50	10.00 ± 0.50	-	
	2.0	12.00 ± 0.34	11.00 ± 0.10	8.00 ± 0.45	
	2.5	15.00 ± 0.30	20.00 ± 0.20	10.00 ± 0.20	
<i>Escherichia coli</i>	0.5	3.00 ± 0.50	5.00 ± 0.45	-	22
	1.0	5.00 ± 0.40	9.00 ± 0.50	-	
	1.5	6.00 ± 0.38	10.00 ± 0.30	7.00 ± 0.50	
	2.0	16.00 ± 0.50	12.00 ± 0.50	8.00 ± 0.30	
	2.5	16.00 ± 0.50	18.00 ± 0.50	9.00 ± 0.10	
<i>Staphylococcus aureus</i>	0.5	-	9.00 ± 0.50	5.00 ± 0.30	26
	1.0	16.00 ± 0.20	11.00 ± 0.30	7.00 ± 0.51	
	1.5	18.00 ± 0.50	12.00 ± 0.53	9.00 ± 0.20	
	2.0	19.00 ± 0.40	15.00 ± 0.40	10.00 ± 0.40	
	2.5	20.00 ± 0.45	20.00 ± 0.42	12.00 ± 0.31	

Zone of inhibition expressed in mean ± SEM

Table 4. Antimicrobial activity of methanolic leave, root and stem bark extract of *Bryophyllum pinnatum* on various concentrations using agar well diffusion technique

Microorganism	Concentration (mg/ml)	Leaf Extract (mm)	Root Extract (mm)	Stembark extract (mm)	Control Ciprofloxacin Tablets (mm)
<i>Klebsiella pneumoniae</i>	0.5	5.00 ± 0.45	-	-	25
	1.0	5.00 ± 0.20	-	-	
	1.5	6.00 ± 0.51	2.00 ± 0.40	-	
	2.0	8.00 ± 0.10	4.00 ± 0.50	-	
	2.5	10.00 ± 0.20	6.00 ± 0.30	10.00 ± 0.10	
<i>Escherichia coli</i>	0.5	-	-	-	22
	1.0	-	9.00 ± 0.10	-	
	1.5	-	10.00 ± 0.40	-	
	2.0	10.00 ± 0.10	11.00 ± 0.50	-	

Microorganism	Concentration (mg/ml)	Leaf Extract (mm)	Root Extract (mm)	Stembark extract (mm)	Control Ciprofloxacin Tablets (mm)
<i>Staphylococcus aureus</i>	2.5	12.00 ± 0.50	13.00 ± 0.53	-	26
	0.5	-	-	-	
	1.0	3.00 ± 0.50	-	-	
	1.5	5.00 ± 0.10	-	-	
	2.0	9.00 ± 0.30	2.00 ± 0.50	-	
	2.5	11.0 ± 0.50	3.00 ± 0.30	-	

Zone of inhibition expressed in mean ± SEM

Table 5. Antimicrobial activity of methanolic leave, root and stem bark extract of *Erythrina senegalensis* on various concentrations using agar well diffusion technique

Microorganism	Concentration (mg/ml)	Leaf extract (mm)	Root extract (mm)	Stembark extract (mm)	Control Ciprofloxacin Tablets (mm)
<i>Klebsiella pneumoniae</i>	0.5	6.00 ± 0.30	-	-	25
	1.0	9.00 ± 0.50	-	-	
	1.5	10.00 ± 0.20	-	-	
	2.0	11.00 ± 0.51	-	-	
	2.5	12.00 ± 0.10	7.00 ± 0.52	-	
<i>Escherichia coli</i>	0.5	-	-	-	22
	1.0	-	-	-	
	1.5	-	-	-	
	2.0	-	2.00 ± 0.40	3.00 ± 0.20	
	2.5	7.00 ± 0.51	6.00 ± 0.51	7.00 ± 0.45	
<i>Staphylococcus aureus</i>	0.5	-	-	-	26
	1.0	-	-	-	
	1.5	-	-	-	
	2.0	-	-	-	
	2.5	-	2.00 ± 0.54	5.00 ± 0.43	

Zone of inhibition expressed in mean ± SEM

common infectious diseases. Medicinal plants and their secondary metabolites have shown to be a reliable source of future antimicrobial with abilities to combat a wide range of infectious pathogen [4]. The purpose of the current study was to investigate the qualitative phytochemical constituents and antimicrobial activity of the methanolic leaf, root and stem bark extracts of *Cochlospermum tinctorium*, *Bryophyllum pinnatum* and *Erythrina senegalensis* from Takum Local Government area of Taraba State.

“Phytochemicals constituents are secondary metabolites of plants with diverse pharmacological and biochemical effects on living organisms. Alkaloids and flavonoids found in plants have diuretic, anti-inflammatory and analgesic effects. Alkaloids are capable of reducing headache associated with hypertension, used in the management of cold, fever and chronic Catarrh. Flavonoids are known for their antioxidant activity and hence they help to protect the body against cancer and other degenerative diseases” [23,13]. Tannins are known to have antiviral, antibacterial and antitumor activities. Saponin is used as hypercholesterolemia, hyperglycemia, antioxidant, anticancer, anti-inflammatory and weight loss. The presence of these phytochemicals (Alkaloids, Glycosides, Phenols, Saponins, flavonoids and steroids) in *Cochlospermum tinctorium*, *Bryophyllum pinnatum* and *Erythrina senegalensis* supports their use as medicinal plants. These chemical constituents could be responsible for their antibacterial activity containing complexes of chemicals with unique biological activity, which is attributed to toxins and secondary metabolites they contain [24].

The results of the antibacterial studies showed that *Cochlospermum tinctorium*, methanolic leaf and root extracts possess varied antibacterial activity against the tested isolates (Table 3), *Klebsiella pneumonia*, *Escherichia coli* and *Staphylococcus aureus* were susceptible to the extracts at 2.0 mg/ml and 2.5 mg/ml with zone of inhibition ranging between 15 mm to 20 mm when compared to the standard control ciprofloxacin tablets (25 mm, 22 mm and 26 mm) respectively, However the methanolic stem bark extract showed minimal antibacterial activity with 5.00 ± 0.30 mm and 12.00 ± 0.31 mm as the least and highest zone of inhibition recorded for the bacterial isolates compared to the control.

This result agrees with the findings of Tijani et al. [25] who documented the antibacterial activity of

the methanol root extract of *C. tinctorium* (500, 1000, and 2000 µg/ml) using hole-in-plate bioassay technique with ciprofloxacin (10 µg/ml) and gentamicin (10 µg/ml) as standard drugs. The extract demonstrated significant antibacterial activity at 2000 µg/ml against *Staphylococcus aureus* (19.00 mm), *Corynebacterium ulcerans* (17.20 mm), *Klebsiella pneumoniae* (11.00 mm), *Escherichia coli* (14.30 mm), *Proteus mirabilis* (11.00 mm), and *Shigella dysenteriae* (19.00 mm). The highest activity of the extract was observed against *Staphylococcus aureus* and *Staphylococcus dysenteriae* (19.00 mm). Further, Muhammad et al. [26] reported the antibacterial activities of the methanol root extract of *C. tinctorium* and its n-hexane, ethyl acetate, and aqueous fractions (500, 1000, and 2000 µg/ml) using hole-in bioassay plate method. The extract produced the highest activity at 2000 µg/ml against *Pseudomonas aeruginosa* (8.72 ± 0.26 mm), *Escherichia coli* (20.33 ± 0. mm), *Staphylococcus aureus* (15.67 ± 0.58 mm), and *Klebsiella pneumoniae* (19.00 ± 1.0 mm). “The antibacterial activity of the methanol root extract of the plant could be due to the presence of alkaloids, flavonoids, tannins, and cardiac glycosides. Flavonoids are known to possess effective antimicrobial activity against a wide range of microorganisms due to their ability to form complex with cellular proteins and bacterial cell walls” [10].

The methanolic leaf and root extract of *Bryophyllum pinnatum* (Table 4) showed minimal antibacterial activity against *Klebsiella pneumonia*, *Escherichia coli* and *Staphylococcus aureus*, these isolates were resistant to the methanolic extracts at all concentrations with the highest zone of inhibition of (11.0 ± 0.50) mm and the lowest (3.0 ± 0.40) mm when compared to the standard control ciprofloxacin tablet (25 mm, 22 mm and 26 mm). Additionally, the methanolic stem bark extract had no antibacterial activity against the isolates. This findings does not agree with that of Aibinu et al. [27] who documented that extracts from *Bryophyllum pinnatum* leaves, the methanol extract was the most active. It showed marked antibacterial activities against Control strain of *Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus subtilis* and *Pseudomonas aeruginosa* and Akinpelu [28] and Ofokansi [29] that showed strong activities of methanol extract of *Bryophyllum pinnatum* against some Gram-positive organisms. The antimicrobial effect of methanol extract against these organisms can be attributed to the ability of the methanol to liberate

most of the active properties in the plants like phenolic, saponin, bryophyllin and other secondary metabolites which are reported poses antimicrobial activities [30,31]. The minimal antibacterial activity is most likely attributed to fact that, the total phenols and saponins deposit in the plants may not in sufficient quantity within this geographic location compared to others.

The methanolic leaf, root and stem bark extracts of *Erythrina senegalensis* (Table 5) exhibited minimal antibacterial effect on all test isolates with zones of inhibition ranging from (2.0 ± 0.54 mm) as the lowest and (12.0 ± 0.10 mm) as the highest compared to the standard control ciprofloxacin tablets (25 mm, 22 mm and 26 mm). This finding does not agree with that of (Osuntukon et al. 2016) who documented that the antimicrobial activities of ethyl acetate bark extract using ethyl acetate to elute shows that *Staphylococcus aureus* is susceptible followed by *Klebsiella pneumonia* while *Candida albicans* is less susceptible. This disparity might be attributed to the solvent used for extracting the active metabolites within these plants.

5. CONCLUSION

This study showed that the methanolic leaf, roots and stem bark extracts of *Cochlospermum tentorium*, *Bryophyllum pinnatum*, and *Erythrina senegalensis* obtained in Takum Local Government Area of Taraba State contains active phytochemicals in sufficient quantities such as Alkaloid, Glycoside, Flavonoid, Phenol, Saponin, Tannins and Steroids. These compounds might be responsible for their antibacterial activity of these plants. Additionally, the methanolic leaf, root and stem bark extract of *Cochlospermum tentorium* was the most potent against *Klebsiella pneumonia*, *Escherichia coli* and *Staphylococcus aureus* compared to the leaves, roots and stem bark extracts of *Bryophyllum pinnatum*, and *Erythrina senegalensis* which had minimal antibacterial activity against the tested isolates.

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CONSENT AND ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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