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Phytochemistry and Antimicrobial Studies of the Solvent Partitioned Portions of Methanolic Stem-Bark Extract of *Boswellia dalzielii* (Burseraceae)

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ABSTRACT

This study was aimed to determine the phytochemical constituents and assess the antimicrobial potency of different solvent partition portions of methanol stem-bark extract of *Boswellia dalzielii.* The plant material was collected, prepared and cold macerated using methanol as solvent. The crude methanol extract obtained was further partitioned with different solvents based on their polarity-n-hexane (NHE), chloroform (CFE), ethyl acetate (EAE), n-butanol (NBE), and water (RAE) respectively. The extractives obtained were subjected to phytochemical screening and further assayed for anti-infective potency; adopting agar well diffusion protocol against some selected human pathogenic isolates viz *S. typhi, E. coli, K. pneumoniae, S. dysentriae, P. aeruginosa P. Mirabilis* (Gram -ve), *S. aureus, S. pyogene, Corynaebacterium spp.* and *B. subtilis* (Gram +ve) bacteria and *C. albicans* (fungal) strain. The MIC, MBC and MFC were ascertained using the standard protocol of microdilution assay. The activity index (AI), percent activity (PA), and spectral intensity index (SII) were also assessed in comparison to reference antibiotics (Erythromycin, ciprofloxacin, ketoconazole). The results of phytochemical screening showcased that, NBE has the highest content of secondary metabolites (alkaloids, aloes, cardiac glycosides, flavonoids, cyanogenic glycosides, terpenoids, resins, saponins, steroids, and carbohydrates) followed by CFE. Anthraquinones and phlabatanins were absent in all portions. NBE and CFE were found to be the most potential extract against the MDR strains tested but *C. albicans* (29.66±0.33mm), *S. dysentriae* (24.66±0.33mm) and *S. aureus* (24.33±0.33mm) were found to be the most sensitive strains. RAE showed very poor sensitivity across the microbes tested. The MIC, MBC and MFC results indicated that NBE, CFE and EAE showed a remarkable bacteriostatic, bactericidal and fungicidal effect against *S. dysentriea, C. albicans, S. aureus* and *E. coli* at 6.25mg/ml. NBE and CFE portions have high AI when compared to reference antibiotics and evaluation of PA revealed that all the G+ve, G-ve and fungal strain were 100% sensitive to those two portions. NBE possesses the maximum SII (11.75), followed by CFE (10.99) and EAE (9.01) which indicated that NBE was the most potent portion. The presence of high content of phytochemical constituents in NBE was responsible for this broad-spectrum antimicrobial activity. This finding provides a logical justification to the traditional healers for the utilization of the plant in the management of different ailments (diarrhoea, candidiasis, dysentery) caused by the tested microbes. Due to high potency of the NBE we are currently working on isolation and purification of the bioactive component(s) responsible for the antimicrobial activities observed in this study through the bioassay-guided protocol.

Keywords: Phytochemistry, Antimicrobial Studies, *Boswellia dalzielii*, Partitioned Portions, Stem-Bark Extract

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1. INTRODUCTION

It is eminent that diseases caused by pathogenic microbes are prevalent globally, which account for high-level well-being problems, particularly in developing nations like Nigeria [1]. The emerging and re-emerging multidrug-resistant microbes in recent times posed several serious problems in the treatment of various infections which further continued to be clinical as well as public health concerns [2]. Such pathogens (bacteria or fungal) have been developing resistance rapidly to most of the currently available antimicrobial drugs either by the exchange of genetic material, mutation and via several other resistance mechanisms that are widespread in the bacterial population [3].

Hyper-mutability, multidrug efflux, and plasmid addiction are the recently discovered factors for the emergence, dissemination, and maintenance of resistance further, such factors compromise the potential of the majority of the drugs, hence, the need for new better and affordable antimicrobials have been dramatically increasing [2].

Medicinal plants are considered one of the most promising sources of novel bioactive compounds which could further be utilized as a potential alternative or complementary treatment for drug-resistant pathogens [4]. Secondary metabolites and bioactive compounds of plants exhibited remarkable bacteriostatic, bactericidal, and fungicidal properties and other modes of action include various targets to kill bacterial cells or fungal cells, so have been investigated as therapeutic agents [2].

Boswellia dalzielii (Burseraceae) is one of the medicinal plants with so many therapeutic properties such as anti-diarrhoea, anti-inflammatory, antimicrobial, antirheumatic immuno- modulatory among others [5,6;7,8]. *B. dalzielii* has also been reported for the treatment of dental problems, coughs, and asthmatic attacks, bronchitis [6]. This study is designed to evaluate phytochemical constituents and antimicrobial activities of different solvent portioned portions of *B. dalzielii* stem-bark to justify scientifically the therapeutic claims from an ethnomedicinal point of view.

2. MATERIALS AND METHOD

Collection and Identification of Plant

The stem-bark of *Boswellia dalzielii* Hutch was collected from Bagale (Long. 12^{o} 34′ E; Lat. 9^{o} 18′ N), Gieri Local Government Area, Adamawa State, Nigeria. The plant material was identified and authenticated by a taxonomist from the Department of Biological Sciences, University of Maiduguri. The herbarium specimen was deposited at the Post Graduate Research Laboratory, Department of Pure and Applied Chemistry with voucher number (#340) provided. The stem bark of the plant was cleaned air-dried under shade for several days and pulverized into a fine powder and then coded "*Plant material*".

Extraction and Fractionation of the plant Material

The air-dried pulverized plant material (2000 g) was extracted exhaustively with 95 % methanol in distilled water using the maceration method. The combined methanolic extracts were concentrated to dryness at reduced pressure between 40°C to 45°C using a rotary evaporator and the extract coded BDME-*Boswellia dalzielii* methanolic extract. Exactly 250g of BDME was partitioned successively with solvents of graded polarities: n-hexane, chloroform, ethyl acetate, aqueous, and n-butanol to afford n-hexane extract (NHE), chloroform extract (CFE), ethyl acetate extract (EAE), n-butanol extract (NBE) and residual aqueous extract (RAE) respectively by maceration method. The partitioned portions were then subjected to phytochemical screening and *in vitro* antimicrobial susceptibility tests as well as the MIC, MBC, and MFC of the susceptible organisms.

Phytochemical Screening

The phytochemical screening of the solvent partitioned portions (NHE, CFE, EAE, NBE, and RAE) was conducted for secondary metabolites- alkaloids, flavonoids, cardiac glycosides, cyanogenic glycosides, aloes, cardenolides, resins, terpenoids, saponins, tannins, steroids, anthraquinones, and carbohydrates following standard protocols as described by [9,10,11].

Antimicrobial Studies

Test Microorganisms/Standard Antibiotics

A total of eleven (11) microorganisms were used in this study: Six Gram-negative bacteria (*Salmonella typhi, Escherichia coli, Klebsiella pneumoniae, Shigella dysentriae, Pseudomonas aeruginosa,* and *Proteus mirabilis*); four Gram-positive bacteria (*Staphylococcus aureus, Corynebacterium spp., Streptococcus pyogene,* and *Bacillus subtilis*) and one fungal strain (*Candida albicans*). Standard susceptibility antibiotic discs that were used in this study include Ciprofloxacin (5µg/disc), Erythromycin (5µg/disc), Gentamicin (10 µg/disc), and Ketoconazole (10 µg/disc) [Oxoid Ltd., Hampshire, England]. These microorganisms were clinical isolates obtained from the Department of Microbiology, University of Maiduguri Teaching Hospital (UMTH), Nigeria.

Antimicrobial Susceptibility Studies

The solvent partitioned portions of the extracts (NHE, CFE, EAE, NBE, and RAE) were subjected to antimicrobial susceptibility studies, minimum inhibitory concentration (MIC), and minimum bactericidal concentration (MBC) as well as minimum fungicidal concentration (MFC) accordingly. Activity index (AI), percentage activity (PA), bacterial/fungal susceptibility index (BSI/FSI), spectral intensity index (SII) were all conducted to establish the relationship between the activity (efficacy and potency) of the extracts compared with the standard antibiotics mentioned above following standard protocol adopted from Shahidi, [12] with little modification by [2,7].

The *in-vitro* antimicrobial activity of the solvent partitioned portions of the stem bark of *B. dalzielii* on these aforementioned pathogens was evaluated using the hole-in plate disc diffusion technique as described by [13] as modified by [14].

The partitioned portions were prepared in four different stock concentrations of 25 mg/ml, 50 mg/ml, 100 mg/ml and 200 mg/ml by dissolving 0.25 g, 0.5 g, 1.0 g and 2.0 g, respectively into 10 ml each of 95 % methanol in distilled water (v/v) as vehicle and working concentrations of 25, 50, 100 and 200 mg/hole.

The microorganisms were maintained on agar slants. The inocula were prepared by subjecting the test organisms to the nutrient broth and inoculated for 24 h at 35 ^{O}C. After inoculation, the broth cultures were diluted to 1:1000 for Gram-positive bacteria and 1:5000 for Gram-negative bacteria. One millilitre of the diluted cultures was inoculated into 19 ml sterile molten nutrient agar (48 ^{O}C) and poured into sterile Petri-dishes. These were swirled gently and then allowed to solidify. Afterward, holes of 9 mm diameter were bored into the solidified and inoculated nutrient agar plates using a sterile number VI cork borer. All the holes were filled with equal volumes of 0.1 ml (25, 50, 100, 200 mg/hole) of the extracts. The standard discs of the reference antibiotics earlier mentioned were placed on already bacteria-inoculated nutrient agar plates for an hour to allow the extract to diffuse into the agar. Thereafter, the plates were then incubated overnight at 37˚C and 35˚C for the fungi and bacterial strains respectively. At the end of the incubation period, inhibition zones were recorded in millimeters as the diameter of growth-free zones around the bored holes using a transparent metre rule. The partitioned portions and the standard antibiotics were independently tested in triplicate. Diametres of zones of inhibition ≥10 mm exhibited by plant extracts were considered active [6].

Activity Index (AI)

The AI was specifically designed to express the relationship of the inhibition zone of the extract in question to that of standard antibiotics under study [2,6,14]. This was estimated using the formula (100*D)/d, where D represents the diameter of the inhibition zone of the extract and d is the diameters of the inhibition zone of the standard drug (expressed as %) [12].

Percentage Activity (PA)

PA demonstrates the total antimicrobial efficacy of particular extracts or shows the number of microbial strains susceptible to a particular extract. The PA was calculated using the formula (100*X)/Y, where X is the number of susceptible strains to a specific extract and Y represents the total number of tested microbial pathogens. The percentage activity was expressed as % Gram-positive (G+), % Gram-negative (G-), Fungal strains, and %T as total activity against Grams

positive, Gram-negative, and fungal strains pathogens [2,6,12].

Bacterial /Fungal Susceptibility Index (BFSI)
BFSI is used to compare the relative susceptibility between all the bacterial/fungal strains tested. The values of BFSI range between 0 (resistance to all extracts) to 100 (susceptible to all extracts).This was calculated using the formula (100*A)/B, where A is the number of extracts effective against each microbial strain and B represents the number of total extracts (expressed as %) [2,6,12].

Average Percent of Bacterial/Fungal Susceptibility (APBFS)
This was determined using the formula (X/Y) where X represents the sum of % activities of Gram-positive, Gram-negative, and Fungal strains (%G+, %G- %F) and Y is the number of total samples. This represents the overall susceptibility of each group of bacterial/fungal strains [2,6,14].

Spectral Intensity Index (SII)
SII was determined using this relation: A*%T/100, where A represents the mean diameter of inhibition zone (DIZ) of all sensitive bacterial/fungal strains to a specific extract and %T (total percentage activity i.e. mean % Gram-positive, % Gram-negative, and % fungal strains) [2,12]. The SII was designed to assess how effective the pharmaceutical agent or an extract is against tested pathogens.

Determination of Minimum inhibitory concentration (MIC)
The MIC was determined using the nutrient broth dilution technique as described by [14,15]. The MIC value was determined for the microorganisms that were sensitive to the extracts under study. The microorganisms were prepared as described earlier. Each extract was first diluted to the highest concentration (100 mg/ml) in 95% methanol in distilled water (v/v) and then a two-fold serial dilution of the extract was then made to a concentration ranging from 3.123 to 50 mg/ml using nutrient broth (by dissolving 13 g/L). The extracts were inoculated with 1 ml suspension of the organisms and thereafter incubated at 35°C and 37°C for bacterial and fungal strains respectively. MIC was defined as the lowest concentration where no visible turbidity was observed in the test tubes [6].

Determination of Minimum Bactericidal Concentration (MBC)
The MBC was determined by using the broth dilution technique previously described by [15] as adopted by [14,16] by assessing the test tubes resulting from MIC determinations. A loopful of the content of each test tube was inoculated by streaking on a solidified nutrient agar plate and then incubated at 35°C for 24 hours and observed for bacterial growth. The lowest concentration of the sub-culture that shows no bacterial growth was considered the MBC [14].

Determination of Minimum Fungicidal Concentration (MFC)
The MFC was determined by using the broth dilution technique previously described by [15] as adopted by [14] by assessing the test tubes resulting from MIC determinations. A loopful of the content of each test tube was inoculated by streaking on a solidified nutrient agar plate and then incubated at 37°C for seven days and observed for fungal growth. The lowest concentration of the sub-culture that shows no fungal growth was considered the minimum fungicidal concentration [7,14].

3. DATA ANALYSIS

All the generated data were presented as Mean ± standard error mean (SEM). Statistical analysis to determine the mean differences among the zones of inhibition exhibited by the extracts against each organism and the standard antibiotics using one-way analysis of variance (ANOVA) with Student - Newman - Keul's multiple comparison test using GraphPad InStat, where $P<0.05$ considered significantly different (GraphPad Software, 2003).

4. RESULTS AND DISCUSSION

The extractive values for the organic solvents partitioned portions (250 g) of the crude extract were found to be 3.40 % w/w (8.51 g; yellowish-brown viscous oil), 0.17 % w/w (0.44 g; yellowish-brown mass), 0.46 % (1.15 g; brownish-black mass), 11.57 % (28.92 g; light-brown mass), 25.09 % (62.72 g; reddish-brown mass) for n-hexane, chloroform, ethyl acetate, n-butanol and aqueous respectively as presented in Table 1. The difference experienced in % yields could be accounted

for by the strength and solubility of solvents used to dissolve the plant extract [1].

The phytochemical examinations of the solvents partitioned portions revealed the presence of alkaloids, aloes, cardenolides, cardiac glycosides, terpenoids, cyanogenic glycosides, flavonoids, steroids, resins, saponins, tannins, higher fatty acids and carbohydrates (Table 2). Anthraquinones and phlobatannins were absent in all the portions while alkaloids, resins, and tannins were present in NBE and RAE portions only. Cardenolides, cardiac glycosides, cyanogenic glycosides, flavonoids, steroids, and terpenoids were present in all the portions but saponins were present only in CFE, NBE, and RAE. Aloes were only absent in EAE but present in others. Alkaloids, tannins, flavonoids, saponins, cardiac glycosides, and carbohydrates were detected by previous researchers [6,17,18,19] in the plant which is in agreement with this research.

Tannins can decrease bacterial cell, proliferation by blocking key enzymes of microbial metabolism [19]. The antimicrobial effects of flavonoids have been attributed to their ability to complex with extracellular, soluble protein and to complex with bacterial cell wall proteins [7]. Alkaloids have been shown to possess both antibacterial and antidiabetic activities [20]. Steroids are known for their antibacterial activity especially associated with membrane lipids and cause leakages from liposomes [21]. Steroids and triterpenoids show analgesic properties and are responsible for central nervous system activities [21]. Terpenoids are responsible for the dissolution of the cell wall of microorganisms by weakening the membranes and tissues [19]. Cyanogenic glycosides have shown remarkable activity in Gram +ve bacteria and Gram -ve bacteria [9]. The presence of these constituents in the stem bark of *B. dalzielii* suggests that the plant is pharmacologically active, thus supporting the claims by traditional healers.

Table 1: The extractive profile of the solvents partitioned portions of the Stem Bark of *B. dalzielii*

S.No.	*Extract/portion	Code	Weight (g)	Colour	Texture	% Yield
1	n-Hexane	NHE	8.51	Dark green	Gummy mass	3.40
2	Chloroform	CFE	0.44	Yellowish-brown	Dried mass	0.17
3	Ethyl acetate	EAE	1.15	Brownish black	Dried mass	0.46
4	n-Butanol	NBE	28.92	Light brown	Powdered mass	11.57
5	Aqueous	RAE	62.72	Reddish-brown	Powdered shiny mass	25.09

Key: NHE = n-Hexane portion, CFE = Chloroform portion, EAE = Ethyl acetate portion, NBE = n-Butanol portion, RAE = aqueous portion

Table 2: Phytochemical constituents of solvents partitioned portions of the stem bark of *B. dalzielii*

S. No.	Phytochemicals	Test	Results				
			NBE	NHE	EAE	RAE	CFE
1	**Alkaloids**	Dragendorff's Mayer's Wagner's	+ - -	- - -	- - -	+ - -	- - -
2	**Aloes**		+	+	-	+	+
3	**Anthraquinones** **Free Anthraquinones** **Combined Anth.**	Borntrager's Borntrager's Borntrager's	- - -	- - -	- - -	- - -	- - -

4	**Cardenolides**	Legal's Keller-Kilianis	+ +	- +	- +	- +	+ +
5	**Cardiac glycosides**	Salkwoski's Liebermann-Burchard	+ +	+ +	+ +	+ +	+ +
6	**Terpenoids**		+	+	+	+	+
7	**Cyanogenic glycoside**		+	+	+	+	+
8	**Flavonoids**	Shinoda's Ferric chloride Lead acetate NAOH	+ + + -	+ + + -	+ - - -	+ + - -	+ + + -
9	**Higher fatty acids**		+	+	-	+	+
10	**Phlobatannins**		-	-	-	-	-
11	**Resins**		+	-	-	+	-
12	**Saponins**	Frothing Fehling's	+ +	- -	- -	+ +	- +
13	**Tannins**	Ferric chloride Lead acetate Gold beater's 10% HCl	+ + + -	- - - -	- - - -	+ + - -	- - - -
14	**Steroids**		+	+	+	+	+
15	**Carbohydrates** i.General test ii.Monosaccharides iii.Free reducing sugar iv.Combined reducing sugar v. Soluble starch vi. Ketoses vii.Pentoses	 Molisch's Barfoed's Fehling's Fehling's Salivanoff's	+ + + + + + + +	+ - - - - - - -	+ - - - - - - -	+ + + + + + + +	+ - - - - - - -

Key: + = present, - = Absent, NT =not tested, NBE =n-butanol portion, NHE =n-hexane portion, EAE =ethyl acetate portion, CFE =chloroform portion, RAE =aqueous portion

Susceptibility Pattern of Partitioned Portions of *B. dalzielii*

The results of the susceptibility pattern of the solvents partitioned portions (NHE, EAE, CFE, NBE, and RAE) compared with standard drugs are summarized in Tables 3-6 at different concentrations (25, 50, 100, and 200mg/ml) respectively. Diameters of inhibition zones (DIZ) exhibited by all the portions at 25 mg/hole are presented in Table 3. The results showed that the inhibitory activities against Gram +ve, Gram -ve and fungal strains ranged from 7.00±0.00 to 10.66±0.33 mm,7.00±0.00 to 11.66±0.33mm, and 7.00±0.00 to 13.00±0.00 mm respectively. RAE portion had shown resistance to all the pathogens studied, likewise NHE, except the *C. albicans* that had DIZ as 8.00±0.00 mm. The results also showed that NBE had low activity against *C. Albicans* (13.00±0.00mm) and *S. dysentriae* (11.66±0.33mm) while CFE had similar activity against *S. aureus*. The activities of CFE, EAE, and NBE were not significant (P>0.05) different compared to each other against *E. coli.* There were no significant (P>0.05) different activities between EAE and NBE portions against Corynebacterium *spp.* There were insignificant (P>0.05) different activities observed among the standard antibiotics against *S. pyogene.* The rest of the extract portions and antibiotics studied had shown a significant (P<0.05) different against the tested pathogens. *B. subtili* showed resistance across all the five extractive portions. Table 4 summarizes the DIZ of all the pathogens at 50mg/hole concentration against

the extractives. Gram- positive bacteria range from 7.00±0.00 mm to 14.00±0.00 mm, Gram-negative bacteria ranges from 7.00±0.00 mm to 15.66±0.33 mm and fungal strain ranges from 7.00±0.00 mm to 19.33±0.33 respectively. The DIZ of NHE, EAE and CFE showed insignificantly (P>0.05) different against *C. albicans.* Also, the activities of CFE and the standard antibiotic (Erythromycin) were not significantly (P>0.05) different against *C. albicans.* The DIZ exhibited by *S. typhi* was found to be insignificantly different (P>0.05) between NBE and Erythromycin. The activities displayed among the portions (CEF, EAE and NBE) against *E. coli* at 50 mg/hole dose had shown insignificantly (P>0.05) different. The activities of CFE, NBE and RAE also showed no significant (P>0.05) difference against *K. pneumoniae.* Most of the tests conducted among the portions and antibiotics showed significantly (P<0.05, 0.01, 0.001) different. The activities of all standard antibiotics (Erythromycin, Ciprofloxacin, Gentamicin, and ketoconazole) had shown insignificantly (P>0.05) differences against *S. pyogene.* The activities of Gram-positive bacteria range from 7.00±0.00 mm to 14.00±0.00 mm, Gram-negative bacteria range from 7.00±0.00 mm to 15.66±0.33 mm, and fungal strain range from 7.00±0.00 mm to 19.33±0.33 respectively at 100mg/hole concentration (Table 5). CFE, EAE, NBE, and Erythromycin were insignificant (P>0.05) different against *E. coli* while NBE and Erythromycin were insignificantly (P>0.05) different against *P. aeruginosa.* The effects of NBE and Ciprofloxacin was not statistically different (P>0.05) against *C. Albicans*. The activities against *E. coli* at this dose were found to be insignificant (P>0.05) between portions (CFE, EAE, and NBE). Significant variation in the data was observed among other comparisons; this trend was similar to the report by [6,12]. The inhibition expressed by most portions was insignificantly (P>0.05) different from those of Erythromycin against *E. coli* while another comparison was significantly different (P<0.05, 0.01, 0.001) as the case may be. These patterns were in various cases similar to the work of [2,6,12,22]. The highest activity against the Gram +ve bacteria was 19.33±0.33 exhibited by the CEF portion while the least activity was 9.33±0.33 mm exhibited by the NBE portion. The results from this Table against gram-negative bacteria studied showed 20.33±0.33 mm as the highest DIZ against *S. dysentriae* expressed by NBE portion and the lowest was 7.00±0.00 mm against *E. coli* and *P. mirabilis* expressed by RAE and EAE. Table 6 presents the susceptibility patterns of the solvent partitioned portions at the highest dose of 200 mg/hole. This Table showed DIZ ranging from 12.66±0.33 (NB) to 24.33±0.33 (CFE) against Gram +ve bacteria, while from 9.66±0.33 mm (EAE) to 24.66±0.33 mm (NBE) against Gram -ve bacteria and 14.00±0.00 mm (CFE) to 29.66±0.33 mm (NBE) [Fungal strains] respectively. At the highest dose 200 mg/hole, the statistical analysis revealed no significant (P>0.05) different between NBE and Gentamicin against *S. typhi.* The activities by CFE, Erythromycin and Gentamicin were relatively insignificant (P>0.05) different when compared to *S. dysentriae*; the means of inhibition expressed by CFE and Gentamicin were also insignificant (P>0.05) against *K. pneumoniae.* Similarly, between CFE, NBE, and Gentamicin against *E. coli.* The DIZ of NBE and Erythromycin showed no significant (P>0.05) difference against *S. aureus.* The activities of CFE and Erythromycin when compared showed no significant (P>0.05) difference against B. *subtilis.* The DIZ exhibited by NHE and Erythromycin showed no significant (P>0.05) different against *S. typhi.* The inhibition against *S. dysentriae, E. coli, K. Pneumoniae, and Corynebacterium spp.* were non-significantly (P>0.05) different when NHE, CFE, NBE, RAE, Ery, Cip, Gen, Ket was compared with each other. This level of activity is an indication of the extracts and reference drugs being susceptible to these pathogens. These affect were possibly because the portions contain some kind of components with similar activities to those antibiotics especially against *E. coli, S. dysentriae* and, *S. aureus.* These evaluations seemed to favourably relate to the reports by [6,12,19,23]. The remaining comparisons of DIZ were significant (P<0.05, 0.01, 0.001) between the activities of all the portions studied against *P. mirabilis, P. aeruginosa, B. subtilis* and *C. albicans.*

The dosage-dependent effects were in line with [24] earlier reported for *Securideca longepedunculata,* [25] for *Bauhinia variegata* and Usman [26] for *Bauhinia rufescens* LAM. The lowest activities observed at 25 mg/hole were probably due to the dose-dependent effects shown mostly against the pathogens studied. The MIC, MBC, and MFC of the extractive

portions (Table 7) revealed that NBE, CFE and EAE were more sensitive against *S. dysentriae, E. coli, S. Aureus,* and *C. albicans* with the highest MIC values of 6.25 mg/ml. NBE and EAE also had the highest MBC/MFC values of 6.25 mg/ml against *S. dysentriae* and *C. albicans* respectively while CFE and NBE had moderate MBC values of 12.50 mg/ml against *S. aureus* and *E. coli*. The RAE and NHE portions showed the least sensitivity with the MIC/MBC values of 100 mg/ml each against *E. coli* and *S. typhi* respectively. The sensitivity pattern of the solvent partitioned portions (Table 8) showed that the activity indices towards the Gram +ve bacteria revealed that CFE had the highest AI of 117.92% when correlated with Erythromycin against *S. aureus* while NBE recorded the least AI of 33.46 %, 21.47%, and 26.77% respectively when compared to Erythromycin, Ciprofloxacin and Gentamicin against *B. subtilis*. When correlated with Gram +ve antibiotic (Erythromycin), NBE had 51.77 % as AI against *S. aureus*. The bacterial susceptibility index (BSI) on the Gram +ve bacteria studied showed that Corynebacterium *spp* and *S. aureus* had highest value of 60.00 % each. The results of the sensitivity pattern of Gram -ve bacteria (Table 9) showed that NBE portion exhibited the highest AI when compared with Erythromycin and Gentamicin at 95.66% and 101.64% respectively against *S. dysentriae*. The least AI was against *E. coli* expressed by RAE as 31.60 % and 22.22 % when correlated with Erythromycin and Gentamicin respectively. *S. dysentriae* and *K. pneumonia*e had the highest BSI of 80.00 % each while *E. coli* had BSI of 40.00 % only. The activity index of fungal strain revealed that NBE had the highest value of 95.99 % and 180.09 % when correlated with ketoconazole respectively against *C. albicans* with 80.00 % FSI as well. NBE and CFE portions had the percentage activity of 100 % each followed by EAE with 83.30 % and the least was RAE with only 22.22 %. The SII for the portions indicated that NB had the highest index of 11.75 mm while RAE maintained the least at 1.35 mm (Table 10). The APBFS showed that the fungal strain had the highest value of 80.00%, Gram -ve (73.33 %) and Gram +ve (60.00 %). Supportive to the data presented on AI, BSI/FSI, SII and APBFS of the partitioned portions showed that the NBE portion had the highest SII of 11.75 mm and hence the reason for the bio-assay directed activity/isolation of the active compounds which is already on the way.

Overall, the dosage-dependent approach in this study is in line with similar work by [6,25,26]. The NBE portion was observed to be the most active followed by CFE and hence, contains bioactive phytochemical agents against the tested bacterial and fungal strain(s) and therefore these remarkable results prompted us to work towards the isolation and characterization of the active compounds from the most active portion (NBE) through bio-assay directed protocol.

Table 3: Susceptibility patterns of the solvent partitioned portions of stem bark extract of *B. dalzielii* at 25 mg/hole compared with standard antibiotics

Microorganism	Concentrations (25mg/hole) /Diameters of Inhibition Zone Mean ± SEM (mm)								
	NHE	*CFE*	*EAE*	*NBE*	*RAE*	*Ery. 5µg*	*Cip. 5µg*	*Gen. 10 µg*	*Ket. 10 µg*
E. coli	0.00±0.00^{a}	7.00±0.00^{b}	7.33±0.33^{b}	7.00±0.00^{b}	0.00±0.00^{a}	12.66±0.33^{c}	20.33±0.33^{d}	18.00±0.00^{e}	-
S. typhi	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	7.66±0.33^{b}	0.00±0.00^{a}	10.66±0.33^{c}	21.66±0.88^{d}	17.00±0.57^{e}	-
S. dysentriae	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	11.66±0.33^{b}	0.00±0.00^{a}	17.00±0.00^{c}	24.00±0.00^{d}	16.00±0.00^{c}	-
P. aeruginosa	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	7.00±0.00^{b}	0.00±0.00^{a}	12.00±0.00^{c}	25.66±0.33^{d}	19.33±0.33^{e}	-
K. pneumoniae	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	13.33±0.33^{b}	25.00±0.00^{c}	15.00±0.00^{d}	-
P. mirabilis	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	8.00±0.00^{b}	0.00±0.00^{a}	14.00±0.00^{c}	20.00±0.57^{d}	17.66±0.57^{e}	-
S. aureus	0.00±0.00^{a}	10.66±0.33^{b}	8.00±0.00^{c}	0.00±0.00^{a}	0.00±0.00^{a}	13.00±0.00^{d}	25.00±0.00^{e}	17.00±0.00^{f}	-
S. pyogene	0.00±0.00^{a}	8.00±0.00^{b}	0.00±0.00^{a}	7.00±0.00^{b}	0.00±0.00^{a}	21.00±0.57^{c}	20.00±0.57^{c}	19.00±0.00^{c}	-
B. subtilis	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	17.33±0.57^{b}	25.00±0.00^{c}	21.66±0.57^{d}	-
Cory. Spp.	0.00±0.00^{a}	0.00±0.00^{a}	7.00±0.00^{b}	7.00±0.00^{b}	0.00±0.00^{a}	17.00±0.00^{c}	28.66±0.33^{d}	20.00±0.00^{e}	-
C. albicans	8.00±0.00^{a}	0.00±0.00^{b}	7.66±0.00^{a}	13.00±0.00^{c}	0.00±0.00^{b}	-	-	-	25.00±12^{d}

Key: Data are mean ± SEM, n=3, *E. coli =Escherichia coli. S. typhii =Salmonella typhii, S. dysentriae=Shigella dysentriae, P. aeruginosa= Pseudomonas aeruginosa, K. pneumoniae=Klebsiella pneumoniae, P. mirabilis= Proteus mirabilis, S. aureus=Staphylococcus aureus, S. pyogene =Streptococcus pyogene, B. subtilis=Bacillus subtilis, C. spp.=Corynebacteria species, C. albicans= Candida albicans,NHE=n-hexane portion, CFE=chloroform portion, EAE=ethyl acetate portion, NBE=n-butanol portion, RAE=aqueous portion,Cip=ciprofloxacin, Ery.=Erythromycin, Gen. =Gentamycin, Ket.= ketoconazole,*means with different superscript along the same row are significantly (P<0.05 or P<0.001) different.

Table 4: Susceptibility patterns of the solvent partitioned portions of stem bark extract of *B. dalzielii* at 50 mg/hole compared with standard antibiotics

Microorganism	Concentrations (50mg/hole) /Diameters of Inhibition Zone Mean ± SEM (mm)								
	NHE	*CFE*	*EAE*	*NBE*	*RAE*	*Ery. 5µg*	*Cip. 5µg*	*Gen. 10µg*	*Ket. 10µg*
E. coli	0.00±0.00^{a}	9.33±0.33^{b}	9.00±0.00^{b}	10.00±0.00^{b}	0.00±0.00^{a}	12.66±0.33^{c}	20.33±0.33^{d}	18.00±0.00^{e}	-
S. typhi	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	10.00±0.33^{b}	0.00±0.00^{a}	10.66±0.33^{b}	21.66±0.88^{c}	17.00±0.57^{d}	-
S. dysentriae	7.00±0.00^{a}	9.00±0.00^{b}	0.00±0.00^{c}	15.66±0.33^{d}	7.00±0.00^{a}	17.00±0.00^{e}	24.00±0.00^{f}	16.00±0.00^{e}	-
P. aeruginosa	0.00±0.00^{a}	0.00±0.00^{a}	7.66±0.00^{b}	9.33±0.33^{c}	0.00±0.00^{a}	12.00±0.00^{d}	25.66±0.33^{e}	19.33±0.33^{f}	-
K. pneumonia	0.00±0.00^{a}	7.00±0.00^{b}	8.66±0.00^{c}	7.00±0.00^{b}	7.00±0.00^{b}	13.33±0.33^{d}	25.00±0.00^{e}	15.00±0.00^{f}	-
P. mirabilis	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	10.66±0.33^{b}	0.00±0.00^{a}	14.00±0.00^{c}	20.00±0.57^{d}	17.66±0.57^{e}	-
S. aureus	0.00±0.00^{a}	14.00±0.00^{b}	12.66±0.33^{c}	7.66±0.33^{d}	0.00±0.00^{a}	13.00±0.00^{c}	25.00±0.00^{e}	17.00±0.00^{f}	-
S. pyogene	0.00±0.00^{a}	12.00±0.33^{b}	0.00±0.00^{a}	9.00±0.00^{c}	0.00±0.00^{a}	21.00±0.57^{d}	20.00±0.57^{d}	19.00±0.00^{d}	-
B. subtilis	0.00±0.00^{a}	9.33±0.33^{b}	0.00±0.00^{a}	7.00±0.00^{c}	0.00±0.00^{a}	17.33±0.57^{d}	25.00±0.00^{e}	21.66±0.57^{f}	-

Cory. Spp.	0.00±0.00[a]	7.33±0.33[b]	9.33±0.33[c]	9.00±0.00[c]	0.00±0.00[a]	17.00±0.00[d]	28.66±0.33[e]	20.00±0.00[f]	-
C. albicans	11.00±0.00[a]	7.00±0.00[b]	10.00±0.00[a]	19.33±0.33[c]	0.00±0.00[d]	-	-	-	25.00±12[e]

Key: Data are mean ± SEM, n=3, *E. coli =Escherichia coli. S. typhii =Salmonella typhii, S. dysentriae=Shigella dysentriae, P. aeruginosa= Pseudomonas aeruginosa, K. pneumoniae=Klebsiella pneumoniae, P. mirabilis= Proteus mirabilis, S. aureus=Staphylococcus aureus, S. pyogene =Streptococcus pyogene, B. subtilis=Bacillus subtilis, C. spp.=Corynebacteria species, C. albicans= Candida albicans,NHE=n-hexane portion, CFE=chloroform portion, EAE=ethyl acetate portion, NBE=n-butanol portion, RAE=aqueous portion, Cip=ciprofloxacin, Ery.=Erythromycin, Gen. =Gentamycin, Ket.= ketoconazole,*means with different superscript along the same row are significantly (P<0.05 or P<0.001) different.

Table 5: Susceptibility patterns of the solvent partitioned portions of stem bark extract of *B. dalzielii* at 100 mg/hole compared with standard antibiotics

Microorganisms	**Concentrations (100mg/hole) /Diameters of Inhibition Zone Mean ± SEM (mm)**								
	NHE	***CFE***	***EAE***	***NBE***	***RAE***	***Ery. 5µg***	***Cip. 5µg***	***Gen. 10µg***	***Ket 10µg***
E. coli	0.00±0.00[a]	13.00±0.00[b]	13.00±0.00[b]	13.00±0.00[b]	7.00±0.00[c]	12.66±0.33[b]	20.33±0.33[d]	18.00±0.00[e]	-
S. typhi	8.00±0.00[a]	0.00±0.00[b]	0.00±0.00[b]	13.66±0.33[c]	0.00±0.00[b]	10.66±0.33[d]	21.66±0.88[e]	17.00±0.57[f]	-
S. dysentriae	9.33±0.33[a]	13.00±0.00[b]	0.00±0.00[c]	20.33±0.33[d]	8.66±0.33[a]	17.00±0.00[e]	24.00±0.00[f]	16.00±0.00[e]	-
P. aeruginosa	0.00±0.00[a]	0.00±0.00[a]	9.33±0.33[b]	12.33±0.33[c]	0.00±0.00[a]	12.00±0.00[c]	25.66±0.33[d]	19.33±0.33[e]	-
K. pneumonia	0.00±0.00[a]	11.00±0.00[b]	10.00±0.00[b]	9.33±0.33[c]	9.00±0.00[c]	13.33±0.33[d]	25.00±0.00[e]	15.00±0.00[f]	-
P. mirabilis	0.00±0.00[a]	0.00±0.00[a]	7.00±0.00[b]	12.33±0.33[c]	0.00±0.00[a]	14.00±0.00[d]	20.00±0.57[e]	17.66±0.57[f]	-
S. aureus	0.00±0.00[a]	19.33±0.33[b]	15.00±0.00[c]	10.33±0.33[d]	0.00±0.00[a]	13.00±0.00[e]	25.00±0.00[f]	17.00±0.00[g]	-
S. pyogene	0.00±0.00[a]	16.66±0.33[b]	0.00±0.00[a]	11.66±0.33[c]	0.00±0.00[a]	21.00±0.57[d]	20.00±0.57[e]	19.00±0.00[e]	-
B. subtilis	0.00±0.00[a]	13.00±0.00[b]	0.00±0.00[a]	9.33±0.33[c]	0.00±0.00[a]	17.33±0.57[d]	25.00±0.00[e]	21.66±0.57[f]	-
Cory. Spp	0.00±0.00[a]	10.33±0.33[b]	10.00±0.00[b]	12.00±0.00[c]	0.00±0.00[a]	17.00±0.00[d]	28.66±0.33[e]	20.00±0.00[f]	-
C. albicans	16.00±0.00[a]	10.00±0.00[b]	13.50±0.00[c]	25.00±0.00[d]	0.00±0.00[e]	-	-	-	25.00±12[d]

Key: Data are mean ± SEM, n=3, *E. coli =Escherichia coli. S. typhii =Salmonella typhii, S. dysentriae=Shigella dysentriae, P. aeruginosa= Pseudomonas aeruginosa, K. pneumoniae=Klebsiella pneumoniae, P. mirabilis= Proteus mirabilis, S. aureus=Staphylococcus aureus, S. pyogene =Streptococcus pyogene, B. subtilis=Bacillus subtilis, C. spp.=Corynebacteria species, C. albicans= Candida albicans,NHE=n-hexane portion, CFE=chloroform portion, EAE=ethyl acetate portion, NBE=n-butanol portion, RAE=aqueous portion, Cip=ciprofloxacin, Ery.=Erythromycin, Gen. =Gentamycin, Ket.= ketoconazole,*means with different superscript along the same row are significantly (P<0.05 or P<0.001) different.

Table 6: Susceptibility patterns of the solvent partitioned portions of stem bark extract of *B. dalzielii* at 200 mg/hole compared with standard antibiotics

Microorganism	Concentrations (200mg/hole) /Diameters of Inhibition Zone Mean ± SEM (mm)								
	NHE	*CFE*	*EAE*	*NBE*	*RAE*	*Ery. 5µg*	*Cip. 5µg*	*Gen. 10 µg*	*Ket 10 µg*
E. coli	0.00 ± 0.00^{a}	$17.66\pm0.33^{b,b'}$	15.66 ± 0.33^{c}	$16.66\pm0.33^{c,b'}$	9.00 ± 0.00^{d}	12.66 ± 0.33^{e}	20.33 ± 0.33^{f}	$18.00\pm0.00^{g,b'}$	-
S. typhi	11.00 ± 0.00^{a}	0.00 ± 0.00^{b}	0.00 ± 0.00^{b}	18.00 ± 0.00^{c}	0.00 ± 0.00^{b}	10.66 ± 0.33^{a}	21.66 ± 0.88^{d}	17.00 ± 0.57^{c}	-
S. dysentriae	13.66 ± 0.33^{a}	18.66 ± 0.33^{b}	0.00 ± 0.00^{c}	24.66 ± 0.33^{d}	12.33 ± 0.33^{a}	17.00 ± 0.00^{b}	24.00 ± 0.00^{d}	16.00 ± 0.00^{b}	-
P. aeruginosa	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	10.00 ± 0.00^{b}	15.66 ± 0.33^{c}	0.00 ± 0.00^{a}	12.00 ± 0.00^{d}	25.66 ± 0.33^{e}	19.33 ± 0.33^{f}	-
K. pneumonia	0.00 ± 0.00^{a}	14.66 ± 0.33^{b}	12.00 ± 0.00^{c}	13.00 ± 0.00^{d}	13.00 ± 0.00^{d}	13.33 ± 0.33^{d}	25.00 ± 0.00^{e}	15.00 ± 0.00^{b}	-
P. mirabilis	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	9.66 ± 0.33^{b}	15.66 ± 0.33^{c}	0.00 ± 0.00^{a}	14.00 ± 0.00^{c}	20.00 ± 0.57^{d}	17.66 ± 0.57^{e}	-
S. aureus	0.00 ± 0.00^{a}	24.33 ± 0.33^{b}	19.00 ± 0.00^{c}	13.66 ± 0.33^{d}	0.00 ± 0.00^{a}	13.00 ± 0.00^{d}	25.00 ± 0.00^{b}	17.00 ± 0.00^{e}	-
S. pyogene	0.00 ± 0.00^{a}	22.66 ± 0.33^{b}	0.00 ± 0.00^{a}	14.66 ± 0.33^{c}	0.00 ± 0.00^{a}	21.00 ± 0.57^{b}	20.00 ± 0.57^{b}	19.00 ± 0.00^{d}	-
B. subtilis	0.00 ± 0.00^{a}	17.66 ± 0.33^{b}	0.00 ± 0.00^{a}	12.66 ± 0.33^{c}	0.00 ± 0.00^{a}	17.33 ± 0.57^{b}	25.00 ± 0.00^{d}	21.66 ± 0.57^{e}	-
Cory. Spp.	0.00 ± 0.00^{a}	15.00 ± 0.00^{b}	13.00 ± 0.00^{c}	15.66 ± 0.33^{b}	0.00 ± 0.00^{a}	17.00 ± 0.00^{d}	28.66 ± 0.33^{e}	20.00 ± 0.00^{f}	-
C. albicans	23.00 ± 0.00^{a}	14.00 ± 0.00^{b}	16.00 ± 0.00^{c}	29.66 ± 0.33^{d}	0.00 ± 0.00^{e}	-	-	-	25.00±12

Key: Data are mean ± SEM, n=3, *E. coli =Escherichia coli. S. typhii =Salmonella typhii, S. dysentriae=Shigella dysentriae, P. aeruginosa= Pseudomonas aeruginosa, K. pneumoniae=Klebsiella pneumoniae, P. mirabilis= Proteus mirabilis, S. aureus=Staphylococcus aureus, S. pyogene =Streptococcus pyogene, B. subtilis=Bacillus subtilis, C. spp.=Corynebacteria species, C. albicans= Candida albicans,NHE=n-hexane portion, CFE=chloroform portion, EAE=ethyl acetate portion, NBE=n-butanol portion, RAE=aqueous portion, Cip=ciprofloxacin, Ery.=Erythromycin, Gen. =Gentamycin, Ket.= ketoconazole,* means with different superscript along the same row are significantly ($P<0.05$ or $P<0.001$) different.

Table 7: MIC, MBC, and MFC Values for Fractionated Portions of *B. dalzielii*

S/No	Microorganisms	Partitioned Portions				
		CFE	NHE	EAE	NBE	RAE
		Concentrations (mg/ml)				
1	***S. aureus***	6.25* 12.50**	-	12.5* 12.5**	50.00* 50.00**	-
2	***S. pyogene***	12.50* 25.00**	-	-	25.00** 25.00**	-
3	***B.subtilis***	50.00* 50.00**	-	-	50.00* 50.00**	-
4	***C. spp.***	50.00* 50.00**	-	12.5* 12.5**	25.00* 25.00**	-
5	***E. coli***	12.50* 25.00**	-	25* 25**	6.25* 12.50**	100* 100**
6	***S. typhii***	-	100.00* 100.00**	-	12.50* 12.50**	-
7	***S. dysentriae***	25.00* 25.00**	50.00* 50.00**	-	6.25* 6.25**	50.00* 50.00**
8	***P. aeruginosa***	-	-	50* 50**	25.00* 25.00**	-
9	***K. pneumonia***	50.00* 50.00**	-	50* 50**	25.00* 25.00**	50.00* 50.00**
10	***P. microbilis***	-	-	100* 100**	25* 25**	-
11	***C.albicans***	50.00* 50.00***	12.50* 25.00***	6.25* 6.25***	6.25* 6.25***	-

Key: * =MIC value, ** =MBC value, *** =MFC, - =No growth, CFE =chloroform portion, NHE =n-Hexane portion, EAE =Ethyl Acetate portion, RAE = Aqueous portion, NBE =*n*-Butanol portion

Table 8: Sensitivity pattern of partitioned portions of the stem bark extract of *B. dalzielii* against Gram positive bacteria and fungal strain compared with standard antibiotics

	Activity Index of Microorganisms (%)				
Portion	**BS**	**CR**	**SA**	**SP**	**CA**
NHE	**-**	**-**	**-**	**-**	**-**
CFE	46.15[a] 29.62[b] 36.93[c]	38.42[a] 23.33[b] 32.66[c]	117.92[a] 66.65[b] 90.18[c]	56.50[a] 47.46[b] 62.44[c]	- 31.00[b] 58.16[c]
EAE	-	46.27[a] 27.45[b] 39.33[c]	84.09[a] 54.66[b] 64.31[c]	-	- 47.32[a] 88.78[b]
NBE	33.46[a] 21.47[b] 26.77[c]	51.36[a] 30.47[b] 43.66[c]	51.77[a] 29.26[b] 39.59[c]	33.64[a] 28.26[b] 37.18[c]	- 95.99[b] 180.09[c]
RAE	**-**	**-**	**-**	**-**	**-**
***BSI (%)**	**40**	**60**	**60**	**40**	**80(FSI)**

Key: BS=*Bacillus subtilis*, CR=*Corynaebacterium spp.*, SA=*Staphylococcus aureus*, SP=*Streptococcus pyogene*, CA=*Candida albicans*, NHE=n-Hexane, CFE=chloroform, EAE=Ethyl acetate, NBE=n-Butanol, RAE= Aqueous, a=Erythromycin, b=Ciprofloxacin, c=Gentamicin, BSI= bacterial susceptibility index, FSI= fungal susceptible index, *≥7 (DIZ) as the susceptible value, - = no activity.

Table 9: Sensitivity pattern of partitioned portions of the stem bark extract of *B. dalzielii* against Gram-negative bacteria compared with standard antibiotics

	Activity Index of Microorganisms (%)					
Portion	**EC**	**ST**	**SD**	**PA**	**KP**	**PM**
NHE	-	35.65[a] 17.54[b] 22.35[c]	35.28[a] 24.99[b] 37.49[c]	-	-	-
CFE	92.79[a] 57.78[b] 65.26[c]	-	47.84[a] 33.88[b] 50.83[c]	-	49.00[a] 26.13[b] 43.55[c]	-
EAE	71.07[a] 44.26[b] 49.99[c]	-	-	44.98[a] 22.49[b] 27.93[c]	28.00[a] 14.54[b] 24.88[c]	23.80[a] 13.33[b] 18.87[c]
NBE	73.71[a] 45.90[b] 51.84[c]	92.53[a] 45.54[b] 58.02[c]	95.66[a] 67.76[b] 101.64[c]	73.87[a] 35.46[b] 46.37[c]	45.00[a] 23.99[b] 39.99[c]	66.64[a] 46.65[b] 52.83[c]
RAE	31.60[a] 20.00[b] 22.22[c]	-	41.16[a] 29.16[b] 43.73[c]	-	54.39[a] 29.00[b] 48.33[c]	-
***BSI (%)**	**40**	**20**	**80**	**20**	**80**	**20**

Key: EC=*E.coli,* ST=*S. typhi*, SD=*S.dysentriae,* PA=*P. aeruginosa*, KP=*K. pneumoniae*, PM=*P. mirabilis*, NHE=*n*-Hexane, CFE=chloroform, EAE=Ethyl acetate, NBE=*n*-Butanol, RAE= Aqueous, a=Erythromycin, b=Ciprofloxacin, c=Gentamicin, BSI= Bacterial susceptibility Index, *≥7 (DIZ) as the susceptible value, - =no activity

Table 10: Sensitivity indices of partitioned portions of the stem bark extract of *B. dalzielii*

Portion	**Percent Activity (%)**				**Spectral Intensity Index(mm)**	**Average Percent Bacterial/fungal susceptibility (%)**			
	Gram Positive	**Gram-negative**	**Fungal Strain**	**%T**		**Gram Positive**	**Gram-negative**	**Fungal strain**	**%T**
NHE	0.00	50.00	100.00	50.00	4.37	60.00	73.33	80.00	71.11
CFE	100.00	100.00	100.00	100.00	10.99				
EAE	100.00	50.00	100.00	83.30	9.01				
NBE	100.00	100.00	100.00	100.00	11.75				
RAE	0.00	66.67	0.00	22.22	1.35				

Key: NHE=n-hexane; CFE=Chloroform; EAE=Ethyl acetate; NBE=n-butanol; RAE=aqueous; %T=Percentage total; BSI=Bacterial susceptibility index; FSI=Fungal susceptibility index

5. CONCLUSION

The present findings bequeath a rationale for the utilization of *B. dalzielii* in folk medicine for the management of different diseases particularly the ones associated with the tested microbes. It has also revealed the potential value to develop herb-based products as antimicrobial agents against MDR bacteria/fungal. In conclusion, these solvent partitioned portions were found to be effective, most especially n-butanol portion which had a broad-spectrum antimicrobial profile which can be related to the presence of

secondary metabolites in the plant extractives. Research is under way in our laboratory to isolate, purify and characterize the bioactive compound(s) through bioassay-directed procedures. The study also indicated dose-depended activities across the extractives.

6. CONFLICT OF INTEREST

The authors declare no conflict of interest.

7. ACKNOWLEDGMENTS

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