



Assessment of the Chemical contents and anti-microbial potentials of the Underutilized Plant - *Phyllobotryon spathulatum* (Müll.) Arg.

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Received: October 25, 2023; Accepted: May 4, 2024; Published: June 30, 2024

Doi: 10.5281/zenodo.12601671

Abstract: This paper examined the phytochemical and antimicrobial potentials of the underutilized plant -*Phyllobotryon spathulatum*. The percentage moisture, crude fibre, fat, ash, protein and carbohydrate contents in the root and leaf of this plant was analysed. The investigated minerals show that the leaf had more minerals than the root with potassium being the most concentrated. Vitamins contents in the leaf of *P. spathulatum* were higher than that of root with vitamin C content in leaf of 46.84 mg/100g compared to 1.52 mg/100g in the root. Quantitative determination of the alkaloid, flavonoid, saponin, tannin and cyanide contents in *P. spathulatum* showed that the leaf of the plant had more potential in the quantity of extractable antinutrients with Hydrogen cyanide (HCN) being the most abundant with a value of 5.53 mg/100g while phytates' 1.05 mg/100g was the least. It was evident that chloroform was more inhibiting to the growth of the six tested microorganisms, followed by ethanol and then petroleum ether. Zone of inhibition (IZ) reduced as the levels of extract reduced in all the test organisms. All the extracts used had anti-microbial activities lower than that of standard antibiotics used. A comparative analysis of the different extract used showed that ethanol is the best across board having an MIC of 6.25mg/ml in *Fusarium solani*. Anti-microbial activity of the leaf extracts of *P. spathulatum* observed can be attributed to presence of notable phytochemicals. This nutrient-rich plant can be harnessed in food for man and animals and can as well be explored for ethnomedicine.

Keywords; Epiphyllous Underutilized, Nutrients, Phytochemicals, Antimicrobial

Introduction

Plants have a crucial role in the history of other living organisms. Human depends directly or indirectly on plants and its products, which play essential role in nutrition and drugs. The chemical properties of most medicinal plants have been used over the years to cure ailments.

The report by Kochhar (2016), revealed that about 7,000 species of plants are currently in use for food, another 8,000 species of plants are used for industrial purposes such as timber, pharmaceutical and aesthetic values. Plants contain a wide variety of anti-nutrients, such as flavonoids, terpenoids, tannins and alkaloids

which are known to possess antimicrobial activities. These compounds and their derivatives are the major force driving ethno-medicine and mainstream medicine.

Shackleton *et al.* (2009) observed that a great number of plants and its products remain untapped. It is estimated that there is about 250,000 to 500,000 species of plants on Earth of which a relatively minute fraction (1 to 10%) of these percentage are used as foods by both man and other animal species (Heinrich and Gibbons, 2001). It has been reported earlier that possibly, more fraction of these estimated species are used for medicinal purposes (Moerman, 1996) with more numbers still unknown and underutilized (FAO, 1994; Demele and Abebe, 2004). Abraham (2016) stated that underutilized plant and their products have been recognized as important source of nutrients (minerals and vitamins), dietary fibre and phytochemicals that can support the living and health benefits of the users. Bahru *et al.* (2013) noted that underutilized plant are plants with nutritional and medicinal potentials but are seldom used. Some essential nutrients found in wild plants include but not limited to: fibre, carbohydrates, oils, vitamins, minerals, proteins (FAO, 1998; Janab and Thompson, 2002; WHO, 2002; Osuagwu *et al.*, 2007; Ali and Deokule, 2009; Aynachew, 2018).

Recently observed in Cross River National Park, Akamkpa is a plant –*Phyllobotryon spathulatum*, with the unique feature of bearing

flower in the leaf. This phenomenon has an infrequently used physiological term in the field of botany. Bos (1975) described this as pseudo-epiphyllous inflorescence. Guido *et al.*, (2008) stated that genuine epiphyllous inflorescence is as a result of the displacement of the floral bud from the axil, along the petiole of the extending leaf close to the base of the lamina. An inquiry from the rangers and villagers shows that the plant has no local name or use within the locality. Hutchinson and Dalziel (1954), gave a morphological description of *P. spathulatum* to include; an erect shrub or small tree, to 12 ft. high that is sparingly branched. They also reported the presence of mauve sepals and petals, cream stamens, light red ovary, style deep purple-red and reproductive fruits. Judd (1997) and Libalah *et al.* (2014) highlighted other features of the plant to include a rosette leaves composed of large green mature and small reddish-brown younger leaves with flower bearing many stamens and pink petals on the both abaxial and adaxial midrib of the mature leaves.

Over the years, there has been an avalanche of published local and international researches on the phytochemistry and antimicrobial potentials of medicinal plants with far reaching discoveries (Kudi *et al.*, 1999; Nweze *et al.*, 2004; van Vuuren, 2008; Doughari *et al.*, 2009; Osuagwu and Akomas, 2013; Okorie *et al.*, 2014; Nasir *et al.*, 2015; Akintola *et al.*, 2016; Nduche *et al.*, 2016; Anyanwu and

Okoye, 2017; Feistel *et al.* 2017; Nvau *et al.*, 2018; Amir *et al.*, 2020; Dubale *et al.* 2023; Nour *et al.*, 2023). Plants in the Salicaceae family have been identified to possess phytochemicals active in antimicrobial activities. Phytochemical analysis of *Idesia polycarpa* (Salicaceae) by Feistel *et al.* (2017), showed the presence of phenolic compounds which was implicated in antimicrobial activity of the plant. Cristina *et al.* (2018), identified a Salicaceae plant -*Dovyalis abyssinica* in the treatment of haemorrhoids, ulcers, swelling of throat and wound healing. Flavonoids and other Polyphenolic compounds have powerful antimicrobial effects *in vitro* and *in-vivo* in many test systems. The *I. polycarpa* diet was toxic, as shown in feeding experiments with larvae of *Lymantria dispar*, a herbivorous broadleaf tree generalist insect, and with larvae of *Cerura vinula*, a specialist adapted to poplar region (Feistel *et al.*, 2017). Inhibitory zone diameter (IZD) is measured in millimeter (mm) when Disc Diffusion (DD) or Agar Well Diffusion (AWD) assays is used. Minimum inhibitory concentration (MIC) and AWD assays are the two known common methods used *in-vitro* to investigate the antimicrobial activity of Nigerian plants. Research has shown that the efficacy of a plant extract in inhibiting a test pathogen is dependent on few factors such as the solvent used, the concentration of the solvent used, the type or species of plant used, the part of plant used.

It is recommended that traditional usage of plants should be analysed scientifically for documentation and reference purposes (Mitsunari *et al.*, 2021). However, none of these studies has been carried out using *Phyllobotryon spathulatum*. The dearth of scientific information on the phytochemical contents and medicinal benefits of the underutilized and rarely known *P. spathulatum* has contributed for the absence of its diversified use as food and medicine source in Nigeria. The plant was then collected and investigated to unravel its chemical and antimicrobial potentials to mitigate the effect of malnutrition and lack of drugs for most pathogenic organisms in developing countries of Africa.

Materials and Methods

Proximate, Vitamin and Mineral Analysis

The percentage moisture (MC), Dry matter (DM), crude fibre (CF), fat (EE), ash, protein (CP) and carbohydrate (CHO) contents in the leaf of this plant was analysed using the AOAC (2000) method.

Phytochemical Analysis

Qualitative and quantitative tests to determine the presence and concentration of alkaloid, flavonoid, saponin, steroid, tannin and steroid contents in the root and leaf of *Phyllobotryon spathulatum* was determined using the method of Bohan and Kocipai (1994) and Harborne

(1998) at the Chemistry Laboratory of Michael Okpara University of Agriculture Umudike.

Antimicrobial Activity

Ethanol extract of the leaf, root and stem of *P. spathulatum* collected was prepared using the method of Ijeh *et al.* (2005). Pathogenic microorganisms (inoculum) to be used were obtained from the Pathology Unit, Federal Medical Centre (Queen Elizabeth Hospital) Umuahia.

Extraction/Screening of the Plant Extracts for Antibacterial Activity

The leaves of the plants were plucked, rinsed with water and air-dried at room temperature for several days. The dried leaves were pulverized using a milling machine to obtain fine powder. The active ingredients were extracted by percolation using chloroform,

ethanol and petroleum ether. 50 g of each leaf powder was added to 200ml of the respective solvents. The mixture was covered and allowed to stand for 42 hours for extraction. The mixture was then separated by passing through a clean muslin cloth, after which the filtrate was evaporated to dryness in oven set at 50°C.

0.4g of each crude extract was reconstituted in 2ml of Dimethyl sulphoxide (DMSO) to obtain extract concentration of 200mg/ml. This was serially diluted in 2-folds to obtain the following lower extract concentrations: (100 and 50) mg/ml. The activities of the plant extracts were determined using agar well diffusion techniques of Nweze and Onyishi (2010).

Results

Table 1 shows a comparative proximate content in the root and leaf of the studied plants.

Table 1 Proximate content of *P. spathulatum*

Proximate	Plant part	(%)
DM	Root	93.21±0.0
	Leaf	89.74±0.1
MC	Root	6.78±0.0
	Leaf	10.26±0.1
Ash	Root	8.27±0.0
	Leaf	15.87±0.0
CP	Root	7.69±0.1
	Leaf	19.72±0.1
EE (Fat)	Root	1.32±0.0
	Leaf	2.79±0.0
CF	Root	1.31±0.0
	Leaf	13.34±0.0
CHO	Root	74.62±0.2
	Leaf	38.01±0.3

Values are expressed as means plus standard deviation

Table 2 contains the mineral contents of the investigated plants. Generally, from the

investigated minerals, the leaf had more minerals than the root.

Table 2 Mineral content of *P. spathulatum*

Minerals	Plant part	Amount
Ca (mg/100g)	Root	96.06±0.9
	Leaf	162.8±1.1
K (mg/100g)	Root	143.74±0.1
	Leaf	183.94±0.5
P (mg/100g)	Root	53.59±0.3
	Leaf	78.77±0.7
Mg (mg/100g)	Root	19.09±0.4
	Leaf	24.14±0.9
Na (mg/100g)	Root	37.66±1.2
	Leaf	59.27±1.4
N (%)	Root	1.17±0.0
	Leaf	3.16±0.0

Values are expressed as means plus standard deviation

Vitamin contents of the plant are presented in table 3 below.

Table 3 Vitamin content of *P. spathulatum*

Vitamins	Plant part	(mg/100g)
B1	Root	0.03±0.0
	Leaf	0.45±0.0
B2	Root	0.01±0.0
	Leaf	0.32±0.0
B3	Root	0.70±0.0
	Leaf	2.37±0.0
C	Root	1.52±0.1
	Leaf	46.84±0.0

Values are expressed as means plus standard deviation

The figures contained in table 4 below shows the phytochemical contents of the studied plant part. The leaf of the plant showed more promise in the quantity of extractable antinutrients studied.

Table 4 Anti-nutrient composition of *P. spathulatum*

Antinutrients	Plant part	(mg/100g)
Flavonoid	Root	0.13±0.02
	Leaf	0.85±0.02
Alkaloid	Root	0.53±0.01
	Leaf	0.62±0.02
Tannins	Root	1.39±0.01
	Leaf	3.14±0.02
Phytate	Root	0.40±0.02
	Leaf	1.05±0.00
Saponin	Root	0.27±0.02
	Leaf	1.39±0.01
HCN	Root	1.29±0.01
	Leaf	5.53±0.09

Values are expressed as means plus standard deviation.

The observed phytochemical contents in *P. spathulatum* pivoted the need to study its antimicrobial activity *in vitro* shown in table 5.

Table 5 Antimicrobial activity of different extracts of the leaf of *P. spathulatum* (Inhibition Zone).

Organisms	Chloroform (mg/ml)			Ethanol (mg/ml)			Pet. Ether (mg/ml)			Gen. Flu.	
	200	100		200	100		200	100		200	200
	50			50			50				
	Zone (mm)										
	Inhibition										
<i>Salmonella typhi</i>	19	15	9	16	11	0	11	0	0	18	
<i>Stapylococcus aureus</i>	12	0	0	17	0	0	13	0	0	23	
<i>Escherichia coli</i>	11	0	0	11	0	0	10	0	0	19	
<i>Fusarium solani</i>	21	17	10	16	13	12	10	0	0		21
<i>Pencillium</i>	18	15	0	14	10	0	11	0	0		21
<i>Arpergillius niger</i>	10	0	0	10	0	0	0	0	0		19

Table 6 contains the minimum inhibitory concentration and minimum bactericidal concentration (MBC) or minimum fungicidal

concentration (MFC) of chloroform extract of the leaf of *Phyllobotryon spathulatum* tested against the corresponding pathogenic organisms.

Table 6 MIC/MBC/MFC (mg/ml) of chloroform extract

Pathogen	100	50	25	12.5	6.25 (mg/ml)	3.12	1.56	0.78	MIC	MBC/MFC
<i>F. solani</i>	-	-	-	+	+	+	+	+	12.5	25
<i>Penicillium</i>	-	-	-	+	+	+	+	+	12.5	25
<i>A. niger</i>	-	+	+	+	+	+	+	+	50	100
<i>S. typhi</i>	-	-	-	+	+	+	+	+	12.5	25
<i>S. aureus</i>	-	-	+	+	+	+	+	+	25	50

Key: + = growth, - no growth

Minimum inhibitory concentration and *spathulatum* on the test pathogen is shown in minimum bactericidal/fungicidal concentration table 7.

of Ethanolic leaf extract of *Phyllobotryon*

Table 7 MIC/MBC/MFC (mg/ml) of ethanol extract

Pathogen	100	50	25	12.5	6.25 (mg/ml)	3.12	1.56	0.78	MI C	MBC/MFC
<i>F. solani</i>	-	-	-	-	+	+	+	+	6.25	12.5
<i>Penicillium</i>	-	-	+	+	+	+	+	+	25	50
<i>A. niger</i>	-	+	+	+	+	+	+	+	50	100
<i>S. typhi</i>	-	-	-	+	+	+	+	+	12.5	25
<i>S. aureus</i>	-	-	+	+	+	+	+	+	25	50

Key: + = growth, - = no growth.

Table 8 below shows MIC and MBC/MFC of the petroleum ether leaf extract against the pathogen.

Table 8 MIC/MBC/MFC (mg/ml) of petroleum ether extract

Pathogen	100	50	25	12.5	6.25 (mg/ml)	3.12	1.56	0.78	MIC	MBC/MFC
<i>F. solani</i>	-	+	+	+	+	+	+	+	50	100
<i>Penicillium</i>	-	-	+	+	+	+	+	+	25	50
<i>A. niger</i>	+	+	+	+	+	+	+	+		
<i>S. typhi</i>	-	+	+	+	+	+	+	+	50	100
<i>S. aureus</i>	-	+	+	+	+	+	+	+	50	100

Key: + = growth, - no growth

Summarily, a comparative analysis of the different extract used showed that ethanol was the best extract across board followed by chloroform and petroleum ether extract.

Discussions

Proximate content of P. spathulatum

As stated earlier, *P. spathulatum* is among the unknown and underutilized wild plants in Nigeria. This is corroborated by the absence of its usage as a source of food or medicine by the locals where it grows. Underutilized wild plants and their products have been recognized as important source of nutrients, minerals, vitamins, dietary fibre and phytochemicals that can support the health benefit of the users (Osuagwu *et al.* 2007; Abraham, 2016). Although they serve partly as sources of food, they can provide food nutrients that are essential for human body. Some important nutrients such as protein, crude, fibre, fat, carbohydrates present in some domesticated plants were also found in the investigated wild plant.

Dry matter content of the plant shows that the root has a higher percentage of 93.21 than the leaf. Similar trend was observed in the carbohydrate content of the plant. However, moisture content, Ash content, crude protein, Fat content was more in the leaf than found in the root. The moisture content of the crude sample falls within the limit of the general requirement of 8 – 14%, WHO 1996 and EU regulatory guidelines (2006) indicating less

probability of microbial degradation. Adeshina *et al.*, (2008) stated that excess moisture in crude sample may lead to the loss of important constituent and the growth of microorganisms especially during storage of such sample. The evaluation of total ash value is significant in detecting foreign organic matter and adulteration of sand or earth in a sample (Kunle *et al.*, 2002). Fibre content was more in the leaf than found in the root. The proximate contents of this plant validate the report of Janab and Thompson (2002) which stated that important nutrients present in wild plants include: fibre, carbohydrates, oils, proteins, minerals, ascorbic acid. The quantity of these nutrient required by man has not been clearly stated. However, in FAO guidelines of 1998, any amount less than 100mg in minerals is ideal for daily human and animal consumption. The observed proximate content in this study is in line with the study of Aynachew (2018), using *Dovyalis abyssinica* – of the salicaceae family, observed a relatively high proximate contents in the leaf of the plant. Typically, the ash content of the leaf (15.8%) is within range of the values reported for some commonly consumed leafy vegetable in Nigeria, such as *Gnetum Africana*, *Ocinum graticinum*, *Hibiscus esculenta* and *Talinum triangulare* (Akindahunsi and Salawu, 2005; Antia *et al.*, 2006; Osuagwu and Nwachukwu, 20007; Uraku *et al.*, 2015).

Mineral content of P. spathulatum

From the investigated minerals, the leaf had more minerals than the root with potassium being the most concentrated, 183.94 mg/100g in the leaf and 143.74 mg/100g. Aynachew (2018), observed a relatively high mineral (Ca 108.09 mg/100g) in *Dovyalis abyssinica* –of the Salicaceae family. Wild plants are known to be rich in minerals. This may be due to the abundance of much minerals in the uncultivated soil. The mineral available in plant depends on the quantity present in the medium in which the plant grows (Ali and Deokule, 2009). The quantity of these mineral nutrients required by man has not been clearly stated. However, in FAO guidelines of 1998, any amount less than 100mg in minerals is ideal for daily human and animal consumption.

Vitamin content of P. spathulatum

High vitamin content (Vitamin C 46.84 mg/100g, Vitamins B1 0.45 mg/100g, B2 0.32 mg/100g and B3 2.32 mg/100g) was recorded in the leaf of this studied plant. These vitamin values is higher than the report of Uraku *et al.*(2015) that observed vitamin C content of 2.43mg/100g in lemon grass –a common tea in most developing countries. Vitamins play physiological roles in the normal functioning of the body. Vitamins have greater use in the management of cardio-vascular diseases and oxidative stress (Somer, 1995). Lack of Vitamin A, Fe and Zn are the main micronutrient malnutrition in the world (WHO,

2002). The leaf of the studied plant can be considered to be a good source of vitamins.

Anti-nutrient composition of P. spathulatum

The results of phytochemical analysis showed that the leaf extracts of *P. spathulatum* had varying degree of phytochemical constituents. There is dearth of information on the phytochemical constituent of *P. spathulatum*. The leaf of the plant showed more promise in the quantity of extractable antinutrients studied with HCN being the most with a value of 5.53 mg/100g, followed by tannin 3.14 mg/100g, saponin 1.39 mg/100g, phytate 1.05mg/100g. Flavonoid content in the leaf was 0.85 mg/100g and the least occurring anti nutrient in the leaf of the plant being flavonoid 0.61 mg/100g. Tannins were reported as one of the most important of the bioactive constituents of plants (Uraku *et al.* 2015), reducing feed efficiency and weight gain in chick (Ogbe *et al.*, 2012). On the other hand, saponins decrease the uptake of certain nutrients such as glucose and cholesterol at the gut through intraluminal physicochemical interaction (Ujowundu *et al.*, 2008). These phytochemicals and other bioactive compounds are antibiotic basics of plants (Okwu and Josiah, 2006; Ajayi, *et al.*, 2011, Amir *et al.* 2020). Quantifiable amount of the studied antinutrient observed in the plant root places the root of *P. spathulatum* as potential candidates of plants with anti-nutrients for medicinal purposes since members of the Salicaceae family has demonstrated high

phytochemical contents as reported by Feistel *et al.* (2017) and Aynachew (2018).

The quantity of phytochemicals in plant depends on the species of plant used, the process of extraction and selection of solvent system (Nasir *et al.*, 2015). These chemical compositions obtained are ideal for the medicinal and or therapeutic uses of the plants.

Antimicrobial activity of different extracts the leaf of P. spathulatum

The observed phytochemical contents in *P. spathulatum* pivoted the need to study its antimicrobial activity *in vitro*. Flavonoids and other phenolic compounds have powerful antimicrobial effects *in vitro* and *in-vivo* in many test systems (van-Vuuren, 2008; Edeoga *et al.* 2017; Dubale *et al.* 2023). It was evident that chloroform was inhibitory to the growth of the six tested microorganisms, followed by ethanol and then petroleum ether which only inhibited *Penicilium* growth at 200mg/ml. The zone of inhibition (IZ) was reducing as the levels of extract reduced in all the test organisms and in all solvent used. Ngulde *et al.* (2013), observed that at the varying concentrations of 200mg/ml, 100mg/ml and 50mg/ml, the ethanol extract of *Carissa edulis* was active against the growth of *Salmonella typhi*. Worthy of mention is the performance of these plant extracts against the test drugs. The chloroform extract at 200 mg/ml in the case of *S. typhi* and *F. solani* performed competitively with the test drugs (Gentamycin) having the respective Inhibition

Zone (IZ) of 18mm and 20 mm. These observed IZ is sufficient for *P. spathulatum* to be considered effective for anti-microbial usage. Because many organisms are now exhibiting high resistance to most antimicrobial drugs, Akintola *et al.* (2016), proposes that plant extract exhibiting IZ greater than or equal to 10 mm against selected organisms should be considered to possess antimicrobial activity whereas those showing $IZ \geq 20$ mm against selected organisms are considered noteworthy. Kudi *et al.* (1996), reported that plant extracts exhibiting Inhibition Zone Diameter (IZD) of 6mm and above against a selected pathogen are considered to possess some antimicrobial activity while (Udgire and Pathade 2013), suggested IZD of 10 mm and above. In conformity to this result of this work, Nduche *et al.*(2016), observed all the plant extracts used had activities lower than that of standard antibiotics and suggested that the aqueous leaf extracts of the plants possessed antimicrobial activities against *S. aureus*, *E. coli*, *Salmonella typhi* at different concentrations. Ethanol extract also showed potentials in its IZ when compared with the test drugs. Petroleum ether did not show much potential through its IZ in all the tested organisms. In any case, the IZ of the studied plant is in line with the IZ of most Nigerian medicinal plants as contained in the works of Kigigha and Onyema (2015).

MIC/MBC/MFC of P. spathulatum leaf

The antimicrobial potentials of the leaf of *P. spathulatum* were plainly established through the determination of its minimum inhibitory concentration (MIC). All the solvent used as extractants showed great inhibitory and cidal activity to the test organisms. A comparative analysis of the different extract used showed that ethanol, was the best extract across board having an MIC of 6.25mg/ml in *F. solani*, and followed by chloroform and petroleum ether extracts. This result is in line with the recommendation of Rios and Recio (2005) and Nour *et al.* (2023), which stated that plant extracts having activities where MIC values are below 8 mg/ml are considered to possess some antimicrobial activity. Efficacy of plant extract also depends on the solvent and concentration used. However, ethanol is considered as a choice chemical in extraction of plant phytochemicals for antinutrient study (Omojasola and Awe, 2004). This may be due to the availability of both locally and imported kinds of ethanol to researchers. Chloroform as one of the solvents used as plant extractants in this study showed MIC and Bactericidal activity like ethanol and petroleum ether. The minimum bactericidal concentration (MBC) for chloroform leaf and root extracts of *Cymbopogon citratus* was successfully recorded by Ewansiha *et al.* (2012).

The growths of the fungal pathogens were also inhibited in this study. Fungal pathogens have been confirmed to be susceptible to some plant

extracts. Anti-fungal properties of ethanolic extracts of the leaves of *Baphia nitida*, *Cassia alata*, *Ficus exasperata* and *Gossypium arboreum* inhibited the growth of three fungal pathogens tested (Okafor *et al.*, 2001). The result from this study shows that the plant possesses some anti-fungal properties.

Conclusion

It is evident that this underutilized wild plant possesses high nutritional value. This study has shown that leaf and root of *P. spathulatum* are good sources of recommended nutrients such as fat, protein, fibre and carbohydrates; some essential macro and micronutrients like calcium, phosphorus, and sodium which are needed by man and animals. The importance of these nutrients cannot be over emphasized for effective and proper metabolism as well as the maintenance of good physiological state of man and animal systems. The investigated underutilized wild plant possess high amount of minerals and vitamins is comparable or within range of the dietary recommended which can be employed to mitigate macronutrient malnutrition and improving food security in most developing country where it grows. If the leaf is incorporated into diet, will play important role for proper growth of children and can meet the daily need of human and animal nutrition. Plant essential oils and extracts have been used for several thousands of years, in food preservation, pharmaceuticals, alternative medicine and natural therapies.

Plant extracts are potential sources of different natural antimicrobial compounds especially against bacterial and fungal pathogens. The crude extract of the leaf and root *P. spathulatum* contains appreciable quantities of flavonoid, alkaloid, tannins, phytate, saponin and HCN. Values obtained for this plant parts is within the established values recorded in plants used traditionally for curing various ailments hence, can be used in line with scientific standardization.

Anti-microbial activity of the leaf extracts *P. spathulatum* against the test pathogens observed in this study is due to presence of phytochemicals. Chloroform and ethanol extracts were competitive against the standard drugs (Gentamycin and Fluconazol) used. The various crude extracts of the leaf *P. spathulatum* showed great antimicrobial activities through the observed IZ, MIC and their corresponding MBC/MFC.

Plant extracts have been used traditionally for years, in food preservation, pharmaceuticals, alternative medicine and natural therapies. This study scientifically validates the possible use of underutilized *P. spathulatum* in traditional medicine in order to improve the quality of healthcare within its endemic regions.

Recommendation

Plant extracts remain potential sources of antimicrobial derivatives especially against bacterial and fungal pathogens as observed in this study. The exploration of the plant for food

and medicine should be encouraged because of the rich nutrients and anti-nutrient for mitigating malnutrition and drug deficiency particularly in the developing world. Traditional medicine users can explore this phytochemical-rich plant for the treatment of some pathogen induced diseases. Pharmaceutical companies should sponsor advanced research with this plant to unlock its hidden potentials in solving the problems of access to health care in communities where conventional use of drugs is costly and unavailable for the low income earners.

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