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IN VITRO ANTI-MICROBIAL ACTIVITIES OF SOME MEDICINAL PLANTS USED IN TRADITIONAL REMEDIES IN SOUTHWESTERN PART OF NIGERIA

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ABSTRACT

Ages before man discovered the existence of microorganisms, there has been a pre-knowledge of certain plants with their healing potentials, which possess anti-microbial properties. The present studies focused on the anti-microbial activities of the crude methanol leaf extracts of six medicinal plants, namely *Moringa oleifera, Clerodendrum volubile, Petiveria alliacea, Secamone afzeli, Carpolobia lutea* and *Macrosphyra longistyla* on some selected microorganisms, namely *Escherichia coli* ATCC 29929, *Staphyloccocus aureus* ATCC 29293, *Streptococcus pneumoniae* ATCC 49619, *Pseudomonas aureus* ATCC 27953, *Salmonella typhi* ATCC 14028, *Candida albicans* ATCC 10231, *Malassezia furfur* ATCC 14521 and *Klebsiella pneumoniae* ATCC 4252. The anti-microbial activities of these plants were compared with standard drugs: Lexotil (5µg), Furoxetil (30 µg), Loxaclav (30 µg), Oxavid (5 µg), Cefroden (10 µg), Cepharox (30 µg), Tetracycline (25 µg) and Gentamycin (10 µg). The *in vitro* anti-bacterial activity was performed by disc and agar well diffusion methods. All tests were performed in triplicates. Data collected were subjected to analysis of variance (ANOVA) and means were separated using the Duncan's Multiple-Range Test (DMRT) at $p < 0.05$. Of all the plant tested, *C. volubile* had the best inhibitory effect against *S. aureus* (24.67±0.33 and *S. pneumoniae* (19.67± 0.33), which was better than the control drugs: lexotil (19.67±0.33, 15.33 ± 0.33) and oxavid (18.33±1.67). *Petiveria alliacea* (23.00±0.00) was the second best extract. As *S. aureus* was highly sensitive to *C. volubile* methanol extract, it could be used as an antibiotic against diseases caused by the pathogen.

Keywords: Medicinal plants; methanol extracts; *Clerodendrum volubile; Petiveria alliacea*

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INTRODUCTION

Although scientific or orthodox medicine has tended to overwhelm traditional medicine in many parts of the world, interest in traditional medicine appears to have surged recently. This is not unconnected with the fact that higher plants which are sources of medicinal compounds have continued to play a dominant role in the maintenance of human health, especially the management of infectious diseases (Akinpelu and Onakoya, 2006; Herbert, 2012; Shafi , 2021; Shahraki-Mojahed, 2021; Fazeli-Nasab, 2022). In recent times, multiple drug resistance in human pathogenic microorganisms has developed due to indiscriminate use of commercial anti-microbial drugs in the treatment of infectious diseases. This situation has forced scientists to search for new anti-microbial substances from various sources like medicinal plants which are good sources of novel anti-microbial properties (Amir *et al*., 2011; Aumeeruddy, 2019; Shafodino, 2022). This study was aimed at investigating the anti-microbial potentials of *Clerodendrum volubile* P. Beauv., *Moringa oleifera* Lam, *Petiveria alliacea* Linn., *Secamone afzeli* K.Schum, *Carpolobia lutea* G. Don and *Macrosphyra longistyla* (DC.) Hook.f. which are used traditionally in southwestern Nigeria against some pathogens that are of clinical importance.

Clerodendrum volubile is commonly known as "marugbo" or "eweta" amongst the Ikale, Ilaje and Apoi people in some parts of Ondo State, southwest Nigeria. It is known for its food and medicinal purposes. Its use in the treatment and management of several ailments has made it to be referred to as magic leaf. However, not all the traditional claims have been scientifically proven (Erukainure *et al.,* 2014; Okaiyeto *et al*., 2021).

Moringa oleifera otherwise known as "Drumstick tree, miracle tree or Moringa Ben tree or Horseradish" is a fast-growing, evergreen, deciduous tree. Amazingly, all the plant parts such as leaves, mature seeds, flowers and roots including immature pods, have long been consumed by many for a variety of applications (Kumar *et al*., 2010; Gupta *et al*., 2018). *Petiveria alliacea,* otherwise known as anamu in Brazil, Portugual and other parts of Latin America has a long history in herbal medicine in all of the tropical countries where it grows.

The leaves of *Secamone afzeli* are ground to a paste with palm oil to treat palpitations. A drink of the ground leaves along with those of several other species and three chilis is taken for pneumonia, while the body is wiped with the powdered leaves of *Secamone* in water. *Carpolobia lutea* has found its use in many areas of human diseases such as the treatment of genitourinary infections, gingivitis and waist pains (Ettebong and Nwafor, 2009). According to Nwidu *et al*. (2012), the plant has been employed in traditional medicine against gonorrhoea, infertility, ulcer and malaria. The root decoction is useful in the treatment of internal heat while the hot water extract of the root has been reported to possess anti-microbial activity. *Macrosphyra longistyla* leaf, root and flower have been found useful medicinally. The root has been reported to be used to treat kidney diseases while the leaf has diuretic property and used to treat different infections. The leaf also has abortifacient, anti-malaria and analgesic activities. This study was also aimed at affirming the ethnobotanical claims of the traditional medicine practitioners in some parts of southwestern Nigeria.

MATERIALS AND METHODS

Collection and authentication of plants used

Fresh leaves of *Moringa oleifera* Lam., *Clerodendrum volubile* P. Beauv., *Petiveria alliacea* Linn., *Secamone afzeli* K. Schum, *Carpolobia lutea* G. Don and *Macrosphyra longistyla* (DC.) Hook.f. were collected at different locations in Ogun, Oyo and Ondo States. Samples were deposited in the Herbarium of the Forest Research Institute of Nigeria (FRIN) Ibadan, Oyo State, Nigeria for identification and index numbers were collected.

Test organisms

Typed Culture of *Escherichia coli* ATCC 29929, *Staphyloccocus aureus* ATCC 29293, *Streptococcus pneumoniae* ATCC 49619, *Pseudomonas aeruginosa* ATCC 27953, *Salmonella typhi* ATCC 14028, *Candida albicans* ATCC 10231, *Malassezia furfur* ATCC 14521 and *Klebsiella pneumoniae* ATCC 4252 were collected from Medical Microbiology Laboratory, Olabisi Onabanjo University, Sagamu.

Antibiotics (Control Drugs)

The following standard antibiotics with their respective concentrations were used as control drugs in this study: Lexotil (5 µg), Furoxetil (30 µg), Loxaclav (30 µg), Oxavid (5 µg), Cefroden (10 µg), Cepharox (30 µg), Tetracycline (25 µg) and Gentamycin (10 µg).

Preparation of Plant Extracts

Leaf extracts of *Moringa oleifera* Lam., *Clerodendrum volubile* P. Beauv., *Petiveria alliacea* Linn., *Secamone afzeli* K.Schum, *Carpolobia lutea* G. Don and *Macrosphyra longistyla* (DC.) Hook.f. were used. One (1) gram of each plant extract was weighed into sterile glass universal bottle and 20 millilitres of methanol was added to dissolve the extract. The resultant solution of 1000 mg per 20 mL of methanol, was is equivalent to 50 mg per millilitre of each plant (ready for use).

Anti-microbial Susceptibility Test

Agar well diffusion method was used as described by CLSI (2017). Using a sterile wire loop, 3-5 well-isolated colonies of each test organism were touched and emulsified in 4 mL of sterile nutrient broth. The turbidity of the suspension was matched with 0.5 McFarland. This was then poured on a Mueller Hinton's agar plate; the excess suspension was drained into kidney dish. With the Petri-dish lid in place, the surface of the agar was allowed to dry for 3-5 minutes. Using sterile forceps, the single anti-biotic disc was placed at 15 mm distance to the edge of Petri-dish at least 30 mm equidistance to each other (disc-disc). Within 30 minutes of applying the disc, the plate was inverted and incubated aerobically at 37^0C for 16-18 hours. After overnight incubation, the plates were examined for a clear zone around the disc. The zones of inhibition were measured with a transparent ruler and interpreted using the CLSI (2017) interpretation chart. Using interpretative chart, the zone of inhibition of each anti-microbial agent was interpreted as resistant, intermediate or sensitive.

Determination of Anti-microbial Properties of the Plant Extract using Disc Diffusion Method

Six (6) mm diameter discs were prepared from Whatman No.4 filter paper and sterilised in an autoclave. The sterile filter paper disc was used to absorb 100 ul of each plant extract. The discs were sterilised by autoclaving at 121^0C for 15 minutes. After impregnation, the discs where dried in the oven and refrigerated for use. The Muellar Hinton and Sabouraud dextrose agar plates that were aseptically prepared were dried in the oven. The prepared concentration of standardised inoculi was seeded over the surface of the plates and allowed to dry. The impregnated discs with extracts were placed on the surface of the media. These plates were incubated at 37^0C for 24 hours for bacteria. The inhibition zones were measured and recorded in millimetres.

Determination of Anti-microbial Properties of the Extract using Agar Well Diffusion Method

The prepared concentration of standardised inocular of 0.5 McFarland's standard of each bacterial and fungal isolates were flooded over the surface of the plates and allowed to dry. Then, 6 mm corkborer was used to bore holes of 6 mm in diameter equidistant to each other and 0.1 mL of each plant extract (50 mg per millilitre) was dispensed into their respective wells. These were incubated at 37^0C for 24 h for bacteria and 48 h for yeasts, respectively. After incubation, the plates were examined; using a ruler on the underside of the plates, the diameter of each zone of inhibition was measured in millimetres. Methanol was used as a negative control.

Determination of Minimum Inhibition Concentration

The Minimum Inhibitory Concentration (MIC) was determined according to the method of micro-dillutions (NCCLS, 2000). Twelve test tubes were arranged in a tube rack labeled 1-12. The drug dilution was made as 512- 0.031 (512, 256, 128, 64, 32, 16, 8, 4, 2, 1, 0.5). 1 mL of Nutrient broth and Sabouraud dextrose broth was added to tubes 2 to 14 and 1 mL of anti-fungal concentration was added to tubes 1 and 2 as shown in the table below. Serial doubling dilution was made from tubes 2 to 10 and the remaining 1 mL was discarded. Then, 1mL of anti-fungal was added to tube 11 (negative control) and 1mL of Nutrient broth and Sabouraud dextrose broth was added to tube 12 (positive control). Also, 0.1mL of 0.5 McFarland turbidity of the fungal isolates was added to all the tubes except tube 12 and these were incubated at 37^0C for 24 hours for bacteria and 48 hours for yeasts, respectively. The molds were incubated at 28^oC for 3-5 days. The highest dilution showing no turbidity or lowest concentration of the anti-bacterial and anti-fungal agents that inhibit visible growth of the test organism was taken as the MIC.

RESULTS

Table 2 shows the comparative effects (diameter of zone of inhibition in mm) of methanol leaf extracts on ATCC test organisms using agar disc diffusion method. Comparing the activities of six methanol extracts on the test organisms, SAL and CVL exhibited the most significant anti-bacterial activity against three out of the six bacterial species used for this study. The highest diameter of zone of inhibition was observed with SAL (27.67±0.33 mm) against *Klebsiella pneumoniae*, followed by CVL against *Staphylococcus aureus* (24.67±0.33 mm). CLL demonstrated the least

diameter of zone of inhibition (12.67±2.60 mm) against *Escherichia coli*. MOL (22.33±0.33 mm) and SAL (22.00±1.00 mm) demonstrated the highest significant activity against *Candida albicans* and the MLL against *Malassezia furfur* (19.33±0.67 mm).

Table 3 shows the comparative effects (diameter zone of inhibition in mm) of methanol leaf extracts on ATCC test organisms using agar well diffusion method. Using agar well diffusion method, CVL still maintained the best activity against *Staphylococcus aureus* (25.00±0.00 mm) while the highest diameter zone of inhibition was observed in SAL (27.67±0.33 mm) and MOL (27.67±0.88 mm). There was a significant difference in the anti-fungal activity between the six extracts against *Candida albicans* with MOL showing the best activity (24.00±0.58 mm) and CLL demonstrating the least anti-fungal activity (20.33±1.00 mm). The anti-fungal activity of the six extracts against *Malassezia furfur* was not significantly different from one another.

Table 4 shows the sensitivity zone of inhibition (mm) of commercial antibiotics (standard sensitivity disc) on the test bacteria. The activity of the seven antibiotic discs used were only moderately effective on three out of the six bacterial used. Tetracycline (25 µg) was active only on *S. typhi* while Cefroden (10 µg) demonstrated activity against four out of the six microorganisms.

Table 5 shows the Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal Concentration (MBC) values (mg/ml) of methanol leaf extracts of tested plants. The extract that demonstrated the Minimum Inhibitory Concentration (MIC) value against *S. aureus* was *C. volubile* (0.74 mg/ml). *M. oleifera*, *P. alliacea*, *C. lutea*, *M. longistyla* and *S. afzeli* demonstrated increased MIC (12.5 mg/ml). Minimum Bactericidal Concentration (MBC) value of *C. volubile* (6.25 mg/ml) was closely similar to that of *P. alliacea* (6.65 mg/ml). MIC values against *S. pneumoniae* in the entire methanol extracts were increased (25 mg/ml) compared to that of *S. aureus* except in *M. oleifera*. The result of the diameter zones of inhibition (mm) showed that higher zones of inhibitions were obtained using agar well diffusion method against all the test organisms for all the six extracts except in *K. pneumoniae*, where closely similar diameter zones of inhibition were observed (Figure 1).

DISCUSSION

All the leaf extracts studied showed inhibitory activities against the test organisms with varying diameter zones of inhibitions, which ranged from 12. 67± 2.60 - 27.67 ± 0.33 (disc diffusion method) (Table 2) and 14.67 ± 0.33 - 27.67 ± 0.88 (well diffusion method) (Table 3). The results showed that of all the plant extracts tested against gram-positive organisms, namely *Staphylococcus aureus* and *Stretococcus pneumoniae. Clerodendrum volubile* had the best effect against the organisms (24.67±0.33 and 19.67± 0.33), which was better than the control drugs: lexotil (19.67±0.33, 15.33 ± 0.33) and oxavid (18.33±1.67) (Table 4). *Petiveria alliacea* (23.00±0.00) was the second-best extract. *S. aureus* was highly sensitive to *C. volubile* methanol extract and could be used against diseases caused by the pathogen. Although the anti-microbial activity of *Clerodendrum splendens* against *S. aureus* has been reported (*Sameh et al.,* 2013; Ajaib *et al*., 2014), this is the first report of anti-microbial effect of *C. volubile* on the organism. *Secamone afzeli* exhibited greater anti-microbial activity on *Pseudomonas aeruginosa* in both methods used. This is contrary to the findings of

Aiyelero *et al*. (2009), Boussaada *et al*. (2008) and Cock (2022), who reported that most plant extracts showed greater activities against Gram-positive bacteria. This study is also contrary to the findings of Mensah *et al*. (2006), who reported that the leaf extract of *S. afzeli* showed weak anti-bacterial activity against *S. aureus* and *E. coli* but no activity against *P. aureginosa*. The variation in the reports of activities could be attributed to different concentrations used. *C. volubile, Secamone afzeli, Moringa oleifera* methanol leaf extracts and other tested plants possessed bactericidal activity against *Escherichia coli*, which has been reported to be multi-drug resistant (Sahm *et al*., 2001; Oteo *et al*., 2005; Drago *et al*., 2010; Moyo *et al*., 2012; Ibrahim and Fagbohun, 2012). The ability of the tested plant extracts to inhibit the growth of *E. coli* even at a low concentration is quite revealing.

There has been report that acetone and aqueous leaf extracts of *Moringa oleifera* did not exhibit any anti-fungal activity against *Candida albicans*, *Aspergillus flavus* and *A. niger* (Moyo, 2012). Ahmed (2023) reported the anti-microbial activity against similar organisms. The present study confirmed the report that the acetone extract demonstrated anti-bacterial activity against *Escherichia coli* and *Staphylococcus aureus*. The result of the Minimum Inhibitory Concentration (MIC) (Table 5) and Minimum Bactericidal Concentration (MBC) (Table 6) showed that all the tested leaf extracts had bactericidal effect against the test organisms, albeit in varying concentrations (Tables 5 and 6). The activity of *C. volubile* against *S. aureus* was highest with a low MBC value of 6.25 while *S. afzeli* demonstrated the least bactericidal activity against *P. aeruginosa* with a MBC value of 50.00.

Comparing the results of the two methods employed, the activities of the plant extracts against tested organisms were found to be better using the agar well diffusion method (Figure 1). This could be attributable to easy permeability using the agar well instead of the disc diffusion method.

Table 1: Plants investigated for anti-microbial activities

Plant Name	Code	Family	FHI No.	Plant Part
Secamone afzeli K.Schum	SAL	Asclepiadaceae	108880	Leaf
Moringa oleifera Lam. P. Beauv	MOL	Moringaceae	108881	Leaf
Petiveria alliaceae Linn.	PAL	Phytolacaceae	108885	Leaf
Carpolobia lutea G. Don	CLL	Polygalaceae	108882	Leaf
Macrosphyra longistyla Hook. f.	MOL	Rubiaceae	110582	Leaf
Clerodendrum volubile Linn.	CVL	Verbenaceae	108884	Leaf

Table 2: Effects of methanol leaf extracts on ATCC test organisms using agar disc diffusion method

Organism	CLL	CVL	MLL	MOL	PAL	SAL
Staphylococcus aureus	13.00±0.58^{e}	24.67±0.33^{a}	17.67±0.67^{c}	16.00±0.0^{d}	23.00±0.00^{b}	18.67±0.67^{c}
Streptococcus pneumoniae	16.33±1.67^{ab}	19.67±0.33^{a}	16.00±0.58^{ab}	14.00±0.58^{b}	17.33±2.40^{ab}	17.00±0.58^{ab}
Klebsiella pneumoniae	16.00±1.16^{c}	22.33±0.33^{b}	17.00±0.58^{c}	15.00±0.00^{c}	21.67±0.88^{b}	27.67±0.33^{a}
Escherichia coli	12.67±2.60^{b}	19.33±0.88^{a}	18.00±0.58^{a}	19.00±0.58^{a}	22.00±0.58^{a}	20.33±0.33^{a}
Pseudomonas aeruginosa	15.33±0.67^{d}	17.00±1.16^{cd}	20.33±0.33^{bc}	24.00±2.08^{ab}	22.67±1.20^{ab}	25.33±0.33^{a}
Salmonella typhi	15.33±0.33^{c}	20.33±0.33^{ab}	17.00±0.58^{c}	17.00±0.00^{c}	22.00±0.58^{a}	19.67±1.20^{b}
Candida albicans	18.33±0.33^{c}	19.00±1.00^{bc}	20.67±0.33^{abc}	22.33±0.33^{a}	21.00±1.16^{ab}	22.00±1.00^{a}
Malassezia furfur	17.33±0.33^{b}	18.33±0.33^{b}	19.33±0.67^{a}	17.33±0.67^{b}	19.00±0.58^{ab}	19.00±0.58^{ab}

Values are means ± S.E.M of three measurements (n=3). Means ± S.E.M with different superscripts within a row are significantly different, $p< 0.05$. CLL, CVL, MLL, MOL, PAL and SAL represent methanol leaf extracts of *Carpolobia lutea*, *Clerodendrum volubile, Macrosphyra longistyla, Petivera alliacea* and *Secamone afzeli*

Table 3: Effects of methanol leaf extracts on ATCC test organisms using agar well diffusion method

Organism	CLL	CVL	MLL	MOL	PAL	SAL
Staphylococcus aureus	14.67±0.33^{f}	25.00±0.00^{a}	21.00±0.58^{c}	17.00±0.58^{e}	23.67±0.3^{b}	19.67±0.33^{d}
Streptococcus pneumoniae	17.00±1.00^{cd}	20.33±0.33^{b}	17.67±0.33^{cd}	15.33±1.45^{d}	24.00±0.5^{d}	19.33±0.33^{bc}
Klebsiella pneumoniae	16.00±1.00^{c}	22.33±0.33^{b}	17.00±0.58^{c}	15.00±0.00^{c}	21.67±0.8^{b}	27.67±0.33^{a}
Escherichia coli	17.67±1.45^{c}	20.67±0.67^{bc}	19.00±0.58^{bc}	19.67±0.88^{bc}	24.00±1.1^{a}	21.33±0.33^{ab}
Pseudomonas aeruginosa	16.33±0.33^{e}	19.00±0.00^{d}	21.33±0.33^{c}	27.67±0.88^{a}	23.33±0.3^{b}	27.67±0.67^{a}
Salmonella typhi	17.33±1.20^{c}	23.33±0.33^{a}	18.67±0.67^{bc}	18.67±0.33^{bc}	24.00±0.5^{a}	20.33±0.33^{b}
Candida albicans	20.33±0.33^{c}	22.00±0.58^{b}	23.00±0.00^{ab}	24.00±0.58^{a}	22.00±0.0^{b}	23.00±0.58^{ab}
Malassezia furfur	19.00±1.00^{a}	20.67±0.33^{a}	20.67±0.88^{a}	18.67±0.67^{a}	20.33±0.3^{a}	21.00±1.00^{a}

Values are means ± S.E.M of three measurements (n=3). Means ± S.E.M with different superscripts within a row are significantly different, $p< 0.05$. CLL, CVL, MLL, MOL, PAL and SAL represent methanol leaf extracts of *Carpolobia lutea, Clerodendrum volubile, Moringa oleifera, Macrosphyra longistyla, Petivera alliacea* and *Secamone afzeli* respectively

Table 4: Zone of inhibition (mm) of antibiotics tested against selected pathogens

Antibiotic	*Staphylococcus aureus*	*Streptococcus pneumoniae*	*Klebsiella pneumoniae*	*Escherichia coli*	*Pseudomonas aeruginosa*	*Salmonella typhi*
Lexotil (5µg)	+(19.67±0.33)	+(15.33±0.33)	-	-	+(30.00±0.00)	+(20.67±0.67)
Furoxetil (30 µg)	-	-	+(18.00±1.16)	-	+(29.00±2.89)	+(17.67±1.45)
Loxaclav (30 µg)	-	-	+(27.00±0.58)	_	-	+(20.67±1.76)
Oxavid (5 µg)	+(18.33±1.67)	-	+(23.67±0.33)	-	+(22.00±1.16)	-
Cefroden (10 µg)	-	-	+(20.00±0.00)	+(18.67±0.33)	+(23.00±1.73)	+(18.67±0.67)
Cepharox (30 µg)	-	-	+(19.00±0.58)	-	+(20.00±0.00)	+(28.00±1.16)
Tetracycline (25 µg)	-	-		-	-	+(30±0.00)
Gentamycin (10 µg)	-	-	+(26.00±2.00)	+(20.00±0.00)	-	+(20.00±0.00)

Key: + = Sensitive, - = No inhibition

Table 5: Minimum Inhibitory Concentration (MIC) values (mg/kg) of methanol leaf extracts of tested plants

Organism	Extracts							
	A	B	C	D	E	F	-ve control	+ve control
Staphylococcus aureus	12.5	0.74	12.5	12.5	12.5	12.5	-	+
Streptococcus pneumoniae	12.5	25.0	25.0	25.0	25.0	25.0	-	+
Klebsiella pneumoniae	12.5	12.5	25.0	25	12.5	25	-	+
Escherichia coli	12.5	12.5	12.5	12.5	12.5	12.5	-	+
Pseudomonas aeruginosa	`0.0	25.0	12.5	12.5	12.5	50.0	-	+
Salmonella typhi	25	25.0	25.0	25.0	25.0	25.0	-	+
Candida albicans	12.5	37.5	25.0	25.0	25	25.0	-	+
Malassezia furfur	12.5	12.5	12.5	25.0	25.0	12.5	-	+

Key: MIC= Minimum inhibitory concentration - = No growth + = Growth

A, B, C, D, E and F represent treatment with *Moringa oleifera, Clerodendrum volubile, Petivera alliacea, Carpolobia lutea, Macrosphyra longistyla* and *Secamone afzeli* respectively.

Table 6: Minimum Bactericidal Concentration (MBC) values (mg/kg) of methanol leaf extracts of tested plants

Organism	Extract							
	A	B	C	D	E	F	-ve control	+ve control
Staphylococcus aureus	12.50	6.25	12.5	6.65	12.5	12.5	-	+
Streptococcus pneumoniae	12.5	25.0	25.0	25.0	25.0	25.0	-	+
Klebsiella pneumoniae	12.5	12.5	25	25.0	25.0	50.0	-	+
Escherichia coli	25.0	25.0	12.5	12.5	25.0	25.0	-	+
Pseudomonas aeruginosa	25.0	12.50	12.5	12.5	12.5	50.0	-	+
Salmonella typhi	25.0	25.0	25.0	25.0	25.0	25.0	-	+
Candida albicans	25.0	25.0	37.5	37.5	35.5	37.5	-	+
Malassezia furfur	37.5	37.5	37.0	37.5	37.5	37.5	-	+

Key: MBC= Minimum bactericidal concentration - = No growth + = Growth
A, B, C, D, E and F represent treatment with *Moringa oleifera, Clerodendrum volubile, Petivera alliacea, Carpolobia lutea, Macrosphyra longistyla* and *Secamone afzeli*, respectively

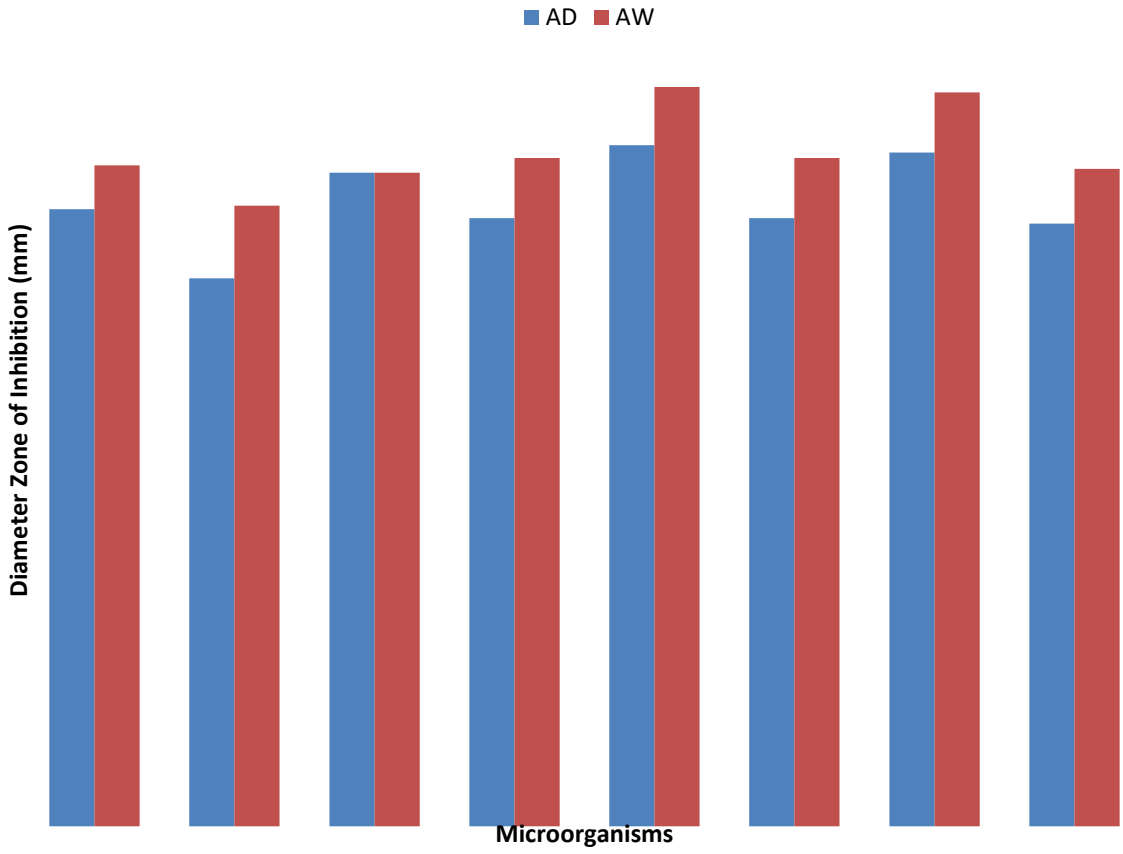

Figure 1: Graph showing comparative anti-microbial activities of extracts using Agar well diffusion and Agar disc diffusion methods
Key: AD- Agar Disc AW= Agar Well

CONCLUSION

The study concludes that the plant extracts competed favourably with the standard drugs. The results revealed that *Petiveria alliacea*, *Secamone afzeli* and *Clerodendrum volubile* demonstrated a greater inhibition against *E. coli*, a gram-negative organism with multi-resistance to drugs. *Clerodendrum volubile* and *Secamone afzeli* demonstrated profound anti-bacterial and anti-fungal activities. Their activities were observed to be comparative with the standard antibiotics used against some bacterial species such as *Staphylococcus aureus*, *Salmonella typhi* and *Klebsiella pneumoniae*. Further work is recommended to identify the pathways of these plant extracts and to affirm their safety level.

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