ORIGINAL ARTICLE

In vitro inhibitory potentials of crude plant extracts on multidrug resistant bacterial species from infected human wounds

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Background: Scientific data on usage of plants to promote wound healing is exclusively scare in Nigeria. AIM: The aim of this study was to determine *in vitro* inhibitory potentials of crude extracts of garlic (*Allium sativum*) and ginger (*Zingiber officinale*) on multiple antibiotic resistant bacteria isolated from deep and superficial human wounds. **Materials and Methods:** Using agar disc- and modified agar well-diffusion methods, 87 wound-borne bacterial strains, *Staphylococcus aureus*, *Proteus mirabilis* and *Pseudomonas aeruginosa* were screened for *in vitro* susceptibility to 15 commonly-available antibiotic discs, 18 antibiotic drugs and three plant extracts. **Results:** *Staph. aureus* strains exhibited 52.5-97.4% resistance to antibiotic (discs), with multiple antibiotic resistance (MAR) of 25.0 -100%. Between 39.1 and 95.7% of *Proteus mirabilis* strains resisted the antibiotics (discs), while MAR was 37.5-100%. Resistance rates displayed by *Ps. aeruginosa* strains were 61.5-100% with MAR of 50.0-100%. Overall antibiotic resistance patterns of respective bacterial species recorded for the antibiotic drugs were *Staph. aureus* (11.1-83.3%), *Pr. mirabilis* (16.7-77.8%) and *Ps. aeruginosa* (16.7-50.0%) and the most-resisted antibiotic drugs were axacef (55.3-82.6%), septrin (84.2-92.3%), primpex (78.3-84.6%), mediphenicol (63.2-73.1%) and augmentin 1 (43.2-76.9%). All the multidrug resistant wound-borne bacterial strains exhibited minimal to moderate susceptibility towards crude extracts of garlic (17.4-34.6%) and ginger (57.7-60.8%). **Conclusion:** Human wound-borne bacterial strains, which were multi-resistant to commonly available antibiotics (discs/drugs) were minimally or moderately susceptible to crude extracts of garlic (*Allium sativum*) and ginger (*Zingiber officinale*), which can be of clinical importance as herbal therapy in wound dressings or other forms of wound treatments.

Key words: Antibiotic resistance, herbal wound treatment, skin wounds, wound care, wound dressing

INTRODUCTION

A wound is described as a break in the continuity of tissue, which results from violence or trauma but it is regarded as healed if there is a restoration of the wounded or inflamed tissue to normal condition. Wounds cause pain, bleeding, disability and sometimes, death; meanwhile, wounds as clinical entities have always been common, are as old as mankind and often possess problems in clinical practice.[1] But naturally, investigative curiosity to promote wound healing has been on since ages and a lot of research has been envisaged to develop better healing agents;[1,2] although the aim of wound treatment or wound healing, as an important biological process involving tissue repair and regeneration has always been to reduce the risks caused by the wound itself and to minimise potential complications,[2] such as microbial invasion, possibly leading to sepsis.

Emergency physicians are often confronted with situations in which a patient with an acute injury is at high risk for an infection[3,4] although most traumatic wounds have a low risk for developing infections. Wounds in most patients will heal uneventfully and do not require the use of antimicrobial agents,[3] while certain types of high-risk trauma justify antimicrobial prophylaxis.[4] More important than antimicrobial administration is also the commitment to aggressive, timely wound care[3] whereas, increasing resistance to commonly used antibiotics has been recorded for patients with superficial skin wounds and leg ulcers.[4-11] The potential importance of antibiotic resistant microorganisms in mediating impaired healing and the potential problems they may present in the spread of antimicrobial resistance in the hospital and out-patient settings have also been reported[8] in many developed countries.[12] Biofilm-related infections also do not succumb so easily to antibiotic treatment because they

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provide a protective mechanism that renders bacterial cells less susceptible to antibiotics.[11,13]

Rapid emergence of antibiotic-resistant bacteria has continued to be a problem of increasing significance in dermatology; therefore, there is the need for determining alternative or adjunct therapy for skin wound bacterial infections. Many medicinal plants have been reported to play very important roles in the process of wound healing and are known to be more potent because they promote the repair mechanisms of wounds in the natural way. The healing process can be physically monitored by assessing the rate of contraction of the wound, period of epithelisation, tensile strength, histopathology and weight of granuloma in different wound models, while the healing tissue synthesizes more collagen to provide tensile strength. Some of the plants have been screened scientifically for the evaluation of their wound healing activities in different pharmacological models and were found to be effective in experimental models.[1]

Usage of medicinal plants in wound treatment is currently unpopular in Nigeria, even in rural areas, while scientific data on herbal wound treatment is also extremely scarce, such that it is almost non-existent. The aim of this preliminary study therefore, was to investigate the *in vitro* inhibitory potentials of crude extracts of three popular herbals on multiple antibiotic resistant Nigerian indigenous bacterial isolates cultured from superficial and deep wounds.

MATERIALS AND METHODS

Bacterial Cultures

Eighty seven bacterial stock isolates from wound specimens, originally obtained from the Department of Medical Microbiology and Parasitology, University College Hospital (UCH), Ibadan, Nigeria were Dr. Adenike Ogunshe's culture collections in the Department of Microbiology, University of Ibadan, Nigeria. The stock cultures were reactivated in sterile unbuffered peptone water for 48 hrs at 35°C, and to assure purity were sub-cultured by streaking on sterile plate count agar cystein lactose electrolyte deficient agar, mannitol salt agar and MacConkey agar (all from Lab M, England). The isolated colonies were further screened for Gram's identity, catalase, methyl-red, indole, starch hydrolysis, citrate utilization and sugar fermentation characteristics to confirm original identities. Bacteriological identities of the wound isolates were performed in compliance with compulsory standard laboratory methods.

Antibiotic Susceptibility Determination (Antibiotic Discs)

Using the Kirby-Bauer agar disc-diffusion method,[14] the antibiotic susceptibility/resistance patterns of the Gram-positive and Gram-negative wound-borne bacterial species to various antibiotics (discs) were determined on sterile Mueller-Hinton agar plate. Test antibiotic discs for the Gram-positive bacteria - PEN (penicillin; 25 µg), CHL (chloramphenicol), GEN (gentamicin; 10 µg), CXC (cloxacillin; 30 µg), Ampicillin (AMP 30 µg), ERY (erythromycin; 5 µg), STR (streptomycin; 5 µg) and TET (tetracycline; 30 µg), and for Gram-negative bacteria were- CXC (cloxacillin; 30 µg) CAZ (fortum; 30 mg); CRX (ciprofloxacin; 10 µg); GEN (gentamicin; 10 µg); CTX (claforan; 30 µg); AUG (augmentin; 30 µg); NIT (nitrofurantoin; 250 µg); OFL (ofloxacin; 30 µg).

Entire surface of each sterile Mueller-Hinton agar plate was seeded with each bacterial isolate using sterile swab sticks after which the plates were left for about 15 minutes before aseptically placing the antibiotic discs on the agar surfaces, using sterile forceps. Plates were incubated at 35°C for 18-24 hrs, and zones of inhibition were measured and recorded in millimetre diameter, while zones of inhibition less than 10.0 mm in diameter or absence of zones of inhibition were recorded as resistant.[14,15]

Antibiotic Susceptibility Determination (Antibiotic Drugs)

Antibiotic susceptibility/resistance patterns of the Gram-positive and Gram-negative bacterial species from wound samples to various antibiotic drugs were determined according to the modification of Tagg *et al*.,[16] method. Antibiotic drugs assayed for in this study were- Erymicin, Erythromycin, Etocin (erythromycin), Axacef (cefuroxime), Nobacin (azithromycin), Loxaprim, Septrin (cotrimoxazole), Ampiclox (ampicilin/cloxacillin), Primpex (trimethoprim and sulfamethoxazole), Mediphenicol, Mefacol (chloramphenicol), Augmentin 1, Augmentin 2, Augmentin 3 (amoxicillin and clavulanate potassium), Oflomed (ofloxacin), Amoxil 1, Amoxil 2 (amoxicillin), Tetradox (doxycycline).

About 6.0 mm in diameter wells were bored into sterile Mueller-Hinton agar plates using flamed mouth of sterile Durham tubes, followed by surface sterilisation of the agar plates by flaming by Bunsen. Selected bacterial strains previously inoculated into sterile peptone water and incubated at 37°C for 18-24 hours were seeded on the cooled Mueller-Hinton agar plates by streaking the entire surface of the sterile plates with the selected bacterial isolates. About 500 µl of each of the antibiotic suspensions (prepared from the antibiotic capsules and caplets dissolved in sterile distilled water) incorporated into sterile, plain semi-solid agar containing 0.5% agar powder to avoid spreading on the surface of the seeded agar plates was dispensed into each set of agar wells and the plates incubated un-inverted at 35°C for 24-48 hrs. Zones of inhibition surrounding the

agar wells were measured and recorded in mm diameter, while wells with no inhibition zones or less than 10.0 mm in diameter were recorded as resistant.

In Vitro Inhibitory Potentials of Crude Plant Extracts

In vitro inhibitory potentials of crude plant extracts of *efinrin* [African basil] (*Ocimum gratissimum* L.), garlic (*Allium sativum*) and ginger (*Zingiber officinale*) on the Gram-positive and Gram-negative bacterial species from wound samples was determined according to the modification of Tagg *et al*.,[16] method, in which sterile, plain semi-solid agar was added to the crude plant extracts to avoid spreading on the surface of the seeded agar plates.

Using Durham tubes, wells of 6.0 mm in diameter were bored into sterile Mueller-Hinton agar plates followed by surface flaming of the agar surfaces. Selected bacterial strains previously inoculated into sterile peptone water and incubated at 37°C for 18-24 hrs were seeded on the cooled agar plates by streaking the entire surface of each sterile plate with each selected bacterial isolate. About 500 µl of each crude plant extracts were dispensed into each set of agar wells and then incubated un-inverted at 35°C for 24-48 hrs. Diameter of the zones of inhibition surrounding the wells were measured and recorded in mm, while wells with no inhibition zones or less than 10.0 mm in diameter were recorded as resistant.

RESULTS

A total of wound-borne 87 bacterial isolates (n = 38 Gram-positive; n = 49 Gram-negative), *Staphylococcus* 38 (43.7%), *Proteus mirabilis* 23 (26.5%) and *Pseudomonas aeruginosa* 26 (29.9%), which were assayed *in vitro* for their antibiotic susceptibility and resistance patterns to antibiotic discs and antibiotic drugs in this study gave varying results but the recorded susceptibility and resistance patterns were not bacterial species-specific [Tables 1 and 2].

Highest antibiotic resistance rates towards the antibiotic discs recorded among the *Staph. aureus* strains were ampicillin/chloramphenicol (68.4%), tetracycline (81.6%), erythromycin (89.5%), penicillin (94.7%), cloxacillin (97.4%); while streptomycin (52.6%) and gentamicin (57.9%) were the least resisted, with MAR of 25-100%. Overall antibiotic resistance rates among *Pr. mirabilis* were 39.1-95.7%, with highest resistance against gentamicin (69.6%), claforan (76.9%), cloxacillin/augmentin (91.3%), ciprofloxacin/fortum (95.7%), and recorded multiple antibiotic resistance (MAR) rates of 37.5-100%. *Ps. aeruginosa* strains exhibited resistance rates of 61.5-100% with the least resisted antibiotic being nitrofurantoin (61.5%), while MAR rates were 50.0-100% [Table 1].

Antibiotic susceptibility and resistance patterns of the wound-borne *Staph. aureus* strains towards the test antibiotic drugs were as shown in Table 2. Out of the 18 antibiotic drugs; very low resistance rates were exhibited against only tetradox (2.6%), amoxil and augmentin 2 and augmentin 3 (5.3%), etocin and amoxil 2 (7.9%), while higher resistance were recorded against other antibiotic drugs, especially septrin (84.2%), primpex (81.6%), axacef/augmentin 2 (55.3%), mefacol (63.2%) and erymycin (52.6%), with recorded MAR rates of 11.1-83.3%. Antibiotic susceptibility/resistance patterns of the wound-borne *Pr. mirabilis* strains against the antibiotic drugs indicated that the highest recorded resistance were against augmentin 1 (43.2%), mediphenicol (65.2%), primpex (78.3%), axacef (82.6%) and septrin (91.3%) but lowest resistance rates were recorded against etocin and augmentin 3 (4.4%), augmentin 2 and tetradox (8.7%). As high as 92.3% resistance rates were recorded among the wound-borne *Ps. aeruginosa* strains in this study, while the lowest resistance were recorded in mefacol (3.8%), ampiclox, etocin, augmentin 2 and 3 and tetradox (7.7%), with MAR of 16.7-50.0% recorded among the *Ps. aeruginosa* strains [Table 2].

None of the wound-borne *Staphylococcus aureus* strains was susceptible to crude extract of *efinrin* (*Ocimum gratissimum*) but 28.9% and 60.5% of the strains were susceptible to crude extracts of garlic (*Allium sativum*) and ginger (*Zingiber officinale*) respectively. A total of 17.4% and 60.8% of the *Pr. mirabilis*, as well as 34.6% and 57.7% of the *Ps. aeruginosa* strains were also susceptible to crude extracts of garlic and ginger respectively [Table 3].

Table 1: Overall *in vitro* antibiotic resistance patterns of wound-borne bacteria (antibiotic discs)

Bacterial species	GEN	AMP	CHL	CXC	ERY	TET	PEN	STR	% MAR
Staph. aureus[17]	22 (57.9%) [10.0-25.0]	36 (94.7%) [15.0-20.0]	26 (68.4%) [10.0-25.0]	36 (94.7%) [15.0-20.0]	35 (92.1%) [15.0-20.0]	31 (81.6%) [10.0-20.0]	36 (94.7%) [15.0]	20 (52.6%) [10.0-25.0]	25.0-100
	GEN	**CTX**	**OFL**	**CXC**	**NIT**	**AUG**	**CAZ**	**CRX**	
Pr. mirabilis[18]	16 (69.6%) [10.0-20.0]	20 (76.9%) [10.0-20.0]	9 (39.1%) [10.0-25.0]	21 (91.3%) [15.0-20.0]	9 (39.1%) [10.0-25.0]	21 (91.3%) [15.0-20.0]	22 (95.7%) [15.0]	22 (95.7%) [15.0]	37.5-100
Ps. aeruginosa[19]	24 (92.3%) [10.0-15.0]	26 (100%)	20 (76.9%) [10.0-20.0]	26 (100%) [-]	16 (61.5%) [10.0-20.0]	25 (96.2%) [25.0]	26 (100%)	25 (96.2%) [15.0]	50.0-100

AMP – Ampicillin; AUG – Augmentin; CAZ – Fortum; CHL – Chloramphenicol; CXC – Cloxacillin; CRX – Ciprofloxacin; CTX – Claforan; ERY – Erythromycin; GEN – Gentamicin; NIT – Nitrofurantoin; OFL – Ofloxacin; PEN – Penicillin; STR – Streptomycin; TET – Tetracycline; MAR – Multiple antibiotic resistance

Table 2: Overall *in vitro* antibiotic resistance patterns of wound-borne bacteria (antibiotic drugs)

Bacterial species	Erymicin	Erythromycin	Axacef±	Etocin***	Nobacin*	Septrin±	Ampiclox**	Primpex±	Mediphenicol±	Mefacol**
Staph. aureus[17]	20 (52.6%) [10.0-20.0]	13 (34.2%) [10.0-25.0]^	21 (55.3%) [10.0-20.0]	3 (7.9%) [10.0-20.0]^	11 (28.9%) [10.0-30.0]^	32 (84.2%) [10.0-20.0]	5 (13.2%) [10.0-20.0]^	31 (81.6%) [10.0-20.0]	24 (63.2%) [10.0-20.0]^	4 (10.5%) [10.0-20.0]
Proteus mirabilis[18]	9 (39.1%) [10.0-20.0]	7 (30.4%) [10.0-25.0]^	19 (82.6%) [10.0-20.0]	1 (4.4%) [10.0-15.0]	3 (13.0%) [10.0-30.0]^	21 (91.3%) [15.0-20.0]	3 (13.0%) [10.0-20.0]	18 (78.3%) [15.0-30.0]^	15 (65.2%) [10.0-20.0]^	4 (17.4%) [15.0-20.0]^
Ps. aeruginosa[19]	6 (23.1%) [10.0-20.0]	7 (26.9%) [10.0-30.0]^	18 (69.2%) [10.0-25.0]	2 (7.7%) [10.0-15.0]	5 (19.2%) [10.0-30.0]^	24 (92.3%) [20.0]	2 (7.7%) [10.0-20.0]	22 (84.6%) [10.0-15.0]	19 (73.1%) [10.0-20.0]	1 (3.8%) [10.0-20.0]
	Augmentin 1±	**Augmentin 2*** **	**Augmentin 3*** **	**Oflomed**	**Amoxil 1***	**Amoxil 2****	**Loxaprim***	**Tetradox*****	**% MAR**	
Staph. aureus[17]	21 (55.3%) [10.0-25.0]^	2 (5.3%) [10.0-20.0]^	2 (5.3%) [10.0-20.0]^	9 (23.7%) [10.0-25.0]^	2 (5.3%) [10.0-20.0]	3 (7.9%) [10.0-20.0]	8 (21.1%) [10.0-20.0]^	1 (2.6%) [10.0-20.0]^	11.1-83.3	
Proteus mirabilis[18]	10 (43.2%) [10.0-25.0]^	2 (8.7%) [10.0-25.0]	1 (4.4%) [10.0-20.0]	3 (13.0%) [10.0-30.0]^	6 (26.1%) [10.0-20.0]	4 (17.4%) [10.0-20.0]	5 (21.7%) [10.0-20.0]	2 (8.7%) [10.0-20.0]	16.7-77.8 [5.6]#	
Ps. aeruginosa[19]	20 (76.9%) 10.0-25.0]^	2 (7.7%) [10.0-20.0]	2 (7.7%) [10.0-20.0]^	12 (46.2%) [10.0-30.0]^	3 (11.5%) [10.0-20.0]	4 (15.4%) [10.0-20.0]	6 (23.1%) [10.0-15.0]	2 (7.7%) [10.0-20.0]	16.7-50.0	

*** – Least resisted; ** – Less resisted; * – Moderately resisted; ± – Most resisted; % MAR – % multiple antibiotic resistance; Erymicin (erythromycin); Erythromycin (erythromycin); Axacef (cefuroxime); Etocin (erythromycin); Nobacin (azithromycin); Septrin (cotrimoxazole), Ampiclox (ampicillin/cloxacillin), Primpex (trimethoprim and sulfamethoxazole), Mediphenicol (chloramphenicol), Mefacol (chloramphenicol), Augmentin 1 (amoxicillin and clavulanate potassium), Augmentin 2 (amoxicillin and clavulanate potassium), Augmentin 3 (amoxicillin and clavulanate potassium), Oflomed (ofloxacin), Amoxil 1 (amoxicillin), Amoxil 2 (amoxicillin), Loxaprim (cotrimoxazole), Tetradox (doxycycline); ^ –zones indicating more of moderate susceptibility

Table 3: Overall *in vitro* inhibitory activities of crude plant extracts on wound-borne bacterial strains

Bacterial species	Garlic	Ginger	Efinrin
Staphylococcus aureus[17]	11 (28.9%) [10.0-15.0]	23 (60.5%) [10.0-20.0]	0 (0.0%) –
Proteus mirabilis[18]	4 (17.4%) [10.0-20.0]	14 (60.8%) [10.0-20.0]	1 (4.3%) [15.0]
Pseudomonas aeruginosa[19]	9 (34.6%) [10.0-20.0]	15 (57.7%) [10.0-20.0]	0 (0.0%) [15.0]

Values in parenthesis are the zones of inhibition in mm diameter

DISCUSSION

Wound samples in this study were mostly polybacterial in nature but the three significantly isolated bacterial species, *Staph. aureus*, *Pr. mirabilis* and *Ps. aeruginosa*, were similar to those commonly isolated from human wound swabs and burn sepsis,[5-7,20-22] suggesting that these particular bacterial species are among the most prominent species associated with wounds, irrespective of geographical locations. Meanwhile, nature of microbial wound colonisation and flora are constantly changing,[23] and it is thus, quite necessary to identify the particular indigenous aetiological bacterial flora of wounds in order to administer a rational and effective antibiotic treatment. It is however, possible that the increasing incidence of antibiotic resistance among wound-borne bacterial species may be geographic-dependent; therefore, this study is one of the very first few that determined the antibiotic susceptibility/resistance patterns of indigenous wound-borne bacteria with regards to antibiotic discs and some corresponding most-commonly obtainable antibiotic drugs in Nigeria.

Except in some cases, relatively higher rates of antibiotic resistance against antibiotic discs (39.1-100%) and clinical antibiotic drugs (30.4-92.3%) belonging to classes of antibiotics like aminoglycosides, cephalosporins, fluoroquinolones, macrolides, penicillins and tetracyclines were reported in the current study. Whereas, similar and increasing presence of resistance in wound bacteria in developed countries,[6,7,9,21,24] which had always posed as a major clinical problem, due to impediment in healing of delayed closure surgical wounds, pressure ulcers/diabetic foot ulcers, and effective treatment of frequently infected, poorly healing wounds had been previously reported among wound bacterial flora.[8,12,20,25-27] Also, various antibiotics, mainly broad-spectrum agents, being frequently and sometimes inappropriately prescribed or administered in wound treatments, additionally often leads to selection of antibiotic-resistant bacterial strains.[7]

In spite of the fact that recorded antibiotic resistance were generally lower among the test antibiotic drugs, relatively high level of resistance exhibited by the wound-borne bacteria in this study still pointed to a global increasing

tendency of antibiotic resistance, and that likely treatment failures in patients with superficial skin wounds is very probable.[5-7,20] Therefore, the importance of local trends of antibiotic resistance and rapid emergence of antibiotic-resistant bacteria, which continues to be a problem of increasing significance in dermatology cannot be over-emphasized;[6,19] thus, the need for natural adjunct wound therapy for wound treatments. Significant proportions of pharmaceutical products in current use are derived from plants,[1,28-34] and in the traditional systems of medicine, various plants have been used to promote wound healing activities, by encouraging blood clotting, fighting infections and accelerating healing of wounds.[35]

Although there is no current scientific inventory of the plants used for wound healing by traditional healers in Nigeria; however, traditional forms of medicine practiced for centuries in Africa and Asia have scientifically investigated several plants for their potentials in the treatment of wound-related disorders.[30,35] The medicinal plants assayed for in this study were selected based on suggestion of their acclaimed adjunct potency in traditional wound healing but garlic (*Allium sativum*) exhibited minimal to moderate (17.4-34.6%) *in vitro* inhibitory potentials on the wound-borne bacterial species, Medicinally, *in vitro* studies indicated that garlic (*Allium sativum*) has been found to have medicinal properties,[36] as well as antibacterial, antiviral and antifungal activities, possibly due to presence of allicin in garlic, which was found to have antibacterial properties. Even as far back as 1858, Louis Pasteur observed garlic's antibacterial activity and it was used as an antiseptic to prevent gangrene during World War I and World War II.[17,37,38] However, low to moderate inhibitory activities could be due to the fact that most of the bacterial strains were isolated from septic wounds; thus indicating their virulence or that they were innately resistant, especially with regards to their significant resistance to antibiotics.

Members of *Zingiberaceae* family are important in traditional medicine for the treatment of many diseases, while ginger (*Zingiber officinale*), which is a rhizome with a warm, sweet, strongly aromatic odour and sharp pungent flavour is popularly known for its culinary and medicinal properties. Due to its volatile oil composed of gingerols that have been found to inhibit Gram-positive and Gram-negative bacteria.[39,40] Higher inhibitory potentials (57.7-60.8%) generally exhibited in vitro by ginger (*Zingiber officinale*) against wound-borne bacterial species in this study could probably be due to its volatile oil composed of *gingerols* that have been found to inhibit Gram-positive and Gram-negative bacteria.[39,40] It has been popularly reported that every culture on earth, through written or oral tradition, has relied on the vast variety of natural chemistry found in healing plants for their therapeutic properties;[41] therefore, the significant bacteriostatic potentials of garlic (*Allium sativum*) and ginger (*Zingiber officinale*), as determined *in vitro* in this study, indicate that they can show significant wound healing activities *in vivo*, for adjunct therapy in wound infections and thus, can be used as antibacterial-eluting wound dressings that do not contain synthetic chemicals or active ingredients that the wound-borne bacteria could develop resistance to. Garlic and ginger may also therefore, be prepared as essential oils and antimicrobial powders for topical wound dressing, especially since there has been data to suggest that a combination of curcumin and ginger extract might provide a novel approach to improving structure and function in skin, as well as concomitant reduction of formation of non-healing wounds in "at-risk" skin.[41-44]

CONCLUSION

Findings of the current study are the first scientific data to report low to moderate *in vitro* bacteriostatic potentials of crude plant extracts of garlic (*Allium sativum*) and ginger (*Zingiber officinale*) on indigenous multiple resistant wound-borne bacterial flora in Nigeria. It was also observed that it was also observed that the inhibitory activities were not bacterial species dependent.

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