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PHYTOCHEMICAL AND ANTIMICROBIAL STUDIES OF STEM-BARK EXTRACTS OF *ANOGEISSUSLEIOCARPUS* FOUND IN DUTSIN-MA, KATSINA - NIGERIA

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ABSTRACT
Preliminary characterization of phytocompounds from stem bark of *Anogeissusleiocarpus* and its antimicrobial effects was carried out in this study. Concentrated and dried extracts obtained, after extraction of the plant material, were subjected to phytochemical screening and FT-IR analysis. Part of extracts obtained were used for antimicrobial studies on eleven pathogenic clinical isolates namely *Methicillin resistant Staphylococcusaureus, Vancomycin resistant enterococci, Staphylococcus aureus, Streptococcus pyogenes, Escherichia coli, Klebsiella pneumonia, Proteus mirabilis, Salmonella typhi, Candida krusei, Candida albicans* and *Candida stellatoidea* using standard protocols. Phytochemical screening of the plant extracts revealed the presence of, alkaloids, steroids, saponins, tannins, flavonoids and reducing sugars. FT-IR's spectroscopic analysis showed characteristic peaks of alcohols, ethers, esters, carboxylic acids, aldehydes, ketones and amines groups matching with some of the metabolites' functionalities already reported in literature. The plant extracts were active against all the test organisms (MIC ranged from 5.0 mg / ml to 1.25 mg / ml; MBC/MFC ranged from 10 mg / ml to 2.5 mg / ml) except *Methicillin resistant Staphylococcusaureus, Staphylococcus aureus, Klebsiella pneumonia and Candida krusei*. It can be concluded that the stem-bark of *Anogeissusleiocarpus* contains phytochemicals that have potentials to be developed into antimicrobial drugs useful for the treatment of diseases caused by those microorganisms the plant indicated activity against it.

Keywords: Phytochemical; Antimicrobials; Stem-Bark; Extracts; *Anogeissusleiocarpus*

INTRODUCTION

There is tremendous demand for new therapeutic agents used for the treatment of drug resistant infectious diseases (Mann, 2012). Positive progress has been made in the production of antimicrobial agents, but the existence of drug-resistant microorganisms and the concealment of unknown microbial diseases are a major concern for public health (Abdullahi *et al.*, 2012). Microorganism resistance to one or more antimicrobial agent is a global health problem that has driven scientists around the world to develop chemotherapy agents that can be used to treat pathogenic microbial diseases (Ali *et al.*, 2017; Lawal *et al*., 2017). Researchers with interest in the curative potentialities of medicinal plant are not only concerned with proof of local uses of the plants but also with identification of the antimicrobial resistant active principles within (Smolinski *et al*., 2003; Kawo *et al*., 2009). Therefore, it is important to investigate these plants extensively in order to arrive at antimicrobial properties and effectiveness of its different parts for possible drug development (Lawal *et al*., 2017).

Many microorganisms transmissible diseases have been treated with herbs (Mann, 2012). Role of plants in primary health care continue to be outstanding and it has been shown that higher plants can source new anti-microbial drugs (Mann, 2012). Indigenous plants contain different compounds and provide an unlimited source of significant substances with complex biological properties (Mann, 2012). Most modern medicines are derived from traditional medicinal plants (Farnsworth, 1985; Cragg and Newman, 2005). Medicinal plants have shown great power in producing new medicines that have beneficial effects on humanity. Plants are a valuable source of active medicines and therapeutic agents which demonstrated potential to treat infectious diseases with less toxicity in comparison with synthetic drugs. In different fields of medicine, a lot of researches and attempts have been made that lead to discovery of new compounds with antimicrobial activity from natural sources for example plants, animals and soil (Kawo *et al*., 2009). Practitioners of traditional herbal medicines have identified the therapeutic efficacy of variety of plants for the treatment of ailments (Mann, 1998; Mann *et al*., 2007). An integral part of African tradition and culture is the science of herbs with plants standing as main components (Adigun *et al*., 2001).

There is continuous need to analyze medicinal plants in order to know their antimicrobial properties and also possibly discover compounds that are responsible for the said antimicrobial

activity (Abinu *et al*., 2007). *Anogeissusleiocarpus* commonly known as chewing-stick belongs to a genus *Anogeissus*. The genus consists of eight species, one from Africa, five from South Asia and two from the South Arab Peninsula (Mann *et al*., 2008; Shuaibu *et al*., 2008). The plant has different names depending on locations in Nigeria. For example it is called 'Marke' by some natives of northern Nigeria (Hausa). Local uses of the plant include its uses in the treatment of skin sore, alopecia, headache, bronchitis, diarrhea, bruises, dysmenorrheal, constipation, dysentery, fever, cataract, anti-cold, inflammation, asthma, tumor, liver diseases and venereal diseases (Ndukwe *et al*., 2007). In Northern Nigeria, leaves infusion of *Anogeissusleiocarpus* is traditionally used to cure wound infections, cough and children's rashes (Bizimana, 1994; Dweek, 1997). The roots are used for the treatment ulcers and as a relief for toothache. Ground bark reduces toothache on rubbing on gums (Ibrahim *et al*., 1997, 2005). The plant's root exhibited antibacterial effects on *Lactobacillus* sp when used as a chewing stick (Owoseni and Ogunnusi, 2006).There has also been evidence of antimicrobial effects against a number of bacteria, malaria parasites and viruses by the plant (Taiwo *et al*., 1999). *Anogeissusleiocarpus* is used medically to treat pneumonia, general body pain, ascariasis, blood clots, tuberculosis, gonorrhoea, pulmonary disease, hemoptysis, and hay fever (Mann *et al*., 2003, 2007, 2008; Barku *et al*., 2013).

Variation of secondary metabolites in plants from one place to another is known (Tijjani *et al*., 2016). Therefore, comparative phytochemical analyses of medicinal plants collected from different locations may lead to discovery of additional phytocompounds with important biological activity that may not be available in the same plants but collected from different locations. In this study, phytochemical screening and antimicrobial test of the stem bark extracts of *Anogeissusleiocarpus,* collected for the first time from Dutsin-Ma, were determined on some selected microorganisms. This will enable us know the compounds available in and the potency of the plant's extractives against the organisms studied; and may also support the usage of this plant in the treatment of infections caused by the microorganisms studied in ethno-medicine.

MATERIALS AND METHODS

Collection and preparation of plant materials

Anogeissusleiocarpus was collected in March, 2019, from Dutsin-Ma Local Government Area, Katsina-Nigeria. The plant was, thereafter, identified at the Department of Biological Sciences, Federal University Dutsin-Ma. The plant's bark was stripped from the plant and then cleaned to remove dust under tap water. It was, after this, air-dried for seven (7) days at room temperature, ground and prepared for use in a plastic container (Mann *et al*., 2012; Christian *et al*., 2013; Wadood *et al*., 2013).

Extraction of plant materials

Five hundred grams (500 g) of the ground plant material was subjected to cold extraction using Hexane, dichloromethane, Ethanol and water for three days with constant shaking. Extracts obtained were filtered and the filtrates were collected and concentrated to dryness in vacuum with rotary evaporator. The concentrated extracts were dried in open air in the laboratory and stored under refrigeration until further use (Bdliya and Abraham, 2010).

Determination of Antimicrobial Activity

Each of the extract (0.1 g) was used to prepare a solution of 10 mg/ml with10 ml of Dimethyl sulphoxide (DMSO) used as diluent. Diffusion method was the method used for the screening of extracts. Medium used to grow the microorganisms was Mueller-Hinton agar. The medium sterilization was done for 15 minutes at 121 ^{o}C. This was subsequently transferred into sterile petri-dishes and allowed to set. Test microorganisms standard inoculums (0.1 ml) was seeded and evenly spread over the surface of the medium with the aid of sterile swab. Holes (or wells) were created by the use of a sterile cork borer (6 mm in diameter) on the medium already inoculated. After this, 0.1 ml of the solution of each the extract (10 mg/ml) was afterwards transferred into the well on the inoculated medium. Incubation of plates containing inoculated medium was done for 24 hrs at 37 ^{o}C, after which zones of inhibition of microorganisms' growth were observed. The zones were measured and recorded (Ali *et al*., 2017; Bauer *et al*., 1966).

Minimum inhibition concentration (MIC)

Broth dilution method was used to determine the MICs of the plant's extracts. Each of the extract's Mueller-Hinton Broth was prepared and dispensed (10 ml) into cleaned test tubes. This was followed by sterilization for 15 minutes at 121 ^{o}C, and thereafter the Broth was cooled. Least concentration was prepared to give McFarland's turbid solution with turbidity standard scale number 0.5. To do this, 10 ml of prepared normal saline was dispensed into sterile test tube and then test microbe incubated for 6 hrs at 37 ^{o}C after inoculation. Test microbe was diluted in the normal saline to match turbidity of McFarland's scale ($1.5X10^{8}$ CFU/ml) when visually compared. Concentrations of 10 mg/ml, 5mg/ml, 2.5 mg/ml, 1.25 mg/ml, 0.63 mg/ml and 0.3 mg/ml of the extracts were obtained with two-fold serial dilution in the normal saline. Having obtained the different concentrations of the extract in the sterile broth, 0.1ml of the test microbe in the normal saline was then inoculated in the different concentrations, incubation was done for 24 hours at 37 ^{o}C thereafter broth test tubes were examined for growth or turbidity. The least concentration of the extract in the sterile broth without turbidity was taken as MIC (Ali *et al*., 2017).

Minimum bactericidal concentration and minimum fungicidal concentration (MBC/MFC)

MBC/MFC were carried in accordance to Ali *et al*., (2017). Preparation of Mueller-Hinton agar was carried out. This was subsequently sterilized for 15mins at 121^{o}C, poured in sterile petri-dishes and then left for sometime to set. MIC contents in the serial dilutions were sub-cultured onto the prepared medium and incubated for 24 hours at 37 ^{o}C after this, plates of the medium were observed for colony growth. MBC/MFC was

observed with plates without colony growth having lowest concentrations of the extracts.

Phytochemical screening

Extracts of *Anogeissus leiocarpus* were subjected to qualitative phytochemical screening for the detection of saponins, flavanoids, steroids, alkaloids, tannins and reducing sugars according to standard method reported by (Kawo *et al*., 2009).

Fourier Transformed Infrared (FTIR) Spectroscopy

FT-IR spectra of the *Anogeissusleiocarpus* extracts were recorded on a Fourier transformed infrared spectrometer (Cary 630) Agilent Technologies, in a range of 4000 to 950 cm^{-1}, resolution of 4 cm^{-1} and scan number 8.

RESULTS AND DISCUSSION

Results

Table 1: Antimicrobial sensitivity test of the plant'sextracts

TEST ORGANISM	AQUEOUS	DCM	ETHANOL	HEXANE
Methicillin resistantStaphylococcus aureus	R	R	R	R
Vancomycin resistant enterococci	S	S	S	S
Staphylococcus aureus	R	R	R	R
Streptococcus pyogenes	S	S	S	R
Escherichia coli	S	S	S	S
Klebsiella pneumonia	R	R	R	R
Proteus mirabilis	S	S	S	S
Salmonella typhi	S	S	S	R
Candida albicans	S	S	S	S
Candida krusei	R	R	R	R
Candida stellatoidea	S	S	S	R

KEY: S→ Sensitive R→ Resistance

Table 2: Zone of inhibition of the extracts against the test microorganism

TEST ORGANISM	AQUEOUS	DCM	ETHANOL	HEXANE
Methicillin resistant staphylococcus aureus	0	0	0	0
Vancomycin resistant enterococci	20	24	22	18
Staphylococcus aureus	0	0	0	0
Streptococcus pyogenes	23	26	23	0
Escherichia coli	22	25	23	20
Klebsiella pneumonia	0	0	0	0
Proteus mirabilis	25	27	24	20
Salmonella typhi	20	24	22	0
Candida albicans	22	27	24	18
Candida krusei	0	0	0	0
Candida stellatoidea	21	26	23	0

Table 3: Minimum inhibition concentration (MIC) of the extracts against the test organisms

TEST ORGANISM	10mg/ml	5mg/ml	2.5mg/ml	1.25mg/ml	0.63mg/ml	0.31mg/ml	10mg/ml	5mg/ml	2.5mg/ml	1.25mg/ml	0.63mg/ml	0.31mg/ml	10mg/ml	5mg/ml	2.5mg/ml	1.25mg/ml	0.63mg/ml	0.31mg/ml	10mg/ml	5mg/ml	2.5mg/ml	1.25mg/ml	0.63mg/ml	0.31mg/ml
Methicillin resistant staphylococcus aureus																								
Vancomycin resistant enterococci	-	-	Ox	+	++	+++	-	-	Ox	+	++	+++	-	-	Ox	+	++	+++	-	Ox	+	++	+++	++++
Staphylococcus aureus																								
Streptococcus pyogenes	-	-	Ox	+	++	+++	-	-	-	Ox	+	++	-	-	Ox	+	++	+++						
Escherichia coli	-	-	Ox	+	++	+++	-	-	-	Ox	+	++	-	-	Ox	+	++	+++	-	-	Ox	+	++	+++
Klebsiella pneumonia																								
Proteus mirabilis	-	-	-	Ox	+	++	-	-	-	Ox	+	++	-	-	Ox	+	++	+++	-	-	Ox	+	++	+++
Salmonella typhi	-	-	Ox	+	++	+++	-	-	Ox	+	++	+++	-	-	Ox	+	++	+++						
Candida albicans	-	-	Ox	+	++	+++	-	-	-	Ox	+	++	-	-	Ox	+	++	+++	-	Ox	+	++	+++	++++
Candida krusei																								
Candida stellatoidea	-	-	Ox	+	++	+++	-	-	-	Ox	+	++	-	-	Ox	+	++	+++						

KEY: - →No turbidity (no growth), ox→MIC, +→ Turbid (light growth), ++→Moderate turbidity, +++→ High turbidity

Table 4: Minimum bactericidal/fungicidal (MBC/MFC) concentration of the extract against the test microorganism

TEST ORGANISM	10mg/ml	5mg/ml	2.5mg/ml	1.25mg/ml	0.63mg/ml	0.31mg/ml	10mg/ml	5mg/ml	2.5mg/ml	1.25mg/ml	0.63mg/ml	0.31mg/ml	10mg/ml	5mg/ml	2.5mg/ml	1.25mg/ml	0.63mg/ml	0.31mg/ml	10mg/ml	5mg/ml	2.5mg/ml	1.25mg/ml	0.63mg/ml	0.31mg/ml
Methicillin resistant staphylococcus aureus	Ox	+	++	++	+++	+++	-	Ox	+	++	++	+++	Ox	+	++	++	+++	+++	Ox	+	++	++	++	
Vancomycin resistant enterococci				+	+	+					+	+				+	+	+				+	+	
Staphylococcus aureus																								
Streptococcus pyogenes	-	Ox	+	++	+++	+++	-	Ox	+	++	++	+++	-	Ox	+	++	+++	+++						
Escherichia coli	Ox	+	++	++	+++	+++	-	Ox	+	++	++	+++	-	Ox	+	++	+++	+++	Ox	+	++	++	++	
Klebsiella pneumonia				+	+	+					+	+						+				+	+	
Proteus mirabilis	-	Ox	+	++	+++	+++	-	-	Ox	+	++	+++	-	Ox	+	++	+++	+++	Ox	+	++	++	++	
Salmonella typhi	Ox	+	++	++	+++	+++	-	Ox	+	++	++	+++	Ox	+	++	++	+++	+++						
Candida albicans	Ox	+	++	+	+	+					+	+				+	+	+				+	+	
Candida krusei	Ox	+	++	++	+++	+++	-	-	Ox	+	++	+++	-	Ox	+	++	+++	+++	Ox	+	++	++	++	
Candida stellatoidea				+	+	+					+	+						+				+	+	
	Ox	+	++	++	+++	+++	-	0x	+	++	++	+++	-	Ox	+	++	+++	+++						
				+	+	+					+	+						+						

KEY: -→No colony growth, ox→ MBC/MBF, +→Scanty colonies growth, ++→Moderate colonies growth, +++→Heavy colonies growth

Table 5: Phytochemical screening of *Anogeissus leiocarpus* extracts

TEST	AQUEOUS	DCM	ETHANOL	HEXANE
Saponins	+	-	+	-
Flavonoids	+	-	+	-
Steroids	-	+	-	+
Tannins	+	-	+	-
Alkaloids	+	+	+	+
Reducing Sugars	+	-	+	-
Phenols	+	+	+	-

Key (+) = present, (-) = absent

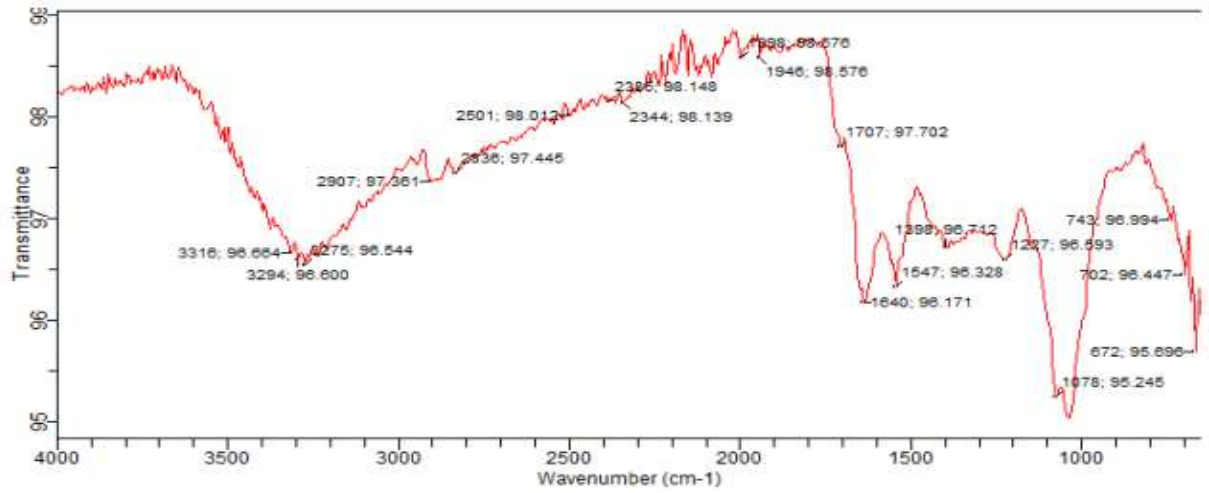

Figure1: FT-IR spectrum of aqueous extract

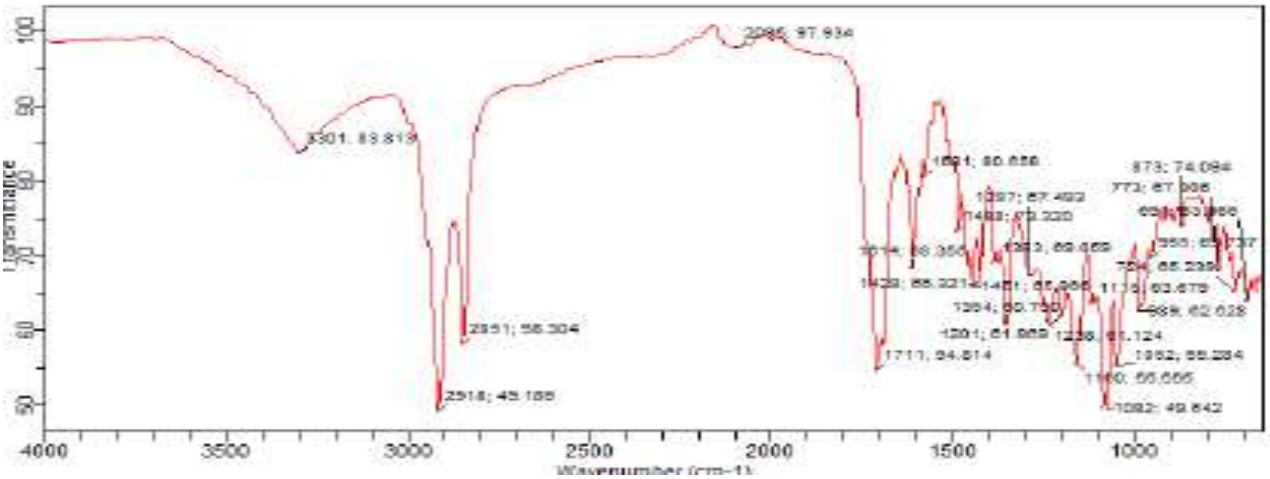

Figure 2: FT-IR spectrum of dichloromethane extract

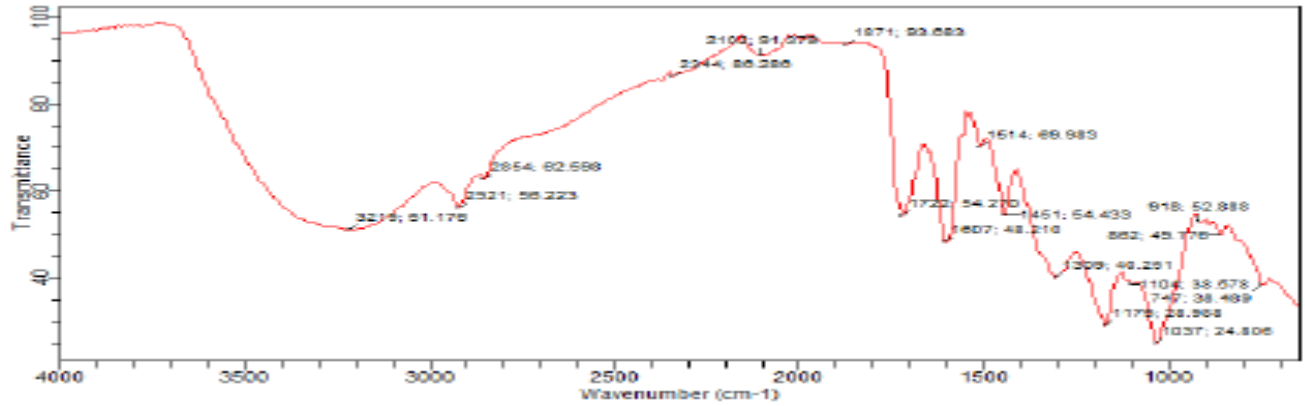

Figure 3: FT-IR spectrum of ethanol extract

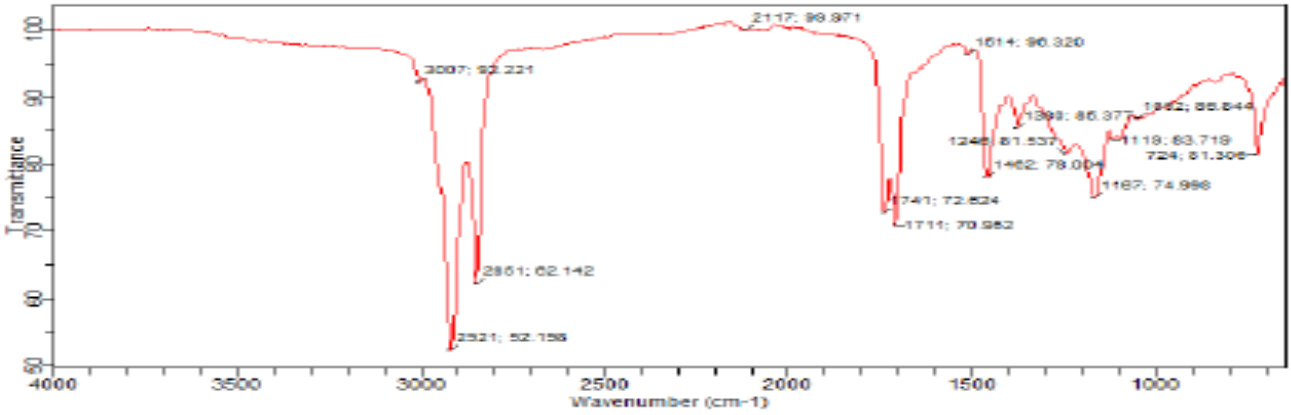

Figure 4: FT-IR spectrum of hexane extract

DISCUSSION

Eleven pathogenic clinical isolates namely *Methicillin resistant Staphylococcus aureus, Vancomycin resistant enterococci, Staphylococcus aureus, Streptococcus pyogenes, Escherichia coli, Klebsiella pneumonia, Proteus mirabilis, Salmonella typhi, Candida albicans, Candida krusei* and *Candida stellatoidea* were used for this study. The plant extracts were active against all the test organisms (zones of inhibition ranged from 18 mm to 27 mm; MIC ranged from 5.0 mg / ml to 1.25 mg / ml; MBC/MFC ranged from 10 mg / ml to 2.5 mg / ml) except *Methicillin resistant Staphylococcusaureus, Staphylococcus aureus, Klebsiella pneumonia and Candida krusei*. The activity against *Escherichia coli* is in line with the findings of Sore *et al*., (2012), Man *et al*., (2008) Elegami, (2002) and Adigun *et al*., (2000). This supports the use of the plant to treat *Escherichia coli* related infectious wounds and diarrhea in ethno-medicine. Activity of the plant extract against *Salmonella typhi* validates the use of the plant for the treatment of headache and fever in trado-medicine. The plant is also active against *Vancomycin resistant enterococci*, *Streptococcus pyogenes* and *Klebsiella pneumonia* and this buttresses the plant's use to treat upper respiratory tract infections (e.g. cough, asthma, bronchitis and pneumonia) traditionally. The antifungal activity against *Candida albicans, Candida krusei* and *Candida stellatoidea* indicates that the plant could be used to cure fungal related ailments.

Phytochemical screening of the stem bark extracts presented in table 5 revealed the presence of saponins. This corroborates with a report by Rao *et al*., (2016), Kawo *et al*., (2009), Mann *et al*., (2010), Kaboré *et al*., (2010), Aliyu and Sani, (2011), Dayok *et al*., (2018). Flavonoids were also present; and this agrees with a similar observation by Kawo *et al*., (2009) and Rao *et al*., (2016). Presence of alkaloids agrees with (Ali *et al*., 2017; Rao *et al*., 2016) findings; but this goes contrary to other reports (Salih *et al*., 2017; Sore *et al*., 2012) which showed absence of the metabolites. Tannins were also present. This aligns with report of Mann, (2012) and also that of Ali *et al*., (2017). Steroids as stated by (Ali *et al*., 2017; Kawo *et al*., 2009; Mann, 2012; Wadood *et al*., 2013) were also present. These compounds were reported to show important biological activities ranging from antimicrobial activity (Elegami, 2002; Batawila, 2005; Taiwo *et al*., 1999; Kubmarawa, 2007; Adigun *et al*., 2000), anthelmintic activity (Ademola, 2011; Agaie, 2007; Soro, 2013), antiplasmodial activity (Shuaibu, 2008a; Akanbi, 2012; Vonthron-Senecheau, 2003), trypanocidal activity (Okpekon, 2004; Atawodi, 2003; Mukhtar *et al*., 2017), leishmanicidal activity (Shuaibu, 2008), antioxidant and hepatoprotective activities (Victor *et al*., 2013; Victor and Grace, 2013; Olajide,

2011; Atawodi *et al*., 2011) among others. It is generally observed that some secondary metabolites for example phenolics, glycosides, steroids and triterpenes were detected in *Anogeissusleiocarpus* by researches both in Nigeria and other countries (Salih *et al*., 2017; Rao *et al*., 2016; Sore *et al*., 2012; Mann *et al*., 2008; Kawo *et al*., 2009; Aliyu and Sani, 2011; Mann *et al*., 2014; Dayok *et al*., 2018). While, in addition, alkaloids were mostly present in the plant collected in Nigeria, for instance in the reports (Mann *et al*., 2008; Kawo *et al*., 2009; Aliyu and Sani, 2011; Mann *et al*., 2014; Dayok *et al*., 2018). Hence, alkaloids may be considered to be the chemical maker for *Anogeissusleiocarpus* grown in Nigeria and might have confer the stated biological activities (either alone or in synergy with other compounds) the plant is said to possess.

In the spectrum of the aqueous extract represented in figure 1, the broad band at 3310 cm^{-1} and both bands at 1227 cm^{-1} and 1078 cm^{-1} was assignable to O–H stretching in phenols or polyphenols and C-O stretch of alkanols respectively. This is supported by C-C stretch in-ring of aromatics with a band at 1398 cm^{-1}. Hence, these suggest the presence of phenolics like flavonoids, tannins and phenolic acids in the aqueous extract. Again, this is in corroboration with the result of the phytochemical screening (Table 5) and also reported literature (Rao *et al*., 2016; Adigun *et al*., 2000).There exist 1640 cm^{-1} and 1547 cm^{-1} absorption bands typical of N-H bending of nitrogen containing compounds. This suggests the presence of alkaloids in line with result of the qualitative test (Table 5) and other reports (Aliyu and Sani, 2011; Mann *et al*., 2014; Dayok *et al*., 2018).

From figure 2, the dichloromethane extract showed a medium absorption band at 3301 cm^{-1} which represents N – H vibrational stretch. This is supported by bands appearing at 1140 cm^{-1} and 1201 cm^{-1} (for N – H stretch); and another medium band at 1614 cm^{-1} typical of N-H bending. Hence, this agrees with the result of the phytochemical screening that indicated the presence of alkaloid (N-containing compound) and also agrees with literature reports (Aliyu and Sani, 2011; Mann *et al*., 2014; Dayok *et al*., 2018).There exist absorptions at 2918 cm^{-1} and 2851 cm^{-1} attributable to C – H stretching vibrations for possible C– H stretch in steroids, alkaloids, fatty acids and other metabolites (Salih *et al*., 2017; Rao *et al*., 2016; Sore *et al*., 2012; Mann *et al*., 2008; Mann *et al*., 2014; Dayok *et al*., 2018). A band appeared at 1420 cm^{-1} for C-C stretch in-ring of aromatics possibly from phenolics was also present (Rao *et al*., 2016; Adigun *et al*., 2000). Band due to C-O stretch from alkanols or ethers appeared at 1092 cm^{-1}. Absorption at 1711 cm^{-1} for C=O (carbonyl) was also observed. This indicates that the secondary metabolites detected, for example steroids and phenolics may contain the carbonyl moiety in its structure as also indicated by other reports (Rao *et al*., 2016; Adigun *et al*., 2000).

Figure 3 represents the FTIR spectrum of ethanol extract of the plant. Absorption frequency at 3210 cm^{-1} that is attributable to phenolic O-H stretch was observed (Rao *et al*., 2016; Adigun *et al*., 2000). In addition, C-C stretch in-ring of aromatics absorption occurred at 1461 cm^{-1}. These may again suggest the presence of phenolics like flavonoids, tannins and phenolic acids in the extract (Rao *et al*., 2016; Adigun *et al*., 2000). Absorption at 2921 cm^{-1} typical of C-H stretching of possibly steroidal or triterpenoidal nucleus of saponins (which was already detected in the qualitative test) was also observed. Carbonyl absorption at 1722 cm^{-1} attributable to C=O stretch of phenolics carbonyl group was also noted. N-H stretch absorption appeared at 1170 cm^{-1}.This may be due to presence of alkaloids in the extract (Aliyu and Sani, 2011; Mann *et al*., 2014; Dayok *et al*., 2018). Band at 1037 cm^{-1} of C-O stretch from alkanol or ether was also noticed. These findings support the earlier one presented in Table 5 and aligns with other reports (Salih *et al*., 2017; Rao *et al*., 2016; Sore *et al*., 2012; Mann *et al*., 2008; Mann *et al*., 2014; Dayok *et al*., 2018).

Figure 4 which represents FTIR spectrum of hexane extract shows the characteristic absorption bands at 2921 cm^{-1} and 2861 cm^{-1} which are attributable to C –H stretch. The C –H might be in structures of the steroids or fatty acids, since the solvent used for the extraction is non-polar (n-hexane). Bands at 1711 cm^{-1} and 1741 cm^{-1} assignable to C=O stretch for ketones and esters of possibly the fatty acids or in other metabolites nuclei were observed and agrees with literature (Salih *et al*., 2017; Rao *et al*., 2016; Sore *et al*., 2012; Mann *et al*., 2008; Kawo *et al*., 2009; Aliyu and Sani, 2011; Mann *et al*., 2014; Dayok *et al*., 2018).

CONCLUSION

The present study confirmed some of the ethno-medicinal uses of *Anogeissusleiocarpus* to cure diseases caused by the microorganism studied. It further established variation of plant-based metabolites with geographical locations and hence the presence of metabolites (e.g saponins, flavonoids, tannins, steroids and triterpenes) in *Anogeissusleiocarpus* cut across different geographical locations where the plant is found. While alkaloids are regarded as chemical marker that could be used to identify the plant located in Nigeria. And these metabolites (alkaloids) might have confer the biological activities (either in isolation or together with other metabolites) the plant is said to exhibit. Therefore, proper identification of alkaloids in the plant located in Nigeria and knowledge of its mechanism of action are highly encouraged.

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