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GC-MS ANALYSIS AND ANTIBACTERIAL PROPERTIES OF GUM EXUDATES OF Anogeissusleiocarpus D.C

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ABSTRACT

This investigation was carried out to evaluate the phytochemical constituents by GC-MS analysis and determine the antibacterial properties of gum exudate of *Anogeissusleiocarpus.*The GC-MS analysis of the ethanolicgum extracts of *A. leiocarpus*was performed using a Perkin-Elmer GC clarus 500 system.The antibacterial properties of the gum exudatewas determine by disc diffusion method. The GC-MS analysis revealed the presence of various phytochemicalsin the gum extracts with the varying degree of biological activities. From the result, Fourteen (14) compounds were identified with 1H-3a-7, methanoazulene (14.31%), Alloaromadendrene(12.24%) being the most abundant compounds identified. Other compounds were, 1-4(4-pyrimidine-2-yl) piperazin-1-yl peropane-1-one, 2,5- dimethyl-3-methylene,1,5-hexadiene, 11,-(2-cyclopentene-1-yl undecanoic acid, 1,6,10,-dodecatriene,-7,11-dimethyl-3-methylene, Bicyclo[5.1.0] octane, 8-(1-methylthyline)-, Docosa-8,14-dyn-1,2,2-diol (Z)- 2Tms derivatives, Polygalitol, Morpholine,4-methyl-4,oxide, Carbamodithioic acid, formylMethyl ester.Results of antibacterial properties showed that, the gum extracts have shown moderate activity on the test organisms. From the results, chloroform and ethanolic extract have significant activity against all the test organisms. On the effect of concentrations of the extracts, the control disc significantly recorded the highest activity in all the test organisms ($P \leq 0.05$) followed by 5000µg/disc and 3000 µg/disc of the crude extract. The activity exhibited by the extracts of the gum sample justified the use of gum exudate as a good source of modern and alternative medicine. Result of GCMS analysis will greatly be helpful for the discovery of potent remedies for various diseases.

Keywords: GC-MS, Gum, Exudate, Antibacterial, Anogeissuss

INTRODUCTION

Medicinal plants are the richest bio – resources of drugs of traditional system of medicine, modern medicine, nutraceuticals, food supplement, folk medicine, pharmaceutical intermediates and chemical entities for synthetic drugs (Divya*et al.,* 2017). Plant based drugs has been used worldwide in traditional medicine for treatment of various disease. The world health organization (WHO) estimates that more than 80% of the populations in developing countries rely on traditional medicine for their primary health care (Nathiya*et al.,* 2012). The plant are rich to contain several active principle with specific therapeutic effect, they represent a source of chemical compounds such as tannins, flavonoids, saponins, resins, alkaloid, etc. with curative properties (Doss 2009). These active constituents of medicinal plants have been considered to be a basic requirement in the discovery of potent medicine and remedies on various diseases (Pawar and Kamble 2017). *A leiocarpus*commonly known as axle wood tree. It is a tall evergreen tree native to Savanna of tropical Africa (Margerate 1998). It is the sole west African species of the genus angiosperm distributed from tropical central and east Africa through the tropical South east Asia. The axle wood tree has many application in Nigeria. It is used medicinally for the treatment of Ascaris, Gonorrhoea, general body pain, Asthma and couphing (Mann *et al.,* 2008). It produces gum known as gum ghatti which is a natural exudation but yield can be increased by making artificial incision, exudate tears are normally less than one cm in diameter and often occur in large vermiform masses varying in colour from nearly white to dark brown (Amar *et al.,* 2006). The gum is calcium and magnesium salt of an acidic polysaccharides composed of L- arabinose, D- galactose, D- rhamnose and D- glucose. Therefore the present study was designed to evaluate the phytochemical constituents and antibacterial properties of *Anogeissussleiocarpus*gum extracts.

MATERIALS AND METHODS

Collection and identification of plant materials

The gum exudate sample was collected from *Anogeissusleiocarpus* (Family Combrataceae) Gajida village of Tofalocal government area of Kano State. Plant sample was identified and authenticated in the Department of Plant Biology Herbarium, Bayero University, Kano. The samples was relatively pure and was collected locally by hand using knife,the gum exudes naturally from the cracks of the cortex/bark as hard nodules or beads and collected by hand using a knife. Impurities such as bark pieces and sand particles, were carefully removed by hand. The gum sample was dried at room temperature and reduced to a fine powder and kept in a labeled polythene bag for further use (Issa*et al.,* 2014).

Extraction of the plant materials

Plant extracts were obtained by cold percolation methods (Haruna*et al.,* 2014). A quantity of (50g) of the dried exudate sample was macerated in equal volume (500ml) of different solvents, water, ethanol, chloroform and petroleum ether in a 750ml capacity flask. The bottles were labeled and kept for two weeks at room temperature and were shaken occasionally (Ishnava*et al.,* 2010). The extracts were filtered using Whatman No. 1 filter paper, then, extract of each solvent was evaporated using a water bath at 60^{o}C . The residues were stored at 4^{o}C for subsequent use (Bare *et al.,* 2014).

Identification and charaterization of phytochemicals by TLC and GCMS analysis

TLC of plant gum extract

Thin layer chromatography (TLC) was used to separate the chemical constituents present in the samples. TLC of the extract was carried out in a pre- coated silica Plate (TLC plate) with suitable solvent (N- hexane and ethyl acetate). The TLC plate was cut into suitable size. A line was drawn horizontally at about 0.5cm from the bottom to serve as the origin (spotting line). With a pencil a thin mark was made at the bottom of the plate on the spotting line. A suitable solvent system (n-hexane and ethyl acetate 1:1) were poured into the TLC chamber and was allowed to saturate. A microcapillary tube was dropped into the prepared plant extracts sample and gently spotted at the marked origin from the base of the TLC plate in equal distance. Then placed in TLC chamber so that the side of the plate with the sample line is facing the mobile phase. The plate was then immersed such that the sample spots are well above the level of mobile phase. Then the spots were given sufficient time to elute and develop the solvent front of about 1cm before the plate apex at which it was removed. The plate was allowed to dry and sprayed with P- anisaldehyde and heated in an oven at 105 ^{O}C for five minutes. The sample spots were visualized under day light and the number of spots were counted (Owlcation 2015).

Column Chromatography

A glass tube 50cm high with diameter of 5cm was used for the column chromatography. The adsorbent silica gel (100g 60-12µm) was packed to about 25cm in the glass tube. 3g of the extract was then loaded on packed adsorbent and allowed to stabilize before elution starts and then adding suitable solvent in gradient wise. Volume of 25 ml each were collected per fraction and allowed to concentrate at room temperature. The fraction collected were monitored on TLC plates and visualized with P-anisaldehydesulphuric acid spray, similar fraction were pooled and coded for GCMS analysis (Zakariyya, 2015).

GC-MS analysis

The GC-MS analysis of the ethanolic extracts of *A. leiocarpus*was performed using a Perkin-Elmer GC Clarus 500 system comprising an AOC-20i auto sampler and a gas chromatograph interface to a mass spectrometer (GC-MS) equipped with an Elite-5ms (5% diphenyl/95/dimethyl poly siloxane) fused a capillary column (30×0.25µm, ID×0.25 µmdf). For GCMS detection, an electron ionization system was operated in electron impact mode with an ionization energy of 70ev. Helium gas (99.999%) was used a carrier gas at a constant flow rate of 1ml/min. and injection volume of 2µl was employed (a split ratio of 10:1). The injector tempreture was maintained at 250 ^{O}C, the ion source temperature was 200 ^{O}C, the oven tempreture was programmed from 110 ^{O}C (Isothermal for 2 minutes) with an increase of 10 ^{O}C /min to 200 ^{O}C, then 5 ^{O}C /min to 280 ^{O}C, ending with a nine minutes isothermal as 280 ^{O}C. Mass spectra were taken at 70ev, a scan internal of 0.5 s and fragment from 45 to 450 Da. The solvent delay was 0 to 2 min. the relative percentage amount of each component was calculated by comparing its average peak area to the total area. The mass detector used in this analysis was Turbo-mass Gold-Perkin-Elmer, and the software adopted to handle mass spectra and chromatograms was a turbo-mass ver-5.2. (Bagvathi andRamasamy 2015). Interpretation on mass-spectrum GC-MS was conducted using the data base of National Institute Standard and technology (NIST). The spectrum of unknown component was compared with the spectrum of known component stored in NIST library. The molecular weight, structure of the components of the plant materials were ascertained by NIST chemistry web book (2018).

Antibacterial evaluation

Preparation of sensitivity disc

Whatman No1. filter paper was punched using paper puncher of which discs of 6.0mm in diameter were obtained. These were placed in sterile capped bijou bottles and sterilized in an oven at 160°C for one hour.

Preparation of concentrate for sensitivity test

Stock solution was prepared using dimethyl sulphoxide (DMSO). Two grams (2g) of the gum extract was

dissolved in 2ml of dimethyl sulfoxide (DMSO) to arrive at 1.0g/ml (1000000µg/ml) which serve as stock solution (Harun*a et al.,* 2014). From the stock solution, four concentrations (5000µ/ml, 3000µ/ml, 2000µ/ml and 1000µ/ml) were prepared. 100 sterilized discs were placed into each bottle which gave disc potencies of 5000µg/disc, 3000µg/discs, 2000µg/discs, and 1000µg/disc respectively (Harun*a et al.,* 2014).

Test organisms

The test organisms that were used in the research were bacterial isolates, Gram positive and Gram negative bacteria, which were all obtained from Aminu Kano Teaching Hospital (AKTH). The organisms include, *Escherichia coli*, *Pseudomonas aeruginosa*(Gram negative), *Staphylococcus aureus*and *Streptococcus pneumoniae* (Gram positive).The organisms were confirmed in the microbiology laboratory of Microbiology Department, Bayero University, Kano using standard Biochemical test (Scott, 1989). The stock culture were maintained on nutrient agar at 4°C in a refrigerator in accordance with Scots (1989)

Standardization of inoculum

Each culture of the isolates were standardized by culturing on nutrient agar for 24hrs at 37°C. The overnight culture were diluted in normal saline (0.5 w/v) until turbidity marched that of 0.5 MacFarland standard with a mean of 3.30×10^{6} CFU/ML (Deeni and Hussain 1991).

Antibacterial susceptibility testing of the extracts.

The sensitivity of each test organisms to the compound was determined using the disc diffusion technique (Okenwa and Donatus, 2013). A loopful of each test organism was aseptically smeared on the surface of a sterile medium, appropriate for the test organisms using a wire loop, the inoculum was spread evenly over the surface of the medium, and then with the aid of pair a forceps, the prepared paper discs were carefully placed and pressed slightly on the surface of the inoculated medium at some distance from one another. The inoculated plates were incubated for 24 hours in an incubator at 37^{o}C. They were examined for growth and the presence of inhibition zone around the paper disc containing the extract was observed and recorded. The level of sensitivity was determined by the diameter of the inhibition zone as measured with a transparent millimeter rule. Amoxicilin (30µg/disc) was used as the positive control against the test organisms.

Results

Result of TLC and column chromatography of the gum exudate

Chromatographic analysis of ethanolic extracts of the gum exudates of the plant under study showed the separated and purified compounds (Plate 1). The result was used for GC-MS analysis.

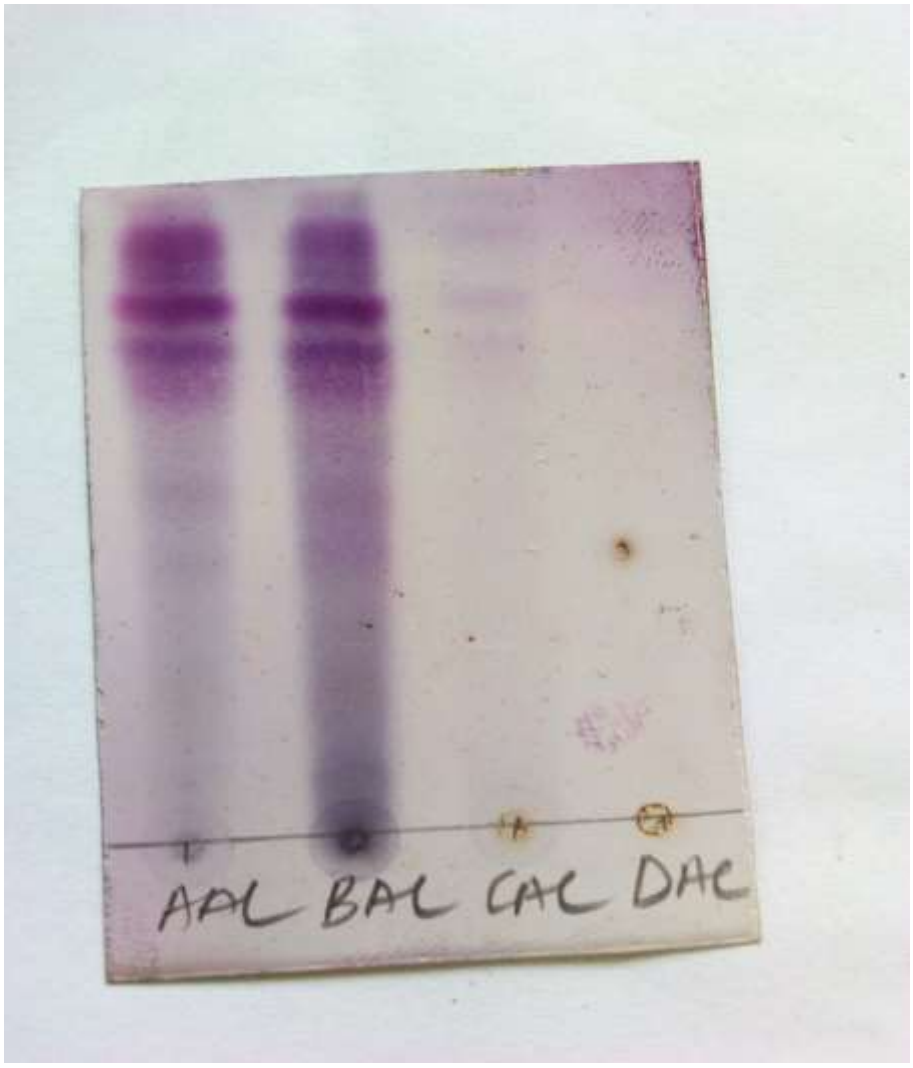

PLATE I.

TLC of the column chromatograph of ethanolic extracts of *Anogeiossusleiocarpus*showing the separated and purified compounds.

Result of GC-MS analysis

Results for GC-MS analysis of ethanolic gum extracts *A. leiocarpus* were presented in tables (1). Results indicated the presence of various phytochemicals with varying degree of biological activity. Fourteen compounds were identified by GC-MS analysis with different percentage peak area and separated at different retention time. Compound identified as 1H-3a-7,methanoazulene, octahydro-1,4,9,9 tetramethyl, being the most abundant compound with peak percentage area14.31% Alloaromadendrene with percentage peak area of 12.24%. Other compounds were, 1-4(4-pyrimidine-2-yl) piperazin-1-yl peropane-1-one, with the perdcentage area of 8.31%, 2,5- dimethyl-3-methylene,1,5-hexadiene percentage area (7.66%). 11,-(2-cyclopentene-1-yl undecanoic acid (+) percentage area 3.99%. 1,6,10,-dodecatriene,-7,11-dimethyl-3-methylene, percentage area of (3.4%). Bicyclo[5.1.0] octane, 8-(1-methylthyliine)-. percentage peak area 2.31%. Docosa-8,14-dyn-1,2,2-diol (Z)- 2Tms derivatives percentage peak area 2.47%, Polygaliitol, percentage peak area 2.61%.

Table 1. Phytochemical constituents of*A. leiocarpus*gum extracts identified by GC-MS analysis

Peak	Compound Names	Molecular Formular	Molecular Weight g/mol	Retention Time	% Area
1	11,-(2-cyclopentene-1-y-undecanoic Acid (+)-	$C_{16}H_{28}O_2$	252.39	56.208	3.99
2	1,6,10-Dodecatriene,7,11-dimetyhl-3-methylene	$C_{16}H_{28}$	204.35	77.457	3.46
3	Bicyclo[5.1.0]octane,8(1methylethyl idene	$C_{11}H_{18}$	150.265	78.263	2.31
4	2,5-dimethyl-3-methylene 1,5-hexadiene	C_9OH_4	122.207	78.739	7.66
5	1-4-(4-pyridine-2-y)Piperazin -1-yl prpane-1-one	$C_4OH_{10}N_2$	86.138	79.069	8.31
6	Carbamodithioic acid, formyl Methyl ester	$C_{11}OH_{12}N_2S_2$	236.356	82.293	1.33
7	Alloaromdendrene	$C_{15}H_{24}$	204.357	83.648	12.24
8	Arachidonic acid TMS derivat ives.	$C_{20}H_{32}O_2$	304.466	84.381	1.21
9	Docosa-8,14-dyn-1,22-diol (Z) -, 2TMS derivative	$C_{28}H_{54}O_2SI_2$	478	84.784	2,47
10	Polygallitol	$C_6H_{12}O_5$	164.157	85.297	2.61
11	2-amino-4-(2-methylpropenyl Pyrimidine-5 carboxylic acid	$C_6H_9N_3O_2$	155.157	85.297	2.61
12	1H-3a,7methanoazuline octa Hydro-1,4,99, tetra methyl	$C_{15}H_{26}$	206.37	85.76	14.31
13	8-methyl-1-6 –nonenoic acid	$C_{10}H_{18}O_2$	170.252	86.725	3.82
14	Morpholine,4-methyl-4,oxide	$C_6H_{11}NO_2$	117.148	87.165	1.46

Results of antibacterial properties

Results of antibacterial properties of the gum extracts showed that, the test organisms were significantly ($P \leq 0.05$) affected by extracts and concentrations. The result is presented in Table (2, 3, 4 and 5). Results showed that, chloroform extracts have significant effect on*E. coli*, *P. aeruginosa*, and *S. aureus*respectively,followed by the remaining gum extracts, aqueous extracts gave significant effect in *S. pneumoniae*. On the effect of concentrations, the control disc recorded significantly the highest effect in all the test organisms followed by concentration of 5000µg/disc of the crude extract (Table 2) The results also indicated significant increase in activity with every increase in the concentration of the extracts. Interaction of extract and concentration was significant in *P. aeruginosa*, *S. aureus*, and *P. pneumonia* (Table 3, 4, 5), from the results of interaction it showed that control disc significantly recorded the highest activity in all the test organisms followed by the chloroform and pet-ether extracts at 5000µg/disc in *P. aeruginosa* and *S. aureus*(Tables 3 and 4). Similarly aqueous extracts also gave significantly high activity in *S. pneumonia*, followed by ethanolic and chloroform extracts (Table 4).

Table 2. Antibacterial activity of gum exudate of *Anogeiossusleiocarpus*against some Bacterial Isolates

Treatment	Test organisms/Zone of inhibition (mm) *E. coli*	*P. aeruginosa*	*S. aureus*	*S. pneumoniae*
Exracts (E)				
Aqueous	12.42^{ab}	10.68^{b}	10.41^{b}	13.55^{a}
Chloroform	13.43^{a}	13.34^{a}	11.44^{a}	11.88^{b}
Ethanol	13.36^{a}	10.55^{b}	10.41^{b}	12.33^{b}
Pet-ether	11.21^{b}	10.11^{b}	11.48^{a}	11.75^{b}
S.E ±	0.462	0.295	0.300	0.217
Concentrations (µgml)				
Control disc µg/disc	32.03^{a}	26.33^{a}	28.07^{a}	30.40^{a}
1000	6.26^{d}	6.25^{d}	6.00^{c}	6.00^{e}
2000	7.08^{cd}	6.79^{cd}	6.00^{c}	7.10^{d}
3000	8.03^{c}	7.59^{c}	6.55^{c}	8.00^{c}
5000	9.61^{b}	8.88^{b}	8.07^{b}	10.39^{b}
S.E ±	0.516	0.330	0.336	0.242
Interaction	NS	*	*	*

Means sharing the same letter are not significantly different ($p<0.05$)

Table 3. Interaction on the effect of gum extracts and concentration of *A. leiocarpus* on growth inhibition (mm) of *P. aeruginosa* Concentrations µg/disc

Extracts	30µg/disc	1000	2000	3000	5000	
Aqueous	26.33^{a}	6.00^{e}	6.00^{e}	7.00^{e}	8.07^{de}	
Chloroform	26.33^{a}	7.00^{e}	9.17^{cd}	11.03^{c}	13.17^{b}	
Ethanol	26.33^{a}	6.00^{e}	6.00^{e}	6.33^{e}	8.07^{de}	
Pet- ether	26.33^{a}	6.00^{e}	6.00^{e}	6.00^{e}	6.20^{e}	
S.E ±	0.661					

Note: Means sharing the same letter are not significantly different ($p<0.05$)

Table 4. Interaction of the effect of gum extracts and concentration of *A. leiocarpus* on growth inhibition (mm) of *S. aureus*

Extracts	Concentration µg/disc 30µg/disc	1000	2000	3000	5000	
Aqueous	28.07^{a}	6.00^{c}	6.00^{c}	6.00^{c}	6.00^{c}	
Chloroform	28.07^{a}	6.00^{c}	7.10^{c}	7.10^{b}	10.03^{b}	
Ethanol	28.07^{a}	6.00^{c}	6.00^{c}	6.00^{c}	6.00^{c}	
Pet- ether	28.07^{a}	6.00^{c}	7.10^{c}	7.10^{c}	10.23^{b}	
S.E ±	0.672					

Means sharing the same letter are not significantly different ($p<0.05$)

Table 5. Interaction of the effect of gum extracts and concentrations of *A. leiocarpus* on growth inhibition (mm) of *S. pneumoniae*

Extracts	Concentration µg/disc 30µg/disc	1000	2000	3000	5000	
Aqueous	30.00^{a}	6.00^{f}	9.33^{cd}	10.00^{c}	12.00^{b}	
Chloroform	30.00^{a}	6.00^{f}	6.00^{f}	7.00^{ef}	10.00^{c}	
Ethanol	30.00^{a}	6.00^{f}	7.07^{ef}	8.00^{de}	10.20^{c}	
Pet- ether	30.00^{a}	6.00^{f}	7.00^{ef}	7.00^{ef}	9.37^{cd}	
S.E ±	0.485					

Means sharing the same letter are not significantly different ($p<0.05$)

DISCUSSION

In this study GCMS of the ethanolic extracts of *A. leiocarpus*showed the presence of various bioactive compounds. Some of these compounds have been reported to have biological activities such as antibacterial, anti-inflammatory, antioxidant, antifungal, anti-insecticidal, anticonvulsant, pesticidal and analgesic activity (Sunil and Pawar 2017). In *Anogeissusleiocarpus*GCMS analysis showed 13 peaks indicating 13 compounds identified. From these compounds, 1Ha-3a-methoazuline- octahydro was the compound with highest percentage peak area (14.31%). This compound also known as pachulane, is an essential oil reported to exhibit antimicrobial properties against *P. aeruginosa, Bacillus subtilis*and fungi*Fusariumoxysporum* (Abdurrazaq*et al.,* 2018). Arachidonic acid was also detected in this plant material, it is one of the polyunsaturated fatty acids and also a carboxylic acid with a 20- carbon chain and four Cis-double bond . Arachidonic acid has also been investigated for antibacterial activity against oral pathogens *streptococcus mutants, Candida albicans, Aggratibacter, Fusabacteriumnucleatum*and*Porphyromonasgingivalis*,as the fatty acid and its esters exhibited strong antimicrobial against these microorganisms, demonstrating some specificicty for individual microbial species (Chifu*et al.,* 2011). The compound Alloaromadendrene was the second with high percentage peak area of 12%. Alloaromadendrene is a sesquiterpene a constituents of essential oil of some plant species, the compound was also reported to have been evaluated for antimicrobial activity against four Bacteria pathogenic fungi and exhibited good activity against *S. aureus, S. epidermis Pseudomonasaeruginosa.* (Minama*et al.,* 2007). Nononaic acid was also identified in the analysis, it is also a major constituent of nonanal essential oil. In the medicinal field essential oils have been used to treat acute and chronic bronchitis and acute sinusitis. Essential oil are known to possess antimicrobial activity which has been evaluated mainly in liquid medium (Inouye *et al.,* 2011). Nonenoic acid was reported to exhibit varied antimicrobial activity against gram positive but remarkable inhibitory effect were observed against *C. utilis*and *S. lutea* (Nurett*et al.,* 2006). Carbamic acid was also identified with the formular H_2NCOOH. The attachment of the acid group to a nitrogen or amines (instead of carbon) distinguishes it from carboxylic acid and amides. The *in vitro* antimicrobial activity of the carbamate compound (Carbamodithioic acid and methyl ester) have been assessed against yeast like Fungi, Bacteria and Algae. The analysedcarbamates exhibited significant antimicrobial activity (Nilo and Marcos 2006).. Morpholine,4-methyl-4,oxide is another compound identified with biological activity, it is organic chemical compound having a chemical formular $O(CH_2\ CH_2)_2NH$, this heterocyclic structure feature both amine and ether functional group. It is used as anticorrosive, antioxidant and antimicrobial activity (Somashekar*et al.,* 2014).

Extracts of*Anogeissusleiocarpus,*gum was evaluated for antibacterial properties. From the results, it was generally observed that, many of the gum extracts had exhibited varying magnitude of inhibitory effect against the test organisms. However, results obtained from the study showed that the growth inhibition was significantly higher at the concentration of 5000µg/ml and 3000 µg/ml. Therefore, there was significant increase in inhibitory effect with every increase in the concentrations of the gum extracts, this actually supports the report by Mann *et al.* (2008) who reported that, the higher the concentration of the plant extract the greater the zone of inhibition. It was also observed from the result that, the zone of inhibition varied, and according to Presscot (2002), the effect of bioactive agent varies with the target organism or species. Result also showed that the ethanolic and chloroform extracts were found to show significantly ($P \leq 0.05$) greater activity against the test microorganisms. This may be due to the better solubility of the bioactive compound in the gum samples. Thus, responsible for better antibacterial activity exhibited in the study. . Results also showed that, majority of the test organisms were resistant against the least concentrations (2000µg/ml and 1000µg/ml) of the gum extracts. This may be due to the fact that, the concentration may not be strong enough to cause inhibition. Various gum extracts have been reported to have antibacterial activity such as *Commiphorawighti* (gum) which has been tested *in-vitro* against gram positive and gram negative bacteria, namely *E. coli, S. aureus, K. pneumonia, E. faecalis, M. luteus, P. aeruginosa, S. tyhpi, B. subtilis*and *B. cereus* (Ishnava*et al.,* 2010). Gum exudates of *Pycanthusangolensis,* has also been reported for antibacterial activity against *S. aureus. S. pyrogenes, E. coli* and *P. aeruginosa* (Onwukaeme*et al.,* 2007). Alcoholic and aqueous extracts of *Acacia* gum are reported also to inhibit growth of *S. aureus, S. epidermis, S. pneumonia, P. aeruginosa, Salmonella typhi, Proteus merabilis. E. coli, Candida albicans,* and *Aspergillusniger*(Sakshi*et al.,* 2015).The antibacterial activity exhibited by the plant gum exudates studied, was an indication of their susceptibility to the plant exudates. The activity exhibited may be due to the presence of some bioactive compounds known to have inhibitory effect against the test microorganisms. The zones of inhibition produced by the control antibiotic (Amoxicilline 30µg/disc) was greater than the crude extracts of the plant material. This may be because it is an industrially refined product.

Conclusion

In conclusion, GC-MS analysis andantibacterial properties of gum exudates of *Anogeissussleiocarpus* have been investigated.From the results of this study, it is revealed that various bioactive compounds with varying degree of

biological activity were found present in the gum exudates of the plants under study. Therefore, Presence of many phytochemicals in the gum exudates could justify the medicinal property of the plant material and in addition they can also be useful for the discovery of potent remedies on various diseases. The antibacterial evaluation of the gum exudates have shown that, the gum exudates had exhibited varying magnitude of activity against the test organisms. This activity may be due to the presence of some bioactive compounds in the extracts of the plant materials, and this justify the use of this plant bio polymer in traditional/alternative medicine.

Recommendation

- Isolation of individual phytochemical constituents and subjecting it to biological activity be carried out as it will give fruitful results.
- It is imperative to conduct more research on the antimicrobial of gum exudates, as there are scanty/scattered report/literature evaluating their antimicrobial potential leading to under estimation and sometime over expectation from gum and gum products in therapeutics. This will undoubtedly contribute immensely towards the development of drugs and health care delivery system.

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