Trop J Nat Prod Res, April 2021; 5(4):732-738

ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

Tropical Journal of Natural Product Research

Available online at https://www.tjnpr.org

Original Research Article

Antimicrobial Activity and Phytochemical Analysis of Some Selected Plants against Clinical Pathogens

Comfort O. Bamigboye[1]*, Ifeoluwa O. Fatoki[1], Omolara F. Yakubu[2], Rasheed Biodun[1]

[1]*Microbiology Unit, Department of Pure and Applied Biology, Ladoke Akintola University of Technology, PMB 4000, Ogbomoso, Nigeria*
[2]*Department of Biochemistry, College of Science and Technology, Covenant University, PMB 1023, Canaan land, Ota Ogun State, Nigeria*

ARTICLE INFO

Article history:
Received 25 August 2020
Revised 20 March 2021
Accepted 24 March 2021
Published online 03 May 2021

ABSTRACT

Plants have been used since ancient times, both as food and medicine, with different plant parts having different antimicrobial potency. This study aimed at assessing the antimicrobial potentials of different metabolites contained in the leaves of *Momordica charantia*, *Nicotiana tabacum*, *Ocimum gratissimum*, and *Calotropis procera* against clinical isolates. The isolates tested were *Escherichia coli*, *Pseudomonas aureginosa*, *Staphylococcus aureus*, *Proteus mirabilis*, *Klebsiella pneumoniae*, and *Candida albicans*. Selected extracts were analyzed for their phytochemical contents and further with Gas chromatography-mass spectrometry (GC-MS). The methanol extracts of *M. charantia*, *N. tabacum*, and *O. gratissimum* were effective against the clinical isolates. In contrast, the isolates were resistant to the methanol extract of *C. procera* and the water extracts of all plants under study. Methanol extracts of *M. charantia*, *N. tabacum*, *and O. gratissimum* contained anthocyanins. The GC-MS analysis revealed the presence of 1-methyl-2-phenylbenzylmidazole, 4-phenyl-pyridopyrimidine in *M. charantia*, tetradecamethyl cycloheptasiloxane in *N. tabacum*, and 3,4-dimethoxycinnamic acid in *O. gratissimum*. It was concluded that leaves of *M. charantia*, *N. tabacum*, and *O. gratissimum* could be explored for pharmaceutical applications.

Keywords: Antimicrobial, Gas Chromatography-Mass Spectrometry, *Momordica charantia*, *Nicotiana tabacum*, Phytochemical.

Introduction

Plants are naturally rich sources of bioactive molecules and phytochemicals used to augment human fitness with limited side effects[1]. More than one-tenth of all plant species have found applications in cosmeceutical or pharmaceutical industries.[2] Different plant types such as climbers, aromatic plants, and trees are exploited as sources of biopharmaceutical products for treating infections[3]. Plants are rich in volatile oils, often referred to as essential oils, and these are found in the seeds, stems, leaves, or flowers and twigs. These essential oils are usually biologically active as antioxidants and antimicrobials.[4,5] Besides, plants contain phytochemicals, chiefly saponins, flavonoids, terpenoids, polysaccharides, tannins, alkaloids, and steroids that contribute to their biological activities.[6,7] Natural products can be exploited as a source of novel biomolecules, separated into bioactive fractions using different polar solvents.[8]Different medicinal plants and plant parts have been found to possess antimicrobial properties. *Nicotiana tabacum* commonly referred to as tobacco is a cash crop that is cultivated on a large scale worldwide.[9] The plant is utilized in the management of cancer, cough, ulcer, and respiratory tract infections.[10] Popova *et al* determined the bioactive constituents in seeds of *N. tabacum*, [11] while Al-Lahham et al. used organic extracts of the root of *N. tabacum* for antimicrobial, cytotoxic, and antioxidant studies. [2] The antiparasitic activities of leaf extract of N. tabacum were determined in a previous study.[12]

*Corresponding author. E mail: coadegunlola@lautech.edu.ng.
Tel: +234-703-106-8220

Citation: Bamigboye CO, Fatoki IO, Yakubu OF, Biodun R. Antimicrobial Activity and Phytochemical Analysis of Some Selected Plants against Clinical Pathogens. Trop J Nat Prod Res. 2021; 5(4):732-738. doi.org/10.26538/tjnpr/v5i4.22

Official Journal of Natural Product Research Group, Faculty of Pharmacy, University of Benin, Benin City, Nigeria.

Momordica charantia commonly referred to as bitter gourd or bitter melon is a climber found distributed in Asia, Australia, and Africa. Its fruits, leaves, and seeds are used singly or combined for the management of rheumatism, liver diseases, pile, jaundice, and leprosy. [13] Zubair et al evaluated the chemical compositions of *M. charantia* seed oil. They discovered that the oil is suitable for soap making.[14] *Ocimum gratissimum* (commonly known as Clove basil) is commonly found in the tropics, including Africa, South-East Asia, and South America. It is used to spice up food or eaten fresh without cooking it. In traditional medicine, it is used to cure diabetes, urinary tract and respiratory infections, skin diseases, and fever.[15] A number of research has confirmed its use as an antioxidant, antibacterial and antinociceptive[15]. Many people rely on herbs, their leaves, roots, and or seeds for treating bacterial infections randomly. However, knowledge of the specific pathogenic infections that these herbs can cure and the phytoconstituents responsible for these activities are also necessary. Additionally, some researches have demonstrated the antibacterial efficacy of these plants however, there is a need to continually monitor the effectiveness of plant extracts as helpful antimicrobial agents due to the development of resistance against existing drugs.[16] Therefore, this study investigates the phytochemical constituents and antibacterial effect of aqueous and methanol extracts of *Momordica charantia*, *Nicotiana tabacum*, *Ocimum gratissimum*, and *Calotropis procera* against some clinical isolates

Materials and Methods

Plant Materials

Fresh leaves of *Momordica charantia* Descourt, *Nicotiana tabacum* Linn, *Ocimum gratissimum* Linn, and *Calotropis procera* (Aiton) Dryand were locally sourced in August, 2018. The plants were identified and authenticated by Prof A.T.J. Ogunkunle of the Department of Pure and Applied Biology, Ladoke Akintola University of Technology, Ogbomoso. The specimen was deposited in the

Herbarium Unit of the Department of Pure and Biology, LAUTECH-Ogbomoso. The Voucher number given to each of the specimens are *Momordica charantia* Descourt LHO 551, *Nicotiana tabacum* Linn LHO 552, *Ocimum gratissimum* Linn, LHO 553 and *Calotropis procera* (Aiton) Dryand LHO 554.

Preparation of plant extracts
The leaves were plucked neatly and kept in an air-tight polythene bag for transportation to the laboratory. The leaves were carefully washed under running tap water, while leaves with larger surface areas underwent surface sterilization.[17] The plant materials were weighed using a weighing balance, ground using a neat mortal and pestle and collected in washed and sterile beakers. The preparation of methanol and aqueous plant extract was completed using the methods previously described.[17,18] Briefly, 50 g of the fresh ground leaves were separately soaked in each of the solvents (plant material to solvent ratio was 1:10 w/v for methanol and 1:2 w/v for water) and extracted for 24 hours at 30 ^{o}C, decanted, filtered using a Whatman filter paper and left to air dry. Precisely 20 mg/mL solution of water and methanol extracts were prepared and filtered using sterile 0.20 µm Cellulose Acetate Membrane Syringe Filters. This solution was further used for phytochemical and GC-MS analysis.

Preparation of Sensitivity Discs
Whatman filter paper was divided into discs of 40 mm in diameter and sterilized in a glass petri dish in a hot air oven at 120 ^{o}C for 2 hours. A 2 mL solution of each extract was aseptically introduced using sterile 2 mL syringes into a sterile petri dish containing the discs. The petri dish was subsequently placed in a hot air oven at 37^{o}C for 10 minutes to ensure absorption of the crude extracts.

Collection and Maintenance of Test Organisms
Pathogenic isolates of *Escherichia coli, Pseudomonas aureginosa*, *Staphylococcus aureus*, *Proteus mirabilis*, *Klebsiella pneumoniae*, and *Candida albicans* previously confirmed to be antibiotic-resistant strains were obtained from a hospital in Ogbomoso. The isolates were maintained on nutrient agar slants by incubating for 24 hours at a temperature range of 35-37 ^{o}C throughout the experiment.

Antimicrobial activity of extracts
The antimicrobial activity of both aqueous and methanol extracts of *Momordica charantia, Nicotiana tabacum, Ocimum gratissimum,* and *Calotropis procera* was carried out in triplicates using the disc diffusion method.[19]

Phytochemical analysis
The methanol extract of *Momordica charantia, Nicotiana tabacum, and Ocimum gratissimum* was exposed to preliminary phytochemical analysis to determine the specific phytoconstituents present in each plant such as phenols, tannins, terpenoids, flavonoids, anthocyanins, glycosides, alkaloids, and saponins using standard procedures.[20,21] The selection of these three plants for further analysis was based on the sensitivity of the isolates in the antimicrobial result.

Gas chromatography-mass spectrometry analysis
The GC-MS analysis of the plant extracts showing antimicrobial activity was carried out by using Agilent 19091S Gas chromatograph (GC) connected to a mass spectrometer 433HP-5MS instrument using the following conditions: silica capillary column fused with 100% phenyl methyl siloxane (length; 30 m x 250 µm; film thickness 0.25 µm). An electron ionization system with ionization energy of 70 eV was used. Approximately 99.999% of Helium gas was employed as the carrier gas at a constant flow rate of 1.5 ml/min, and an injection volume of 1 µl was used (Split ratio of 50:1). The injector temperature was set as -300^{o}C, with an average velocity of 45.67 cm/sec. The oven temperature was set at 100^{o}C (Isothermal for 4 min.) with a gradual increase by 4^{o}C per minute up to 240^{o}C. The total running time for the GC was 37, 38, and 37 minutes respectively.
The relative abundance of each constituent (%) was estimated by relating its average peak area with the total area. The software referred to as turbo mass was used to handle mass spectra and chromatograms. The detection and identification of the components were carried out by employing the NIST Ver. 2.0 the year 2009 library, by using the spectra as described.22

Results and Discussion

Antimicrobial Testing Results
The aqueous and methanol extracts of the leaves of *Momordica charantia, Nicotiana tabacum, Ocimum gratissimum, and Calotropis procera* were screened for their antibacterial activity against pathogenic isolates of *E. coli*, *P. aeruginosa*, *S. aureus*, *P. mirabilis*, *K. pneumoniae*, and *C. albicans*. The methanol extracts of *Nicotiana tabacum*, *Momordica charantia*, and *Ocimum gratissimum* showed inhibitory activity against some isolates. In contrast, all the isolates were resistant to the shrubs' aqueous extracts, likewise the methanol extract of *Calotropis procera*. *Escherichia coli, Pseudomonas aeruginosa, Proteus mirabilis, Staphylococcus aureus,* and *Candida albicans* were sensitive to the methanol extracts of *Nicotiana tabacum* and *Momordica charantia*. At the same time, *Klebsiella pneumoniae* was sensitive to the methanol extract of *Nicotiana tabacum.* The results of the antimicrobial susceptibility test of the extracts using disc diffusion method are presented in Table 1.
The antibacterial activity of the water and methanol extracts of *Nicotiana tabacum, Momordica charantia, Ocimum gratissimum*, and *Calotropis procera* against pathogenic isolates of *Escherichia coli, Klebsiella pneumoniae, Staphylococcus aureus, Proteus mirabilis, Pseudomonas aeruginosa,* and *Candida albicans* was demonstrated. The six clinical isolates used in this research are leading causes of various infectious diseases in this part of the world. The methanol extract of *Nicotiana tabacum* effectively inhibited all the isolates, while the methanol extract of *Momordica charantia* only inhibited the growth of *Escherichia coli, Staphylococcus aureus, Proteus mirabilis* and *Pseudomonas aeruginosa.* However, the bacterial isolates were resistant to the water extracts of all the plants used in this study. It is possible that the bioactive components of these plants are not water-soluble, hence the inactivity.
The methanol extract of *Nicotiana tabacum* effectively inhibited *Pseudomonas aeruginosa* and *Staphylococcus aureus* by 50 and 40 mm, respectively. Simultaneously, it was least effective against *Klebsiella pneumoniae* with a zone of inhibition of 20 mm. Similar antimicrobial activity of different extracts of *Nicotiana tabacum* against *Staphylococcus aureus* and *Proteus mirabilis* has been reported.[23] In an earlier study, the methanol extract of the stem of *Nicotiana tabacum* effectively inhibited the growth of *Pseudomonas aeruginosa*.[24] The zone of inhibition of *Nicotiana tabacum* against *Candida albicans* was 50 mm, which concurs with the result of [25] where ethanol fraction was used. The range of activity of *N. tabacum* is broad, and its leaf extract has been used as a control agent against *Plutella xylostella* (Diamondback moth) and *Grapholita molesta* (Oriental fruit moth), which have proven resistant to pesticides in time past.[26] Antimicrobial activity of *N. tabacum* can be partly attributed to the presence of phenolics as previously established.[15]
Momordica charantia demonstrated considerable activity against five isolates out of the six pathogens studied, with *K. pneumoniae* showing resistance to the plant extract. As shown in Table 2, *Proteus mirabilis* showed the most minor zone of inhibition, measuring 10 mm. Potent antibacterial activity of *M. charantia* against *Klebsiella pneumoniae, Pseudomonas aeruginosa,* and *Escherichia coli* have been reported.[27] In a previous study, the leaf extract of *Momordica charantia* at 20 mg/mL inhibited clinical isolates of *Staphylococcus aureus, Klebsiella pneumoniae, Shigella dysenteriae,* and *Salmonella typhi*. [28] In another report, the use of 10 mg/ml of fruit extracts of wild *Momordica charantia* had no antibacterial effect on *Pseudomonas aeruginosa, Staphylococcus aureus,* and *Escherichia coli*.[29] Interestingly, ethanolic extract of wild *Momordica charantia* at 3 mg/ml gave notable zones of inhibition for *Escherichia coli* (22 mm), *Staphylococcus aureus* (18 mm), and *Candida albicans* (20 mm).[29] The methanol extract of leaves of *Momordica charantia* was also reported for its antimicrobial activity against *Escherichia coli* and *Klebsiella pneumoniae*.[30] The consistent inhibitory activity of this plant confirms that it has good potentials for exploration as a source of bioactive constituents.

ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

The methanol extract of *O. gratissimum* was able to inhibit *S. aureus*, *P. aeruginosa*, *E. coli*, and *P. mirabilis*. No activity was noticed against *K. pneumoniae* and *C. albicans*. The essential oil of *O. gratissimum* showed antibacterial activity against *S. aureus*, *P. aeruginosa*, and *E. coli*.[31] In another study[15], *S. typhimurium*, *S. aureus*, *E. coli*, and *S. flexneri* were inhibited by using less than 5 mg/ml of the essential oil from *O. gratissimum.*

Phytochemical analysis

The result of the extracts' phytochemical analysis confirmed the presence or absence of some phytochemicals, as shown in Table 2. *Calotropis procera* had no antibacterial effect, therefore, its phytochemical constituents were not determined. *M. charantia* contains saponins, anthocyanins, betacyanins, and coumarin, while *N. tabacum* is presented with tannins, saponins, flavonoids, anthocyanins, and phenols. *O. gratissimum* contains flavonoids, anthocyanins, betacyanins, and coumarin. It was discovered that anthocyanin was present in the three plant extracts. Interestingly in this study, only *N. tabacum* contained tannins and phenols. Tannins have been associated with antimicrobial properties, mainly resulting from the hydrolysis of an ester bond. Flavonoids present in *N. tabacum* and *O.gratissimum* have been shown to bind to bacteria's cell wall by forming a complex with specific proteins. They can also initiate membrane rupture of some bacteria.[32] The presence of essential oils as a part of the phytoconstituents in *N. tabacum*, *O. gratissimum*, and *M. charantia* may be partly responsible for the inactivity of the water extracts since oils are hydrophobic.[32,33]

Gas chromatography-mass spectrometry

The chemical constituents in the extracts of *Momordica charantia, Nicotiana tabacum, and Ocimum gratissimum* based on GC-MS analysis are presented in Figures 1, 2 and 3, and Tables 3, 4, and 5, respectively. Some phytoconstituents present in *M. charantia* as confirmed by GC-MS assay are 1-methyl-2-phenylbenzylmidazole, 4-pheny l- pyridopyrimidine, cycloheptasiloxane, hexadecamethyl-cyclooctasiloxane, and 1, 1, 1, 5, 7, 7, 7 – Heptamethyl - 3, 3-bis (trimethylsiloxy) tetrasiloxane, all of which had antimicrobial properties. In the *N. tabacum* leaf extracts, cyclomethicone-7, Hexadecamethylcyclooctasiloxane, Octadecamethyl -cyclononasiloxane, Fumaric acid, and Tetradecamethylhexasiloxane were detected. On the other hand, *O. gratissimum*, 1H-indole, 1-methyl-2-phenyl, N-(Benzylidene)-3-nitrobenzohydra, 4-Bromo-N-(3-pyridylmethylene) - 5 -, 4 - (2-furfurylidenamino) -1, 5 - dimethyl-2-phenyl-, 5-Hexe-3-yn-2-ol, 3,5-triazine-2-carbonylhydrazide, 9,10-Anthracenedione-1,8-diethoxy, 1-Hexene, 3,3,4,4-tetrafluoro-6-iodo and thiosulfuric acid were detected. The methanol extract of *Nicotiana tabacum* analysed using the GCMS technique showed the presence of fifty-seven different compounds. Tetradecamethyl Cycloheptasiloxane is the most abundant compound been 27.113% of the total constituents of *Nicotiana tabacum*. The compound has antimicrobial, insecticidal, anti-inflammatory, antioxidant, dermatological, anticancer, and gastroprotective effects.[34] Other authors have previously confirmed the antifungal properties of tetradecamethyl Cycloheptasiloxane.[22] It is also reported to be responsible for the aroma of *Jasminum sambac* flower, which is used in the production of deodorants.[34] Nicotine, octadecadienoic acid, valeric acid and methyl stearate were detected in previous studies (Sulaiman et al., 2020). Cyclomethicone 7 is first reported as a component of *N. tabacum* in this study the second most abundant compound in both *Nicotiana tabacum* and *Momordica charantia* is Hexadecamethyl-cyclooctasiloxane. It is 3.938 and 6.248% of the total constituents and is renowned for its antimicrobial properties. The presence of this compound in *Allium sativum* (garlic) and *Ferula assa-foetida* (asafoetida) essential oils was also attributed to the ovicidal and larvicidal effects against West Nile Virus vectors. [35]

The third most abundant compound in *Nicotiana tabacum* is 1,1,1,5,7,7,7-Heptamethyl-3,3 bis(trimethylsiloxy)tetrasiloxane. It is 5.292% of the total constituents. It also exists in appreciable quantity in the leaves of *Physalis peruviana*, and the extract was effective than ampicillin and cephazolin against *S. aureus* and some antifungal activities.[36,37] It is also enriched with high antiradical scavenging activities.[38] Fifty out of the ninety-nine compounds in the methanol extract of *Momordica charantia* had either antimicrobial, antioxidant, anticancer properties, or a combination of any of the three. Tetradecamethyl Cycloheptasiloxane, the most abundant compound of *Momordica charantia*, is 17.022% of its total constituents and is yet to be detected from *M. charantia*. It is a distinguished endocrine disrupter that can damage the immune and reproductive systems.[34] The third most abundant compound in *Momordica charantia*, Octadecamethyl-cyclononasiloxane, was reported to have antimicrobial and antioxidant effects.[39] Additionally, it is a central component of leaves of *Eclipta prostrata*. It was found to have antioxidant activity and antibacterial activity against *Salmonella typhi, Escherichia coli, Klebsiella pneumoniae, Staphylococcus aureus, Bacillus subtilis, and Pseudomonas aeruginosa*.[40] Another prominent compound in *Momordica charantia* is the decylpropargyl ester of Fumaric acid, which is 2.455% of its total constituent. It was reported as an anti-inflammatory and analgesic compound[41] and as an additive in the food processing industry.[22] Besides, it was reported as one of the compounds enhancing the antimicrobial effectiveness of Fumaric acid.[28] A previous study demonstrated that *M. charantia* seed essential oil contained limonene, linalool, myristecin, spathulenol, cedrol and apiole.[41] Another study showed that the seed essential oil contained 5-hydroxymethyl-2-(1-methyl-2-imidazolyl)-1H-benzimidazole.[42] This present study demonstrated that 4-phenyl-pyridopyrimidine is an essential in *M. charantia* leaf. GC-MS analysis of *O. gratissimum* leaf extract showed it contains 5-Hexe-3-yn-2-ol, 9,10-Anthracenedione-1,8-diethoxy, 3,5-triazine-2-carbonylhydrazide, Thiosulfuric acid and 1-hexene-3,3,4,4-tetrafluoro-6-iodo which have not been previously detected. Previous reports detected eugenol, cis-ocimene and germacrene-D from *O. gratissimum* from Nigeria, [43] while linalool, camphor, sabinene were some of the compounds detected in Indian species.[44]

Table 1: Antimicrobial testing of methanol extracts on isolates

Clinical isolates	*M. charantia*	*N. tabacum*	*O. gratissimum*	*C. procera*
S. aureus	20 ± 1.5mm	40 ±1.2mm	32 ± 1.8mm	-
P. aeruginosa	20 ± 1.2mm	50 ± 0.8mm	30 ± 1.1mm	-
E. coli	20 ± 0.6mm	40 ± 1.1mm	20 ± 0.7mm	-
K. pneumoniae	-	20 ± 1.3mm	-	-
P. mirabilis	10 ± 1.0mm	30 ± 1.2mm	25 ± 1.4mm	-
C. albicans	20 ± 0.9mm	50 ± 0.3mm	-	-

Table 2: Phytochemical analysis of methanol extracts

Phytochemicals	*M. charantia*	*N. tabacum*	*O. gratissimum*
Tannins	-	+	-
Saponins	+	+	-
Flavonoids	-	+	+
Alkaloids	-	-	-
Anthocyanins	+	+	+
Betacyanins	+	-	+
Glycosides	-	-	-
Terpenoids	-	-	-
Triterpenoids	-	-	-
Phenols	-	+	-
Coumarin	+	-	+

Absent: -- Present: +

ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

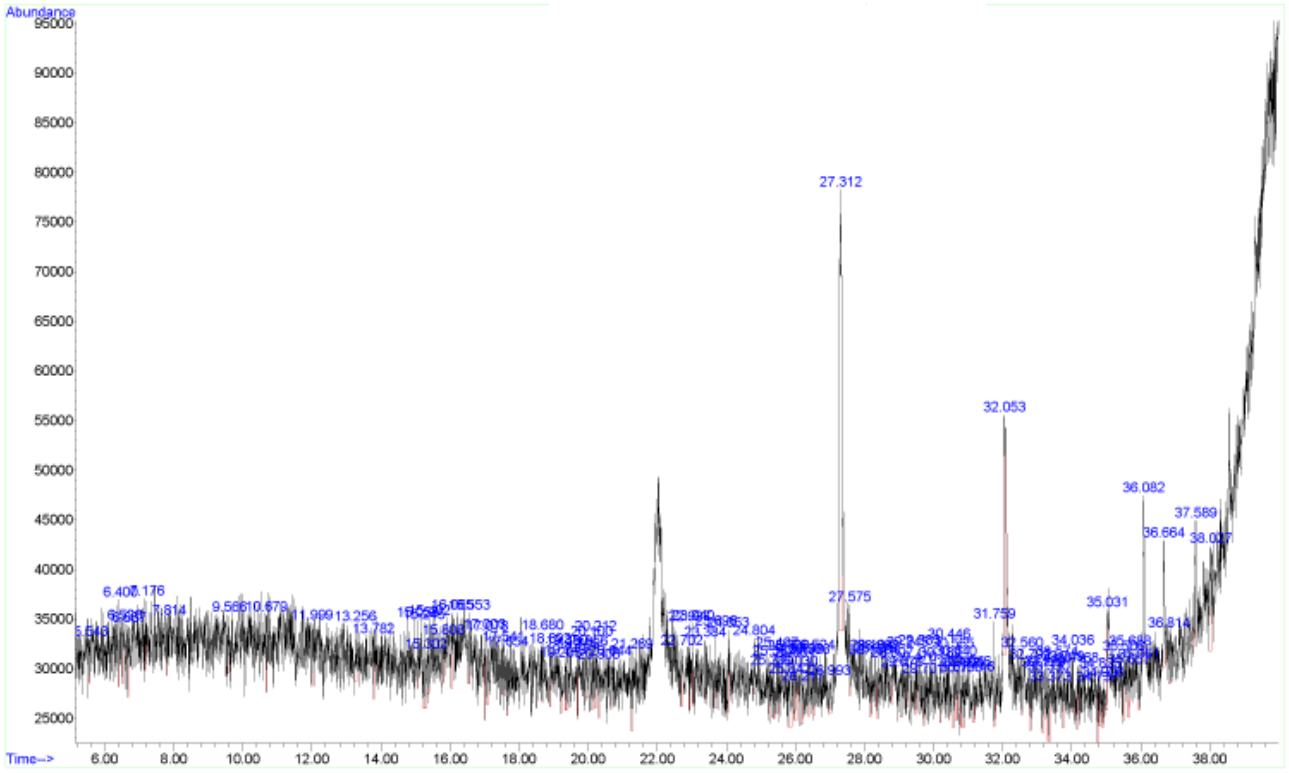

Figure 1: Chromatogram of Methanol Extract of *Momordica charantia* Showing Peak values of Constituent Compounds

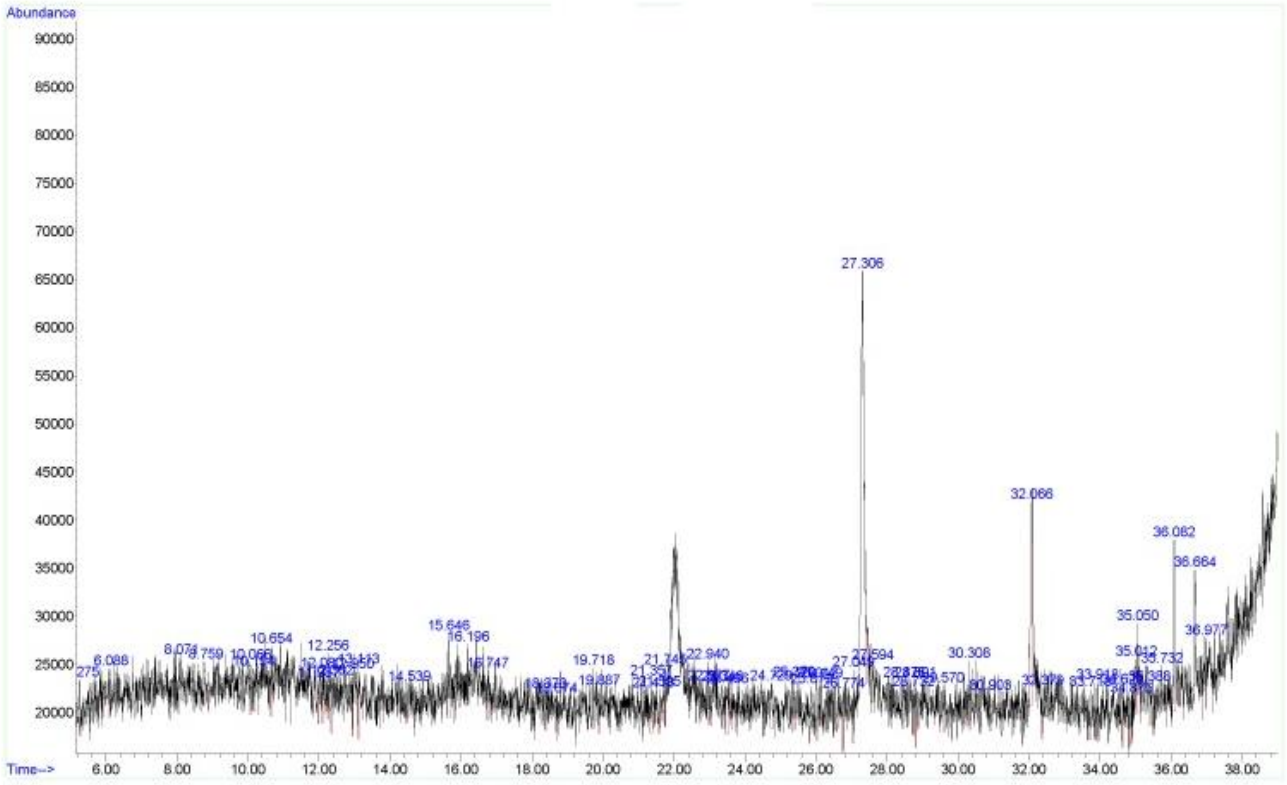

Figure 2: Chromatogram of Methanol Extract of *Nicotiana tabacum* Showing Peak Values of Constituent Compounds

ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

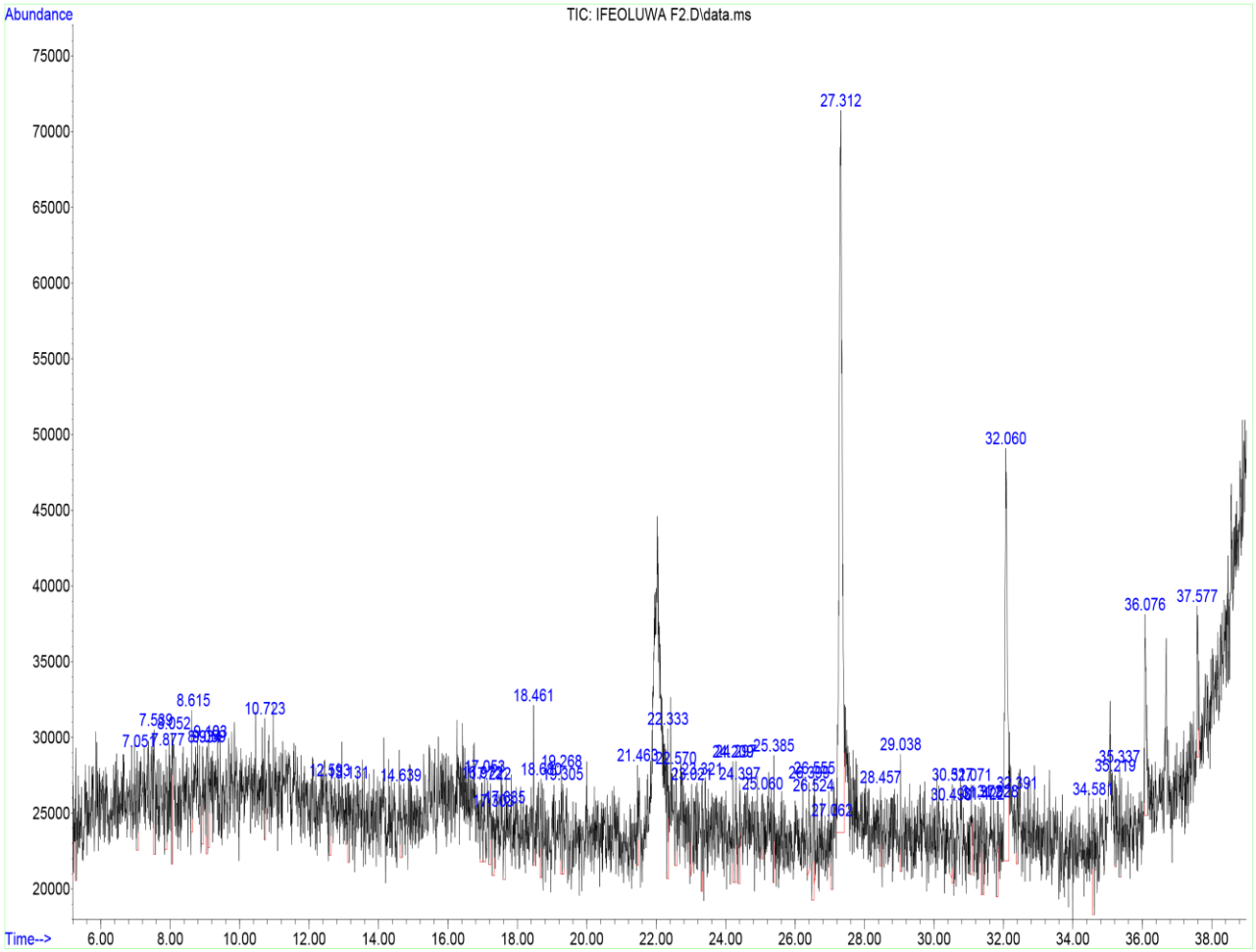

Figure 3: Chromatogram of methanol extract of *Ocimum gratissimum* showing peak values of constituent compounds

Table 3: Chemical constituents in the plant extracts of *Momordica charantia* based on GC-MS analysis

S/N	Retention Time (Minutes)	Compounds	Molecular Formula	Molecular Weight (g)	% of Total
1	15.646	1-Methyl-2-phenylbenzimidazole	$C_{14}H_{12}N_2$	208.264	1.721
2	23.496	4-phenyl-pyrido 2 3-d pyrimidine	$C_{13}H_9N_3$	207.236	1.562
3	27.306	Cycloheptasiloxane, tetradecamethyl	$C_{14}H_{42}O_7Si_7$	519.078	27.113
4	32.066	Hexadecamethyl-cyclooctasiloxane	$C_{16}H_{48}O_8Si_8$	593.238	6.248
5	36.082	1,1,1,5,7,7,7-Heptamethyl-3,3-bis(trimethylsiloxy)tetrasiloxane	$C_{13}H_{40}O_5Si_6$	533.149	5.292

Table 4: Chemical constituents in the plant extracts of *Nicotiana tabacum* based on GC-MS analysis

S/N	Retention Time (Minutes)	Compounds	Molecular Formula	Molecular Weight (g)	% of Total
1	27.312	Cyclomethicone 7	$C_{14}H_{42}O_7Si_7$	519.078	17.022
2	32.053	Hexadecamethylcyclooctasiloxane	$C_{16}H_{48}O_8Si_8$	593.232	3.938
3	36.082	Octadecamethyl-cyclononasiloxane	$C_{18}H_{54}O_9Si_9$	667.386	3.241
4	36.664	Fumaric acid, decylpropargyl ester	$C_{17}H_{26}O_4$	294.391	2.455
5	37.589	Tetradecamethylhexasiloxane	$C_{14}H_{42}O_5Si_6$	458.995	1.893

ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

Table 5: Chemical constituents in the plant extracts of *Ocimum gratissimum* based on GC-MS analysis

S/N	Retention Time (Minutes)	Compounds	Molecular Formula	Molecular Weight (g)	% of Total
1	7.877	1H-indole, 1-methyl-2-phenyl	$C_{15}H_{13}N$	207.276	1.356
2	8.052	N-(Benzylidene)-3-nitrobenzohydra	$C_9H_9N_3O_3$	207.189	1.301
3	8.934	4-Bromo-N-(3-pyridylmethylene)-5-	$C_7H_8BrNO_2S$	250.11	1.390
4	9.059	4-(2-furfurylidenamino)-1,5-dimethyl-2-phenyl-	$C_{18}H_{24}CIN_3O_2S$	381.919	1.237
5	10.723	5-Hexe-3-yn-2-ol	$C_6H_{18}O$	96.129	1.041
6	16.972	3,5-triazine-2-carbonylhydrazide	$H_3N_3O_2$	77.043	1.397
7	17.053	9,10-Anthracenedione-1,8-diethoxy	$C_{16}H_{122}O_4$	268.268	1.210
8	18.461	1-Hexene, 3,3,4,4-tetrafluoro-6-iodo	$C_{16}H_{16}N_4O_3S$	344.389	0.989
9	18.680	Thiosulfuric acid	$H_2S_20_3$	114.133	0.990

Conclusion

In this study, methanol extracts of leaves of *Nicotiana tabacum*, *Momordica charantia*, and *O. gratissimum* at 20 mg/ml possess antimicrobial properties against the selected clinical isolates. The extracts' GC-MS analysis confirmed that 4-phenyl-pyridopyrimidine, cyclomethicone-7 and 1-hexene-3,3,4,4-tetrafluoro-6-iodo are essential oils present in *M. charantia*, *N. tabacum* and *O. gratissimum* respectively, and were first reported in this study. These plants can be a potential source of biopharmaceuticals of natural origin.

Conflict of interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

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