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COVENANT JOURNAL OF PHYSICAL AND LIFE SCIENCES VOL. 13, NO. 1, JUNE 2025; DOI: XXX XXXX XXX

Antimicrobial Activity of Curry Leaf (*Murraya keonigii*) Extracts: An In-Vitro Study

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Received: 26.02.2025 **Accepted: 07.04.2025** **Published: 07.04.2025**

Curry leaves, scientifically referred to as *Murraya koenigii*, are well known for their aromatic taste in foods, but their antimicrobial potential has yet to be extensively studied. This study aimed to determine the antibacterial effect of curry leaf extracts against various microorganisms. The study involved the extraction of bioactive compounds from curry leaves using aqueous and ethanol solvents. Antimicrobial susceptibility testing was performed using agar well diffusion to establish the impact of the extracts on microbial isolates, including *Salmonella* sp, *Bacillus* sp, *Escherichia coli, Candida albicans,* and *Staphylococcus aureus.* Gas Chromatography-Mass Spectrometry (GC-MS) was used to analyse the extracts' chemical components. Although their effectiveness against microbiological isolates varied, it was shown that both ethanol and aqueous extracts have antibacterial properties. Inhibition against *Salmonella* sp., *Bacillus* sp., *Staphylococcus aureus, Candida albicans,* and *Escherichia coli,* the ethanol extract's Minimum Inhibitory Concentration (MIC) was 100 mg/ml, 25 mg/ml, 0, 100 mg/ml, and 100 mg/ml, respectively. The aqueous extract exhibited MIC values of 200 mg/mL against Bacillus sp. and Candida albicans, 25 mg/mL against Salmonella sp., and 12.5 mg/mL against *Escherichia coli*. As for *Staphylococcus aureus*, it was not inhibited. A minimum bactericidal concentration (MBC) of 50 mg/ml of ethanol extract was found for *Bacillus* sp, *Salmonella* sp, and 100 mg/ml for C*andida albicans*. Having no bactericidal effect against *Staphylococcus aureus*, the aqueous extract showed MBC of 200 mg/ml against *Bacillus* sp. and *Candida albicans*, 100 mg/ml against *Salmonella* sp., and 25 mg/ml against *Escherichia coli*. Compounds such as Hexadecanoic acid, Phytol, Octadecanoic acid among others were detected from the extracts. The study points to the therapeutic potential of curry leaves as natural antibacterials.

Keywords: *Murranya koenigii*, antimicrobial susceptibility, Gas Chromatography-Mass Spectrometry, Minimum Inhibitory Concentration, Minimum Bactericidal Concentration

1. INTRODUCTION

ENHANCED antibiotic resistance has called for the discovery of new therapeutic drugs from natural products. Medicinal plants have been a source of pharmacological activity, and *Murraya keonigi*i (curry leaf) is no exception. Curry leaves (*Murraya keonigii* (L.) have a slightly pungent taste [1]. Despite extensive traditional application, further scientific evidence is required for the antibacterial action of *Murraya keonigii*, particularly against infections caused by bacteria. They possess antidiabetic, antioxidant, antibacterial, antifungal, anti-inflammatory, anticarcinogenic, and hepatoprotective properties, among other medical attributes. Heart-related, cholesterol-reducing and anti-diabetic, antimicrobial, antiulcer, antioxidant, cytotoxic, antidiarrheal, and phagocytic activities are some of the numerous pharmacological actions of the plant [2].

The analytical method known as gas chromatography-mass spectrometry (GC-MS) identifies different chemicals in a sample under analysis by utilizing the advantages of both gas chromatography and mass spectrometry. Detection of drugs, environmental analysis, investigation of fires, explosion detection, and identification of samples are a few applications of GC-MS.

GC-MS can identify trace elements in materials which had lost the capability to be identified. It can detect and analyze infinitesimally small levels of a chemical, much beyond that of liquid chromatography-mass spectrometry [3]. Traditionally used in Asian cuisine and traditional medicinal plants, curry leaves have many bioactive compounds such as alkaloids, flavonoids, and terpenoids with reported antibacterial, antioxidant, and anti-inflammatory activities [4]. That is, there are natural chemical compounds in curry leaves that can have medical uses.

This research hopes to bridge this gap by exploring the antibacterial activity of curry leaf extracts using an in vitro approach. The results may lead the way for new plant-based antibacterial medicines, offering a natural and possibly efficacious alternative to synthetic drugs. The results of the research may also shed light on future applications of curry leaf extracts in medicine or food conservation.

2. MATERIALS AND METHODS

2.1. Collection and identification of plants

Plant material for *Murraya keonigii* was collected from the Madonna University dormitory farm in Rivers State, Nigeria's Elele campus. In the online version of Index Herbariorum, the plant was verified and the botanical identification of the plant at the Medicinal Plants Herbarium of the Department of Pharmacognosy, Faculty of Pharmacy, Obafemi Awolowo University, Ile-Ife (code: FPI 2472).

2.2. Isolation of active chemicals from plant extract

Fresh *Murraya keonigii* leaves were washed with distilled water after 14 days of air drying until crispy. The leaves were pounded with the mechanical processor. A total of 500 millilitres of ethanol (for ethanol extract) and 1280 millilitres of water (for the aqueous extract) were combined in separate Winchester containers with 300 grammes of powdered sample each. The maceration was allowed to run for 72 hours, after which the mixture was filtered to remove the marc from the extract. To stop the solvent from evaporating, the vessel's aperture was shut off. After passing through filter paper once again and being moved to a container, the filtrate was once more concentrated in water at 45 degrees Celsius. The extracts were weighed for computation. For both the ethanol and the aqueous solution, the extract was 7.8g and 4.6g, respectively. By following the method of Abbas et al. [5], the percentage yield of the extract was determined to be 2.6% for the ethanol extract and 1.53 % for the aqueous extract.

2.3 Serial Dilution Preparation

The 2-fold dilution technique was then used to serially dilute the two extracts. A total of two grams of ethanol and aqueous extracts were weighed into two different beakers and diluted in ten millilitres of dimethylsulfoxide (DMSO) to make a stock solution of 200 mg/ml concentration and the two-fold dilutions were made to obtain the other concentrations.

2.4. Standardization of test isolates

Time allocation of 24 and 72 hours before use, the isolates (*Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli*, *Salmonella* spp., and *Candida albicans*) were sub-cultured from stored agar slants to selected media (bacteria media) and Sabouraud Dextrose agar (general medium for fungi), respectively. Laboratory isolates were also validated through the use of biochemical testing. The appropriately labelled pure cultures were examined after being standardised to the inoculum size of 1.5×10^8 CFU/mL, or 0.5 McFarland standards. At 600 nm, the cells were diluted to 0.08–0.1 optical density using a spectrophotometer.
[6–9].

2.5. Antimicrobial Susceptibility Testing

The agar well diffusion method, also known as the punch-hole agar diffusion technique, was used to assess the bacterial isolates' susceptibility to the extracts. The isolates were carefully swabbed on the surface of the sterile Mueller-Hinton agar plates using their assigned swab sticks after the plates had been prepared. 50 cc of the extract was added to the holes that had been drilled in the solidified agar plates using a sterile cork borer that had an 8 mm diameter. To measure *Candida albicans* susceptibility, Mueller-Hinton supplementary agar was made using Mueller-Hinton agar and supplemented with 2% glucose and 0.5 g/ml methylene blue to stimulate fungal growth. The plates were swabbed with the fungal isolate. An 8 mm sterile conventional cork borer was used to drill wells around the plates at comparable intervals. A 50 ml amount of each extract concentration was aseptically added to each well on the agar plates. For half an hour, the extracts were allowed to spread out throughout the agar plates. After that, the inoculation plates were flipped over and given a full day to incubate. Each well's inhibition zone diameter (IZD) was determined using a well-calibrated meter rule [6–9].

2.6. Minimum Inhibitory Concentration (MIC) Determination

By using the agar dilution method, the minimum inhibitory concentration of ethanol extract and aqueous extract against the isolates was ascertained. The pour plate technique yielded six (6) agar plates. Six 19 ml bijou bottles of nutrient agar were autoclaved for this purpose. The liquid was shaken a bit before the agar was added to the Petri plates. With one millilitre of each corresponding extract strength, 20 millilitres were placed in bijou bottles to achieve the final volume. One of the four identical quadrants on the Petri plate was inoculated with the appropriate strain of bacteria. Mueller-Hinton supplement agar was utilized for MIC in *Candida albicans*. Plates were incubated overnight to establish growth [6–9].

2.7. Minimum Bactericidal/Fungicidal Concentration (MBC/MFC) determination

The plates of the MIC were incubated for 48 hours with an additional 24 hours. The MBC/MFC of the extract was the lowest concentration and showed no growth after 48 hours.

2.8. GC-MS method for determination of bioactive constituents

GC-MS analysis was performed under the following conditions using a Shimadzu GC-MS-QP 2010 Plus instrument and a gas chromatograph-mass spectrometer. Elite: Single capillary column (30 m x 0.25 mm, 1 D x L, 100% dimethyl polysiloxane) constituted by fused silica. A 70 eV ionisation energy was used in electron ionisation hardware. The carrier gas used was 99.99% helium gas with a two-litre injection volume and one-millilitre per minute injection rate. The injection temperature and ion source temperature were 280 degrees Celsius each. The preheating oven temperature used was 110 degrees Celsius. The relative percentage proportion of each element was aligned to the National Institute of Standards and Technology (NIST) collection data. [6-9]

2.9. Data Analysis

The experiment was repeated twice, and the findings were reported using the mean and standard error of the mean ($\bar{x}$±SEM). The findings were examined using the one-way ANOVA statistical approach to determine whether or not the mean zones of inhibition of extracts of different dosages against the isolates at the $p<0.05$ significance level differed statistically. A p-value of less than 0.05 was considered statistically significant, and the 95% confidence interval was employed as the significance metric. The statistical program utilised was GraphPad Prism 5.

3. RESULTS

3.1. Antibiotic Susceptibility of *Murraya koenigii* Extracts on the Test Isolates

The results presented in Figures 1 and 2 are distinct inhibition zones from the varying concentrations of aqueous and ethanol extracts of curry leaf against *Bacillus* sp., *Escherichia coli, Staphylococcus aureus, Salmonella* sp., and *Candida albicans*. The obtained inhibition zones as a mean of the experiment replicates with P values of 0.0874 and 0.0648 for aqueous and ethanol extracts, respectively. Where One-way ANOVA was used to compare columns, no difference could be detected horizontally.

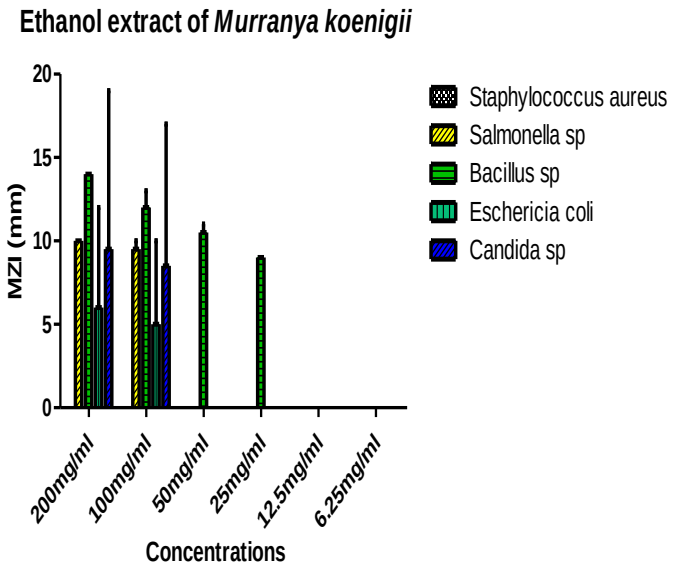

Figure 1: Antimicrobial Activity of Ethanol Extracts of *Murraya keonigii* against the Test Isolate

3.2. Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal/Fungicidal Concentration of Extracts on Isolates

The minimum inhibitory concentration (MIC) of ethanol extract of *Murranya koenigii* against *Escherichia coli, Candida albicans, and Salmonella typhi* was determined to be 100mg/ml and for *Bacillus* sp, it is 25mg/ml (Table 1). The minimum inhibitory concentration (MIC) of aqueous extract of *Murranya koenigii* against *Bacillus* sp, *and Candida albicans* was determined to be 200 mg/ml, and for *Salmonella typhi* it is 25mg/ml, *Escherichia coli* is 12.5mg/ml. The extract has no antimicrobial activity on *Staphylococcus aureus* (Table 1).

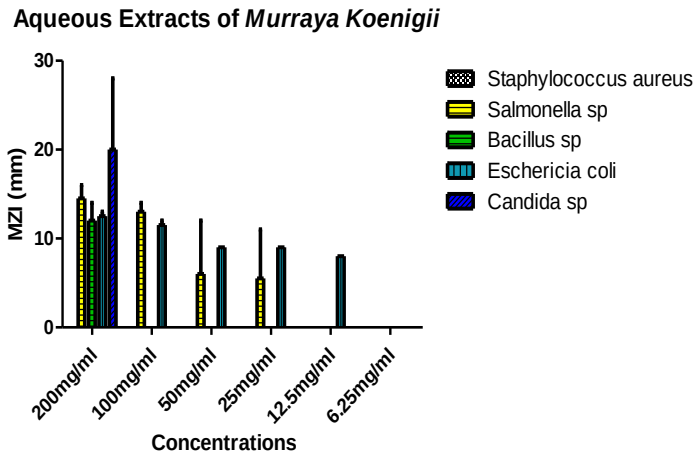

Figure 2: Antimicrobial Activity of Aqueous Extracts of *Murraya keonigii* against the Test Isolates

The MFC of ethanol extract of *Murranya koenigii* against *Candida albicans* was determined to be 200 mg/ml. The MBC of *Salmonella typhi* is 100mg/ml, *Bacillus* sp is 50mg/ml, and *Escherichia coli* is 12.5mg/ml. The results showed no bactericidal activity of the ethanol extracts against *Staphylococcus aureus and Escherichia coli* (Table 1).

The MBC/MFC of aqueous extract of *Murranya koenigii* against *Bacillus* sp *and Candida albicans* was determined to be 200mg/ml, *Salmonella typhi* is 100mg/ml, *Escherichia coli* is 25mg/ml. There was no bactericidal activity of the aqueous extracts on *Staphylococcus aureus* (Table 1).

Table 1: Minimum inhibitory concentration (MIC) and Minimum bactericidal/fungicidal concentrations (MBC/MFC) of the extracts of curry leaf (*Murraya keonigii)* on isolates

Isolates	MIC Extracts		MBC/MFC	
	Ethanol	**Aqueous**	**Ethanol**	**Aqueous**
Escherichia coli	100 mg/ml	12.5 mg/ml	-	25 mg/ml
Bacillus sp.	25 mg/ml	200 mg/ml	50 mg/ml	200 mg/ml
Salmonella typhi	100mg/ml	25 mg/ml	100 mg/ml	100 mg/ml
Staphylococcus aureus	-	-	-	-
Candida albicans	100 mg/ml	200 mg/ml	200 mg/ml	200 mg/ml

The tables presented represent the GCMS result for the aqueous extract (Table 2) and ethanol extract (Table 3) of curry leaf (*Murraya keonigii)* for this particular study. The individual components, retention time, molecular weight, and molecular formula were included. From the result, it can be deduced that the aqueous extract contains 22 photo-components and the ones that are abundant in this aqueous extract are Hexadecanoic acid, methyl ester (11.31%), 9-Octadecenoic acid, methyl ester, (E)-

(11.28%), Bis(2-ethylhexyl) phthalate (10.53%), Methyl stearate (10.20%) and 9-Heptadecanone (6.86%).

The ethanol extract contained 50 phyto-components and the abundant ones include Cyclotetrasiloxane, octamethyl- (26.01%), Cyclotrisiloxane, hexamethyl- (15.41%), and Cyclopentasiloxane, decamethyl- (10.62%).

In aqueous GCMS testing, it was revealed that certain constituents were present in greater concentrations than others. For example, hexadecanoic acid and methyl ester had the highest amount based on area percentage, claiming 11.31%, while methyl 6-cis,9-cis,11-trans-octadecatrienoate had the smallest amount, claiming 0.66% of the area. In the ethanol extract, the result indicates that the most area percentage occupied compound is cyclotetrasiloxane, octamethyl-, with 26.01%, and the lowest occupied values in area percentage are Tris (tert-butyldimethylsilyloxy)arsane and 4-tert-Octylphenol, TMS derivative one, with a value of only 0.15%.

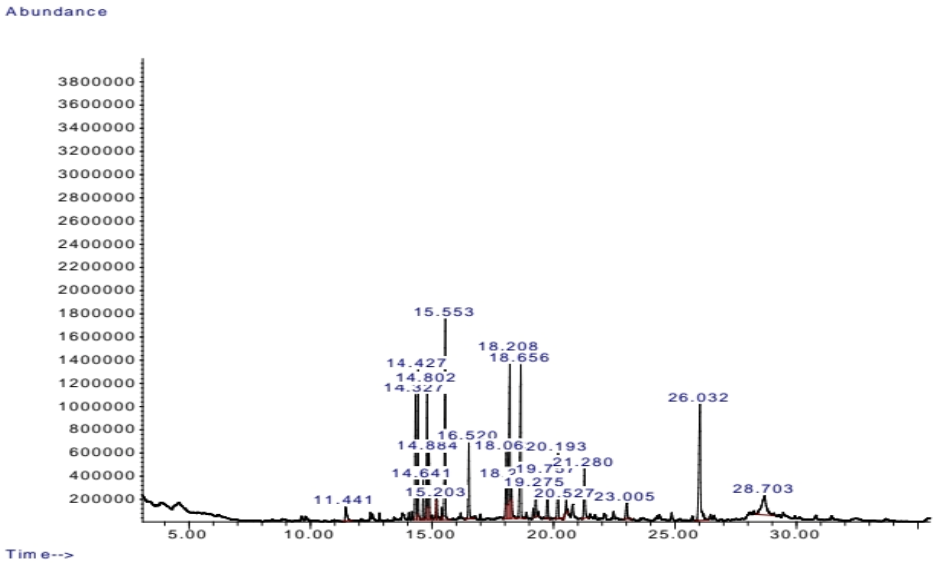

Figure 3: The Chromatogram of the bioactive compounds present in the aqueous extract of curry leaf

Table 2: GCMS result of Aqueous extract of curry leaf (*Murraya keonigii)*

Peak	Retention time (sec)	Area (%) PCT	Library/ID	Molecular weight (g/mol)	Molecular formula
1	11.441	1.33	Apiol	222.24	$C_{12}H_{14}O_4$
2	14.325	6.27	Bicyclo [3.1.1] heptane, 2,6,6-trimethyl	138.25	$C_{10}H_{18}$
3	14.428	6.62	2-Tridecanone	198.34	$C_{13}H_{26}O$
4	14.640	1.68	3,7,11,15-Tetramethyl-2-hexadecen-1-ol	296.5	$C_{20}H_{40}O$
5	14.800	6.86	9-Heptadecanone	254.5	$C_{17}H_{34}O$
6	14.886	2.94	Cyclopentane, 1-methyl-1-(2-methyl-2-propenyl)-	138.25	$C_{10}H_{18}$
7	15.178	1.04	2-Nonadecanone	282.5	$C_{19}H_{38}O$
8	15.200	0.90	(Z)-Methyl hexadec-11-enoate	268.4	$C_{17}H_{32}O_2$
9	15.555	11.31	Hexadecanoic acid, methyl ester	270.5	$C_{17}H_{34}O_2$
10	16.522	3.99	Hexadecanoic acid, ethyl ester	284.5	$C_{18}H_{36}O_2$
11	18.061	4.49	9,12-Octadecadienoic acid (Z, Z)-, methyl ester	294.5	$C_{19}H_{34}O_2$
12	18.210	11.28	9-Octadecenoic acid, methyl ester, (E)-	296.5	$C_{19}H_{36}O_2$
13	18.273	2.30	9-Octadecenoic acid (Z)-, methyl ester	296.5	$C_{19}H_{36}O_2$
14	18.656	10.20	Methyl stearate	298.5	$C_{19}H_{38}O_2$
15	19.274	1.49	(E)-9-Octadecenoic acid ethyl ester	310.5	$C_{20}H_{38}O_2$
16	19.755	2.60	Octadecanoic acid, ethyl ester	312.5	$C_{20}H_{40}O_2$
17	20.196	3.88	Phytol, acetate	338.6	$C_{22}H_{42}O_2$
18	20.528	0.66	Methyl 6-cis,9-cis,11-trans-octadecatrienoate	292.5	$C_{19}H_{32}O_2$
19	21.283	3.27	Methyl 6-cis,9-cis,11-trans-octadecatrienoate	292.5	$C_{19}H_{32}O_2$
20	23.005	1.41	Fumaric acid, trans-hex-3-enyl tri decyl ester	380.6	$C_{23}H_{40}O_4$
21	26.032	10.53	Bis(2-ethylhexyl) phthalate	390.6	$C_{24}H_{38}O_4$
22	28.704	4.96	Oxycodone	315.4	$C_{18}H_{21}NO_4$

Table 3: GCMS result of Ethanol extract of curry leaf (*Murraya keonigii*)

Peak	Retention time (sec)	Area PCT (%)	Library/ID	Molecular weight	Molecular formula
1	5.482	15.41	Cyclotrisiloxane, hexamethyl-	222.46	$C_6H_{18}O_3Si_3$
2	6.575	0.29	Silane, triethoxymethyl-	178.3	$C_7H_{18}O_3Si$
3	6.764	7.03	1H-Indole-2,3-dione, 7-methyl-	161.16	$C_9H_7NO_2$
4	7.027	1.69	Butanoic acid, hexyl ester	172.26	$C_{10}H_{20}O_2$
5	7.387	0.33	Pentasiloxane, dodecamethyl-	384.84	$C_{12}H_{36}O_4Si_5$
6	7.639	0.71	4'-Hydroxyacetophenone, TMS derivative	208.33	$C_{11}H_{16}O_2Si$
7	7.719	6.40	Benzaldehyde-para-carboxylic acid trimethylsilyl ester	222.31	$C_{11}H_{14}O_3Si$
8	7.828	1.73	2-(3-Methylphenyl) isoindole-1,3-dione	237.25	$C_{15}H_{11}NO_2$
9	8.165	2.09	Pentasiloxane, dodecamethyl-	384.84	$C_{12}H_{36}O_4Si_5$
10	8.240	0.19	Cyclotetrasiloxane, octamethyl-	296.61	$C_8H_{24}O_4Si_4$
11	8.314	26.01	Cyclotetrasiloxane, octamethyl-	296.61	$C_8H_{24}O_4Si_4$
12	8.560	0.18	Cyclotetrasiloxane, octamethyl-	296.61	$C_8H_{24}O_4Si_4$
13	8.789	3.18	Dibutoxy(dimethyl)silane	204.38	$C_{10}H_{24}O_2Si$
14	8.904	0.15	Cyclotetrasiloxane, octamethyl-	296.61	$C_8H_{24}O_4Si_4$
15	9.052	0.16	Cyclotrisiloxane, hexamethyl-	222.46	$C_6H_{18}O_3Si_3$
16	9.630	3.13	Benzofuran-2-one, 4-amino-2,3-dihydro-3,3-dimethyl-	177.2	$C_{10}H_{11}NO_2$
17	9.876	0.18	5-Methyl-2-phenylindolizine	207.27	$C_{15}H_{13}N$
18	9.991	0.15	Tris(tert-butyldimethylsilyloxy) arsane	468.7	$C_{18}H_{45}AsO_3Si_3$
19	10.117	0.25	3-(3-Hydroxyphenyl)-3-hydroxypropionic acid, ethyl ester, di-TMS	354.6	$C_{17}H_{30}O_4Si_2$
20	10.157	0.70	2,4-Dihydroxybenzaldehyde, 2TMS derivative	282.48	$C_{13}H_{22}O_3Si_2$
21	10.237	0.25	2-Hydrazino-4,6-dimethylpyrimidine, 2TMS derivative, peak 2	282.53	$C_{12}H_{26}N_4Si_2$
22	10.368	0.29	Methyltris(trimethylsiloxy)silane	310.68	$C_{10}H_{30}O_3Si_4$
23	10.540	0.54	3,3-Diisopropoxy-1,1,1,5,5,5-hexamethyltrisiloxane	324.63	$C_{12}H_{32}O_4Si_3$
24	10.603	0.35	Octopamine, 3TMS derivative	369.7	$C_{17}H_{35}NO_2Si_3$
25	10.786	10.62	Cyclopentasiloxane, decamethyl-	370.77	$C_{10}H_{30}O_5Si_5$
26	10.975	0.24	Methyltris(trimethylsiloxy)silane	310.68	$C_{10}H_{30}O_3Si_4$
27	11.341	0.21	Silicic acid, diethyl bis(trimethylsilyl) ester	296.58	$C_{10}H_{28}O_4Si_3$
28	11.376	1.18	1,1,1,3,5,5,5-Heptamethyltrisiloxane	221.5	$C_7H_{21}O_2Si_3$
29	12.205	0.63	1H-Benzo[4,5]furo[3,2-f] indole	207.23	$C_{14}H_9NO$
30	12.623	0.29	Trimethyl[4-(1-methyl-1-methoxyethyl) phenoxy] silane	238.4	$C_{13}H_{22}O_2Si$
31	13.235	3.74	2,4'-Dimethoxy-2'(tert.-butyldimethylsilyl)oxychalcone	338.5	$C_{21}H_{26}O_2Si$
32	13.418	1.13	2,4'-Dimethoxy-2'(tert.-butyldimethylsilyl)oxychalcone	338.5	$C_{21}H_{26}O_2Si$
33	14.265	0.16	Cyclotrisiloxane, hexamethyl-	222.46	$C_6H_{18}O_3Si_3$
34	14.814	0.26	Methyltris(trimethylsiloxy)silane	310.68	$C_{10}H_{30}O_3Si_4$
35	15.438	1.56	Pentasiloxane, dodecamethyl-	384.84	$C_{12}H_{36}O_4Si_5$
36	15.616	0.87	Cycloheptasiloxane, tetradecamethyl-	519.07	$C_{14}H_{42}O_7Si_7$
37	15.879	0.34	(+/-.)-2-Phenylpropanoic Acid, tert.-butyldimethylsilyl ester	426.8	$C_{26}H_{54}O_2Si$
38	16.285	0.18	1,2-Bis(trimethylsilyl)benzene	222.47	$C_{12}H_{22}Si_2$
39	17.401	0.87	Terbutaline, N-trifluoroacetyl-O, o-tris(trimethylsilyl)deriv.	537.8	$C_{23}H_{42}F_3NO_4Si_3$
40	17.573	0.62	1,2-Bis(trimethylsilyl)benzene	222.47	$C_{12}H_{22}Si_2$
41	18.047	0.15	4-tert-Octylphenol, TMS derivative	278.5	$C_{17}H_{30}OSi$
42	19.112	0.55	Cyclononasiloxane, octadecamethyl-	667.4	$C_{18}H_{54}O_9Si_9$
43	19.272	0.80	Cyclotrisiloxane, hexamethyl-	222.46	$C_6H_{18}O_3Si_3$
44	20.634	0.40	1H-Indole-2-carboxylic acid, 6-(4-ethoxyphenyl)-3-methyl-4-oxo-4,5,6	355.4	$C_{21}H_{25}NO_4$
45	20.811	0.53	Tris(tert-butyldimethylsilyloxy) arsane	468.7	$C_{18}H_{45}AsO_3Si_3$
46	22.030	0.25	Cyclotrisiloxane, hexamethyl-	222.46	$C_6H_{18}O_3Si_3$
47	22.213	0.54	Methyltris(trimethylsiloxy)silane	310.68	$C_{10}H_{30}O_3Si_4$
48	23.472	0.41	Cyclotrisiloxane, hexamethyl-	222.46	$C_6H_{18}O_3Si_3$
49	24.679	0.23	Thymol, TBDMS derivative	264.48	$C_{16}H_{28}OSi$
50	25.623	1.85	Bis(2-ethylhexyl) phthalate	390.6	$C_{24}H_{38}O_4$

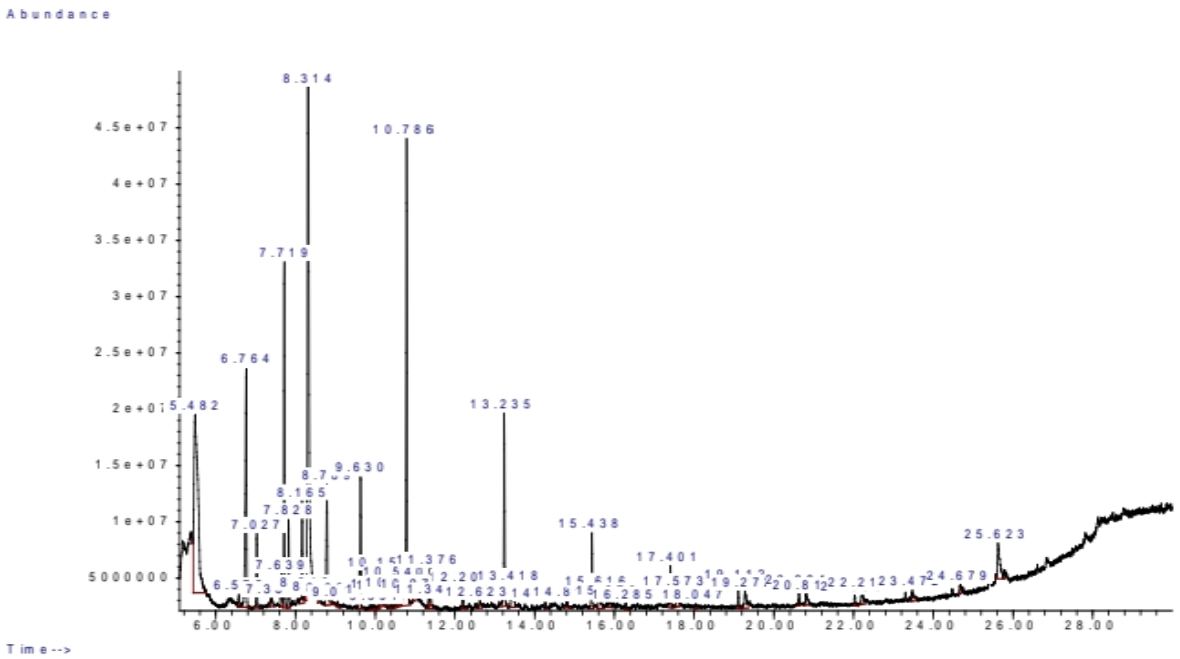

Figure 4: The Chromatogram of the bioactive compounds present in the ethanol extract of curry leaf

4. DISCUSSION

The results of this study revealed that aqueous and ethanol extracts of curry leaves (*Murraya keonigii*) have antibacterial properties on a range of microorganisms. Multi-drug resistant pathogenic bacterial strains that cause infections that are difficult to treat with the standard regimen have become more prevalent as a result of the careless use of antibiotics. Since natural antimicrobials are less hazardous and detrimental to human health overall, the trend of looking for alternative medicine from nature is becoming more popular these days, aside from the use of antibiotics and chemically synthesised medications. [10].

In the present study, curry leaf exhibited antibacterial properties against both Gram-positive and Gram-negative microorganisms. In their experiment, Irfan et al. [2] employed an experimental ethanol extract of curry leaves and reported potency against *Bacillus subtilis*, *Streptococcus* sp. as gram-positive and *E. coli*, *Proteus* sp., *Klebsiella pneumonia*e, and *Pseudomonas aeruginosa* as gram-negative. The current investigation concurs with their findings of inhibitory effect against similar bacteria isolates. It is further corroborated by the work of Doddanna *et al*, [11] with the experiment on the antimicrobial activity of plant extracts (Curry leaf included) on *Candida albicans.*

From the results presented, aqueous extract was shown to be more potent than the ethanol extract of the leaf. According to Ma et al.'s article [12], curry leaves have shown great promise as a natural substitute, particularly given their antibacterial qualities. This investigation supports their findings. The ethanol extract of *Murraya koeinigii* exhibits an antibacterial action on *Staphylococcus aureus* and *Escherichia coli*, according to research by Abdullah et al. [13], which contradicts this conclusion. This study's findings also contradict those of Rana and Yamini [14], who claimed that *Murraya koeinigii*'s aqueous extract did not affect *E. coli*.

From the GC-MS results, some compounds identified in the aqueous and ethanol extracts of curry leaf (*Murraya keonigii*) have been found to have medicinal purposes and possess anti-microbial characteristics. The presence of compounds such as phytol and Hexadecanoic acid in this study is in agreement with the results of Hema et al [15] who identified the same compounds in the curry leaf extract. The presence of compounds such as propane, pentadecanoic acid, n-hexadecanoic acid, Phytol, and Octadecanoic acid have also been identified previously in the study of Madhave et al [16] from curry leaf extracts. Compounds including Cyclotrisiloxane octamethyl, Cyclotrisiloxane, hexamethyl, 9-Octadecenoic acid, Butanoic acid, Thymol, Hexadecanoic acid, methyl ester have been previously reported to have antimicrobial effects [17-21]. The activity of the extract is based on the synergism between the compounds in the extract. This study has reinstated the information from literature that curry leaves possess potent antimicrobials. It suggests from the evidence of this research that *Murraya keonigii* curry leaf ethanol extract is more profoundly antibacterial when compared with its aqueous equivalent. This may be associated to higher densities of reported molecules with higher antimicrobial potentials.

5. CONCLUSION

The findings of this research emphasize the antibacterial properties of curry leaf extracts *(Murraya keonigii*) against different bacterial and fungal pathogens. Both aqueous

and ethanol extracts exhibited varying levels of antimicrobial activity, with the ethanol extract tending to exhibit more inhibitory activity. The bioactive compounds revealed by GC-MS analysis are important for providing information regarding the chemical constituents of the extracts. Isolation and characterisation of these biologically active compounds, investigation of their functionality, and their potential for the treatment of microbial infections are areas requiring further research.

Conflict of interests

The authors have no conflict of interest to declare.

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