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Original Article

EXTRACTION AND ISOLATION OF BIOACTIVE COMPOUNDS FROM CORAL *JUNCEELLA DELICATA* (GRASSHOFF, 1999) FROM WEST COAST OF MUMBAI

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ABSTRACT

Objective: To isolate the bioactive compounds from coral *Junceella delicata* (Grasshoff, 1999) collected from West coast of Mumbai.

Methods: The coral *J. delicata* was collected from Patwadi Village, Madh Island, Malad West Mumbai-400061, Maharashtra, India, during the low tide. The sample was grinded with blender and then macerated by adding an equal volume of MeOH: DCM (1:1). The aliquot was concentrated in a rotary vacuum evaporator at 45 °C. The resultant compound was subjected to Millipore filter system and finally dried in vacuum desiccator. The sample was further subjected for TLC and pure compounds were processed for GC-MS and FTIR for structural determinations.

Results: The distinct and well-separated compounds were processed for GC-MS and FTIR for their structural elucidation. These compounds are (Ethyl aminomethyl formimidate); (Gly-Gly); (2-(2-Pyridyl)-4 methylthiazole-5-carboxylic acid); (7-Methoxy-2-methylquinolin-4-ol); (Fraxidin); (2-methyl-3-trans-propenylpyrazine); (3-tert-Butylpyridine); (Acetaldehyde benzyl ethyl acetal); (α-Methylcinnamic acid); (4-Ethoxycoumarin); (3-Hydroxycoumarin); (2, 4, 7, 9-Tetramethyl-5-decyne-4, 7-diol); (2,2-Bis(3-allyl-4-hydroxyphenyl) propane); (Phenyltriethylammonium cation); (Dodecanedioic acid). These compounds showed biomedical properties.

Conclusion: The isolated bioactive compounds may be used for pharmaceutical and therapeutic applications. Further studies, including molecular-level research, are necessary to confirm their mechanisms of action and clinical relevance. Additionally, safety and efficacy assessments are crucial to support the development of new pharmaceutical products aimed at improving human health.

Keywords: Coral, Madh island, Extraction, Bioactive compounds, Analytical techniques, Structural determination

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INTRODUCTION

Marine organisms are being studied for their bioactive potential. Many invertebrates, including corals, have yielded a vast amount of extremely potent anti-tumour compounds. Coral reefs are the biggest ecosystems in the oceans. Soft corals play a crucial role in creating lead compounds for drugs through their various defense mechanisms: they protect their living space from competitors, combat pathogenic microorganisms with toxic metabolites, and release these substances to survive [1, 2]. Soft corals belong to the Cnidaria phylum, class Anthozoa, subclass Octocorallia, and order Alcyonacea, consist of various genera within the families Xeniidae, Nephtheidae, and Alcyoniidae [3]. Soft corals are present in all parts of the ocean, ranging from warm shallow waters to cold deep waters [4]. Soft corals, unlike hard corals in the Anthozoa class, lack the protective calcium carbonate skeleton found in hard corals. Hence, soft corals employ toxic and bioactive substances for defense against predators [5, 6]. Research conducted on soft corals demonstrated that substances released by them result in the demise of hard corals in their vicinity [7]. Several marine natural compounds have been extracted from soft corals. For instance, research on cytotoxic and anti-viral activities of marine organisms in the Red Sea indicated that soft corals *Sarcophyton trochliophorum* and *Litophyton arboreum* exhibit strong activity against HeLa and U-937 cancer cell lines. These soft corals contain new bioactive compounds that may have cytotoxic, anti-inflammatory, HIV-inhibiting, antibacterial, anti-tumour, and antifungal properties. According to [8], soft corals contain a variety of rich biomedical compounds such as steroids, alkaloids, terpenoids, prostaglandins, sterols, and steroid glycosides. Research has explored the antimicrobial properties of soft corals from the genera *Parerythropodium, Dendronephthya, Lobophytum, and Sarcophyton* [9-12]. Cnidarian toxins are the subject of extensive research in Japan, China and some Western countries. Between 1969 and 2016, there was a decrease in new U. S. Food and Drug Administration (FDA) approvals, with the highest number of approvals in 1996 (53 new molecular entities (NMEs)/y) and the lowest in 2010 and 2016 (15 NMEs/y) [13]. Since soft corals is a promising and underexplored source of bioactive compounds with significant pharmaceutical potential. Further research into their chemical diversity could lead to the discovery of novel therapeutic agents, especially in the field of cancer treatment.

MATERIALS AND METHODS

Sample collection

The coral *J. delicata* was collected from Patwadi Village, Madh Island, Malad West Mumbai-400061, Maharashtra, India (19^0 8' 47652" N, 72^0 47' 17.8116" E) during the low tide. The debris was removed during collection. The sample collected was washed twice with sea water and then rinse three times with distilled water and stored in ice cubes until they were transferred to the deep freezer at 8^0 C at the Department of Zoology, S. S. and L. S. Patkar College of Arts and Science, and V. P. Varde College of Commerce and Economics, Goregaon West, Mumbai-400104.

Identification of coral

Preliminary identification was done by examining the shape and size of the sclerites and by reviewing the literature. The confirmation of identification was done by Dr. Swapnaja Mohite, Professor and Head, Department of Fisheries Biology, College of Fisheries, Shirgaon, Ratnagiri, Maharashtra-415629.

Preparation of crude extract

The coral sample was removed from the deep fridge and bloat with blotting paper and kept in shed dried for 48 h. After 48 h the sample was grinded with blender and then macerated by adding an equal volume of MeOH: DCM (1:1) for 24 h in the water bath at 45 °C. The aliquot mixture obtained was filtered through Whatman filter paper 1. The homogenate was centrifuged at 10,000 rpm for 15 min in cold

centrifuge (Remi centrifuge serial No. VCDX-5983) at -8 °C and supernatant was collected. The aliquot was concentrated in a rotary vacuum evaporator at 45 °C. The resultant compound was subjected to Millipore filter system and finally dried in vacuum desiccator and stored in the refrigerator at-20 °C till further use.

Ethical approval

Ethical approval was sought from the Principal Chief Conservator of Forest, Nagpur (Desk-22(8)/Res/CR-25(22-23)/1431/(22-23) and final approval was taken from the Maharashtra State Biodiversity Board, Nagpur (MSBB/Desk-5/825/2022-23) for collection of *J. delicata* samples. The voucher specimen of *J. delicata* was submitted to the repository at the Zoological Survey of India, Western Regional Office, Pune (ZSI-WRC Misc/18), India.

TLC analysis

CAMAG HPTLC model available at Anchrom test lab. Mulund, Mumbai, was used for the analysis of the samples. In this system stationary phase was precoated with an aluminum plate containing silica gel ($60F_{254}$), whereas the mobile phase was a mixture of chloroform, toluene, and ethanol in a 4:4:1 (v/v/v) ratio. The development of the sample spots was done using twin trough chamber. The Deutorium lamp at 254 nm was used for densitometric scanning of the sample.

GC-MS: (GAS chromatography-mass spectrometry)

The samples were analyzed on GC-MS at the Sophisticated Analytical Instruments Facility (SAIF), IIT Madras, The Agilent Model 8890 GC System with Single Quadrupole Mass Spectrometer (5977B MSD) analyzer is used for the separation and identification of thermally stable volatile compounds. The GC consists of Split/Splitless (SSL) injectors and capillary columns for different applications. NIST spectral library search was used to identify the molecules.

FTIR-spectrophotometer

FTIR spectrophotometers installed at SAIF-IIT Powai, Mumbai were used for the characterization of the bioactive compounds. The model Bruker Hyperion 3000 Microscope connected to a Vertex 80 FTIR System were used. For FTIR, the samples were mixed in KBr and pallets were formed. The scanning was done in the range of 4000 cm^{-1} to 400 cm^{-1}. All the chemicals and reagents used for IR analysis were of analytical grade. Analytical grade solvents and chemicals were used from M/S. S. D. Fine Chemicals, Thane, India.

RESULTS AND DISCUSSION

Characterization of crude extract by HPTLC

The extracts isolated from the coral J. delicata collected from Madh Island, Malad West Mumbai are spotted on HPTLC plates and the plates were developed in a twin-trough chamber using Chloroform: Toluene: Ethanol in a ratio of 4:4:1 (v/v/v). The plates were dried and sprayed with the anisaldehyde sulfuric acid reagent. The development of the sample spots was done using twin trough chamber. The deutorium lamp at 254 nm was used for densitometric scanning of the sample shown in fig. 1. The spraying reagents gave positive tests for the presence of compounds. The distinct and well-separated spots were at Rf values MG-0.38, MY-0.48 and MO-0.78 were taken for analysis, whereas the 0.07, 0.11, 0.18, 0.36, 0.39, and 0.70 were rejected because of overlapping to one another. The densitometric scanning of these spots resulted in the quantification of these substances and found to be 0.07(4.21%), 0.11(17.58%), 0.18(19.84%), 0.29 (5.14%), 0.38(17.93%), 0.48(12.44%), 0.70 (12.82%), and 0.78(10.05%) respectively shown in fig. No. 1. Preparative TLC was performed and the spots at Rf values at MG-0.38, MY-0.48 and MO-0.78 were isolated by scrapping the spots into methanol. Pure compounds were obtained by evaporating the solvent methanol. These compounds are then characterized by FTIR technique.

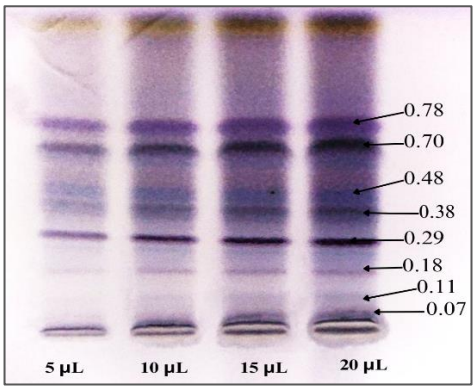


Fig. 1: Photograph showing the separation of bioactive compounds of crude extract of coral *J. delicata* by high-performance thin-layer chromatography

Characterization of isolated extracts of coral *J. delicata* by GC-MS

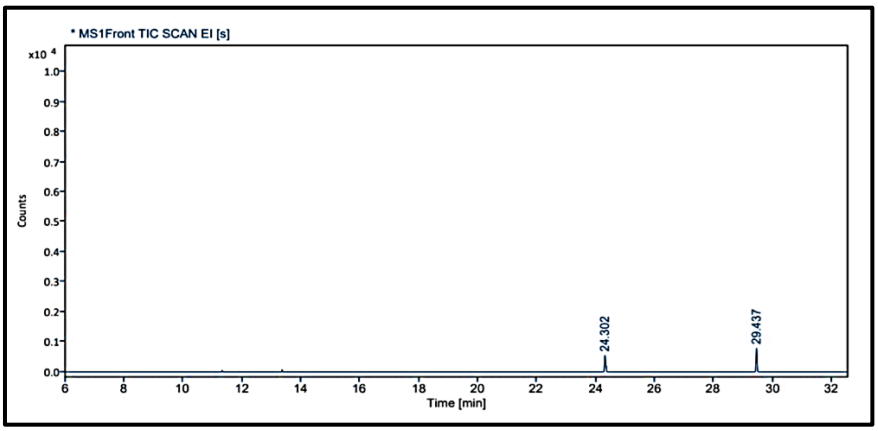


Fig. 1.1: Gas chromatogram showing the isolated compound no. 1 (MG) at Rf value -0.38 on TLC

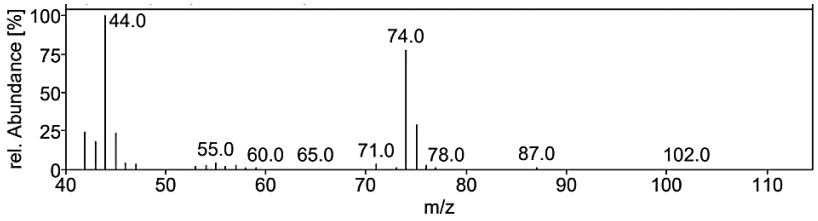


Fig. 1.1a: Mass spectra of the compound No.1 (MG) at RT value 29.437

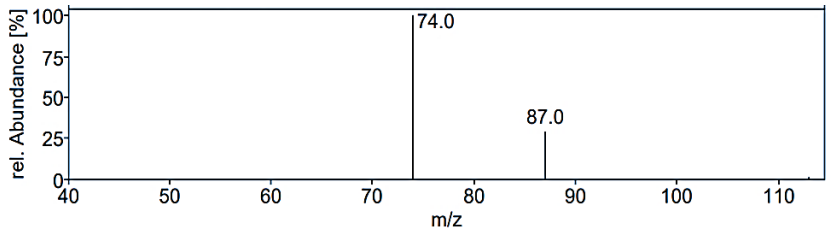


Fig. 1.1b: Mass spectra of the compound No.1 (MG) at RT value 29.437

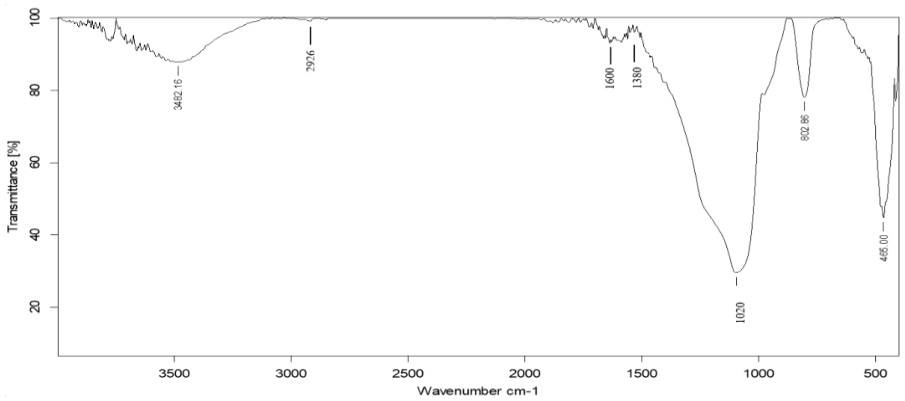


Fig. 2.1: FTIR spectra of the isolated compound No.1 (MG)-0.38 on TLC

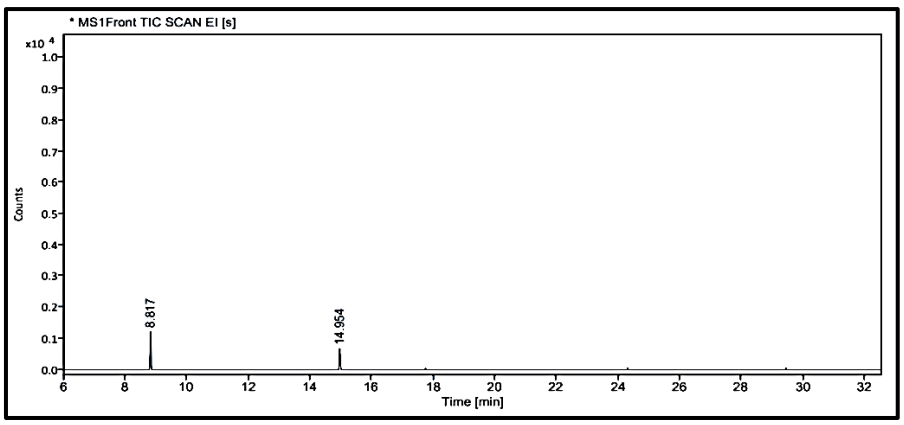


Fig. 1.2: Gas chromatogram showing the isolated compound No. 2 (MY) at Rf value -0.48 on TLC

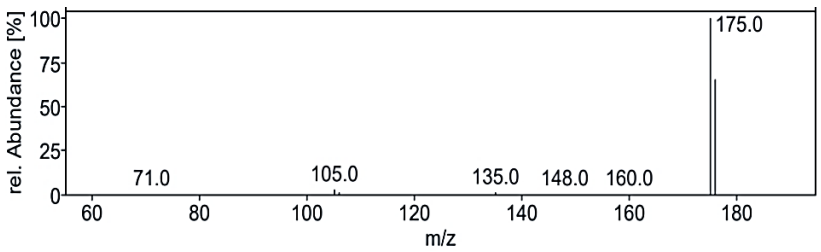


Fig. 1.2. a: Mass spectra of the compound No. 2 (MY) at RT value 8.817

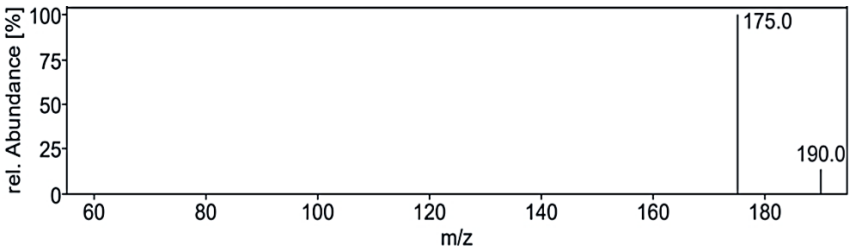


Fig. 1.2b: Mass spectra of the compound no. 2 (MY) at RT value 8.817

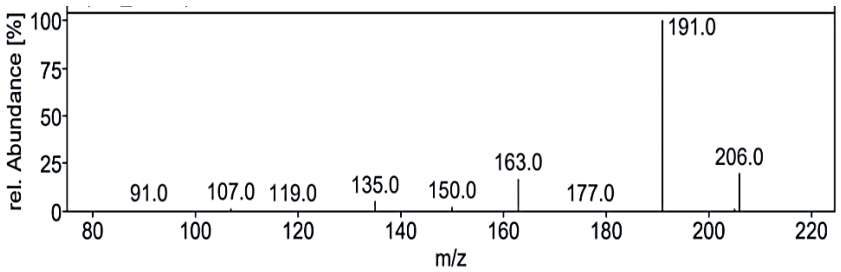


Fig. 1.2c: Mass spectra of the compound no. 2 (MY) at RT value 14.954

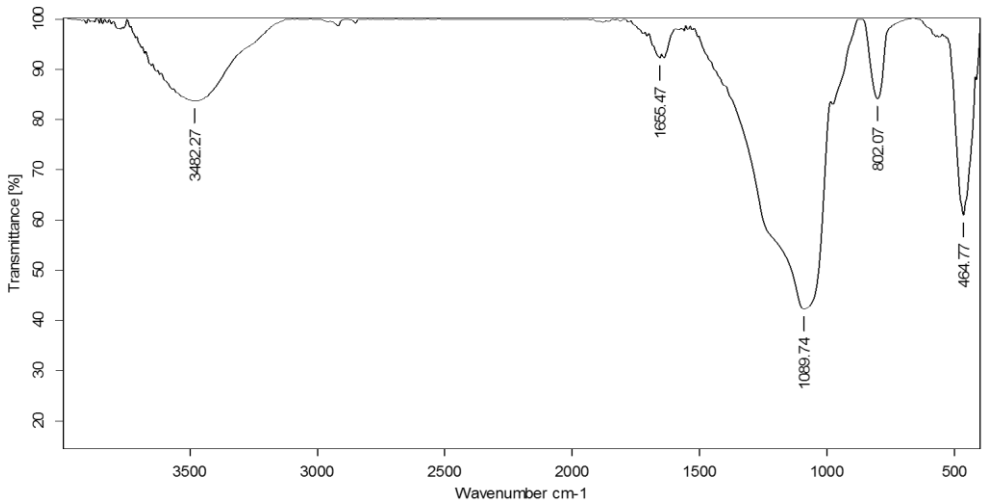


Fig. 2.2: FTIR spectra of the isolated compound No. 2 (MY)-0.48 on TLC

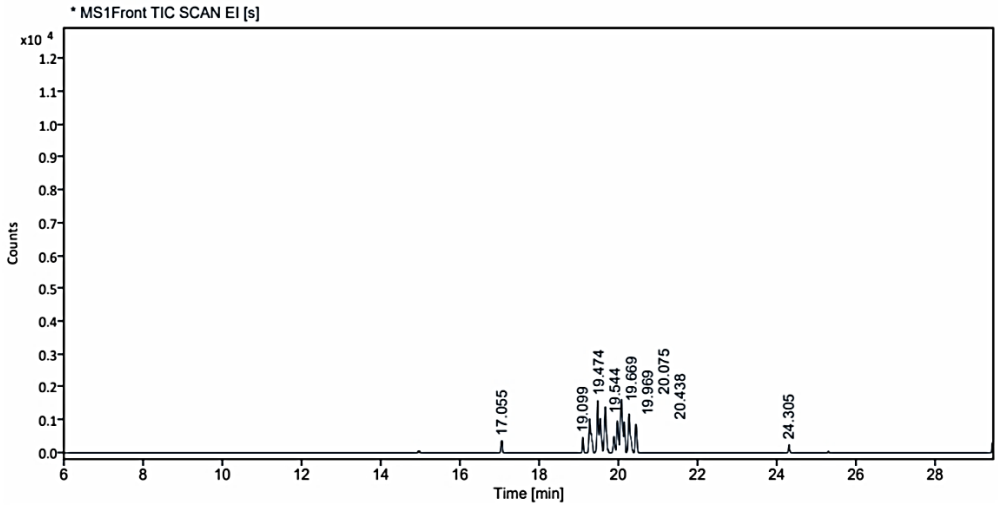


Fig. 1.3: Gas chromatogram showing the isolated compound no. 3 (MO) at Rf value-0.78 on TLC

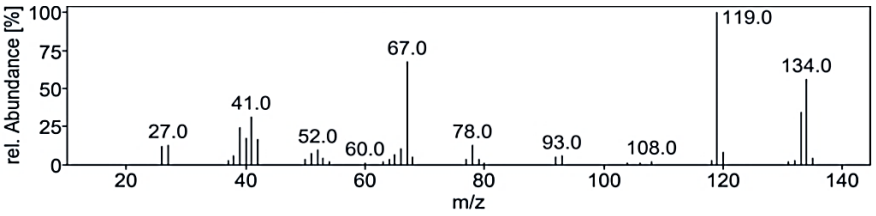


Fig. 1.3a: Mass spectra of the compound no. 3 (MO) at RT value 17.055

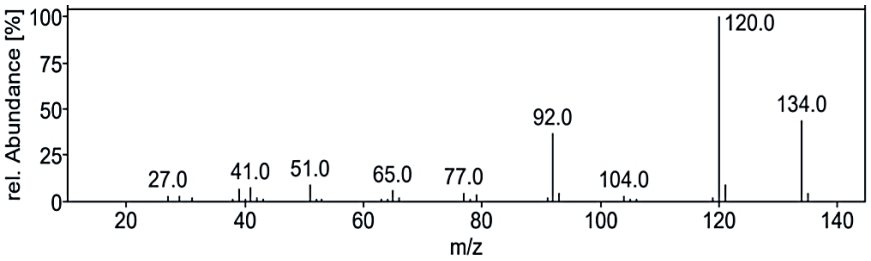


Fig. 1.3b: Mass spectra of the compound no. 3 (MO) at RT value 17.055

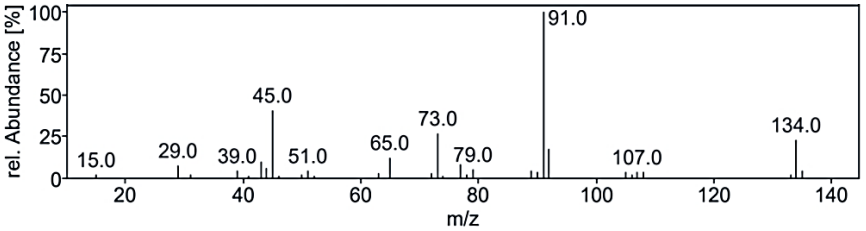


Fig. 1.3c: Mass spectra of the compound no. 3 (MO) at RT value 17.055

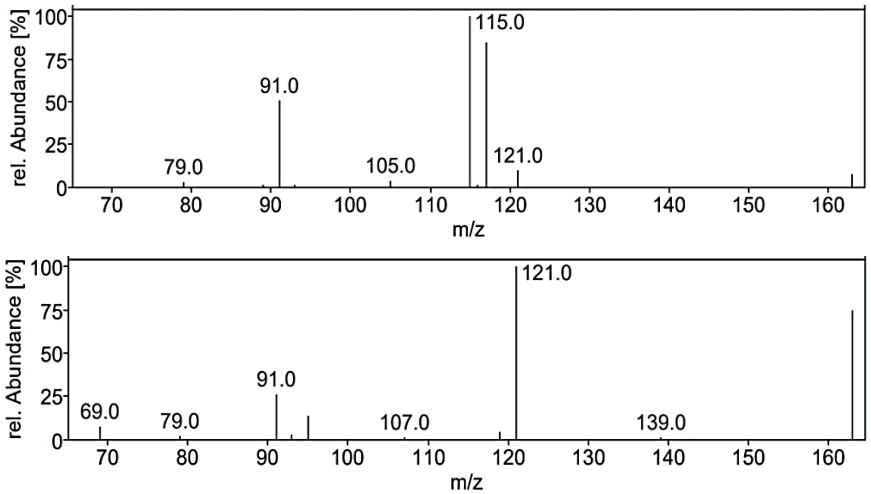


Fig. 1.3d: Mass spectra of the compound no. 3 (MO) at RT value 19.099

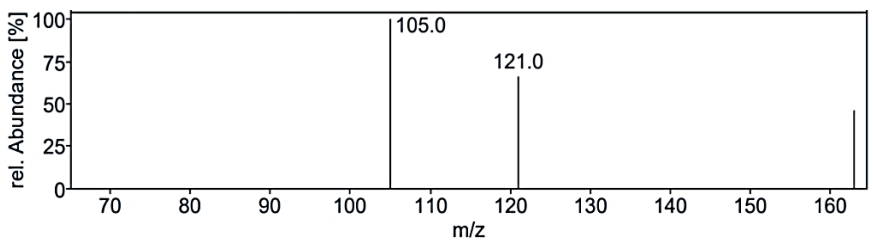


Fig. 1.3e: Mass spectra of the compound no. 3 (MO) at RT value 19.099

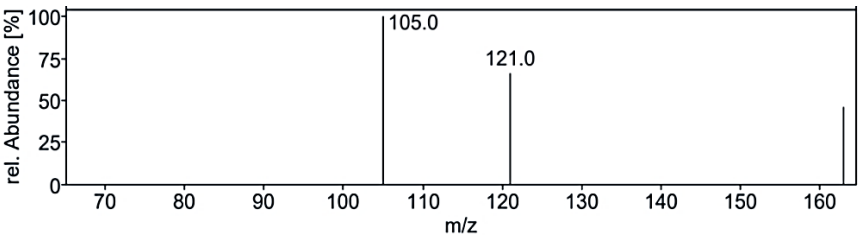


Fig. 1.3f: Mass spectra of the compound no. 3 (MO) at RT value 19.099

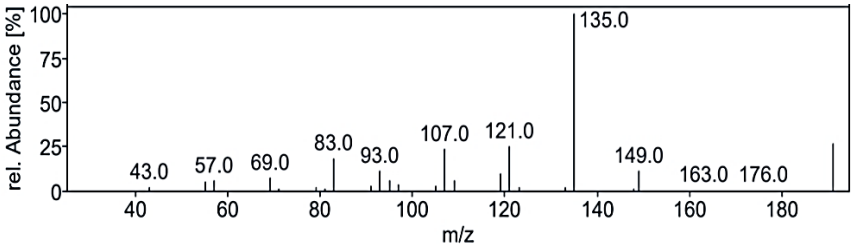


Fig. 1.3g: Mass spectra of the compound no. 3 (MO) at RT value 19.474

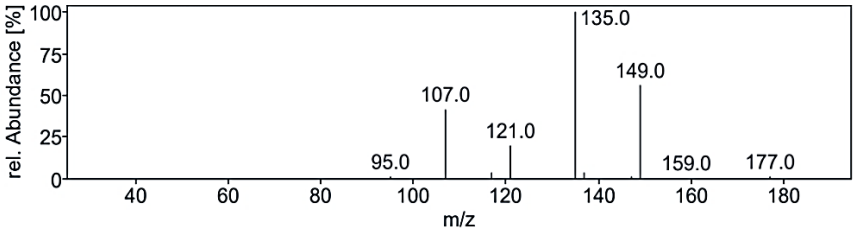


Fig. 1.3h: Mass spectra of the compound no. 3 (MO) at RT value 19.474

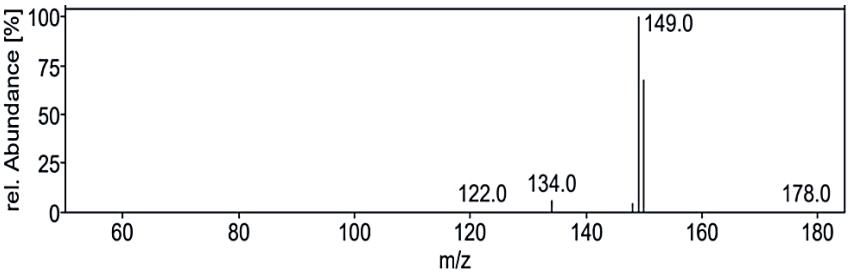


Fig. 1.3i: Mass spectra of the compound no. 3 (MO) at RT value 20.075

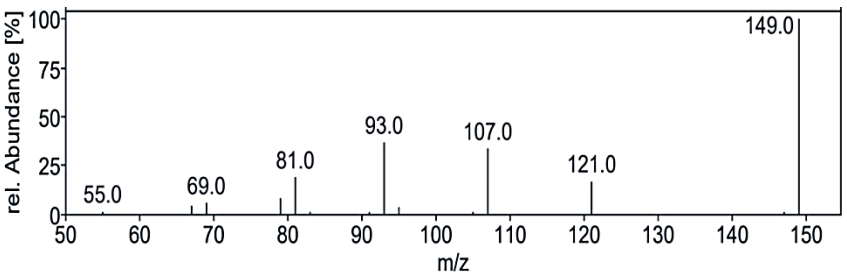


Fig. 1.3j: Mass spectra of the compound no. 3 (MO) at RT value 20.438

GC-MS of the extracts isolated from Coral *J. delicata* has been performed and the results are presented in fig. 1.1 to 1.3.

The gas chromatograms of the extracts of Coral *J. delicata* shown in fig. No. 1.1 to 1.3 indicate that there are a large number of peaks. The total run time of the GC was 53.5 min. The temperature of the system was raised up to 350 °C. However, the selected peaks of RT value could be identified and remaining peaks were not identified due to its overlapping or the lack of database in the library as well as any references that are reported till now for the Coral *J. delicata* extracts. The GC peaks obtained at Rt value of 8.817, 14.954, 17.055, 19.099, 19.474, 20.075, 20.438, and 29.437 were only employed for recording the mass spectra by

irradiating the eluents at these Rt values through the electron impact (EI^+) source of the Mass spectrometer. Fig. No. 1.1. a to 1.3. j are the mass spectra of eluted compounds at Rt values 8.817, 14.954, 17.055, 19.099, 19.474, 20.075, 20.438, and 29.437 of Coral *J. delicata*. The M/Z mass peaks obtained for elements at Rt values 8.817, 14.954, 17.055, 19.099, 19.474, 20.075, 20.438, and 29.437 corresponds to the substances of molecular mass of 102.14 g/mol, 132.12 g/mol, 220.25 g/mol, 189.21 g/mol, 222.19 g/mol, 134.09 g/mol, 135.21 g/mol, 180.25 g/mol, 162.19 g/mol, 190.19 g/mol, 162.14 g/mol, 226.35 g/mol, 308.42 g/mol, 178.30 g/mol, 230.30 g/mol.

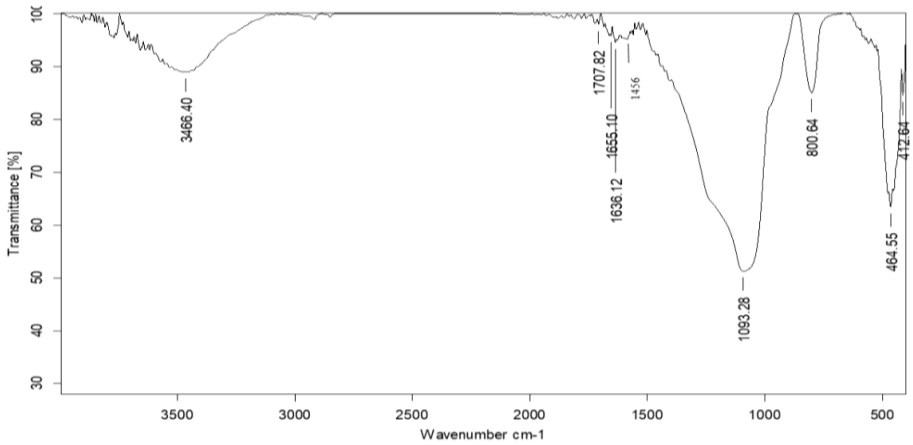


Fig. 2.3: FTIR spectra of the isolated compound No. 3 (MO)-0.78 on TLC

Fragmentation peaks for compound no. 1 (MG)

At an RT value of 29.436 min, the fragmentation peaks were recorded for Compound No. 1 (MG). For the mass spectra with a molecular weight of 102.14 g/mol, the observed peaks included: 102.0 M/Z (10%), 87.0 M/Z (2%), 78.0 M/Z (2%), 74.0 M/Z (80%), 71.0 M/Z (10%), 60.0 M/Z (2%), 55.0 M/Z (5%), and 44.0 M/Z (100%). Similarly, for the mass spectra with a molecular weight of 132.12 g/mol, the peaks were observed at 131.0 M/Z (5%), 113.0 M/Z (2%), 87.0 M/Z (25%), and 74.0 M/Z (100%).

Fragmentation peaks for compound no. 2 (MY)

`The analysis at RT value 8.817 min for Compound No. 2 (MY) yielded peaks for a molecular weight of 220.25 g/mol. The fragmentation pattern showed peaks at 220.0 M/Z (5%), 176.0 M/Z (70%), 175.0 M/Z (100%), 135.0 M/Z (2%), 16.0 M/Z (2%), 105.0 M/Z (2%), and 71.0 M/Z (2%). Another mass spectrum for 189.21 g/mol displayed peaks at 191.0 M/Z (5%), 190.0 M/Z (5%), 176.0 M/Z (10%), 175.0 M/Z (100%), 162.0 M/Z (5%), and 147.0 M/Z (5%). At RT value 14.954 min, the molecular weight of 222.19 g/mol showed peaks at 221.0 M/Z (5%), 206.0 M/Z (22%), 191.0 M/Z (100%), 163.0 M/Z (20%), 150.0 M/Z (5%), 135.0 M/Z (10%), and 107.0 M/Z (2%).

Fragmentation peaks for compound no. 3 (MO)

At RT value 17.055 min, Compound No. 3 (MO) showed fragmentation peaks for a molecular weight of 134.09 g/mol at 134.0 M/Z (50%), 133.0 M/Z (32%), 119.0 M/Z (100%), 108.0 M/Z (2%), 93.0 M/Z (5%), 78.0 M/Z (15%), 67.0 M/Z (65%), 52.0 M/Z (10%), 41.0 M/Z (35%), 39.0 M/Z (24%), and 27.0 M/Z (15%). For the molecular weight of 135.21 g/mol, the peaks included 134.0 M/Z (35%), 121.0 M/Z (7%), 120.0 M/Z (100%), 104.0 M/Z (4%), 92.0 M/Z (30%), 77.0 M/Z (3%), 65.0 M/Z (5%), 51.0 M/Z (10%), and 41.0 M/Z (8%). The molecular weight of 180.25 g/mol displayed peaks at 179.0 M/Z (7%), 134.0 M/Z (25%), 107.0 M/Z (2%), 92.0 M/Z (18%), 91.0 M/Z (100%), 79.0 M/Z (5%), 73.0 M/Z (25%), 65.0 M/Z (15%), 51.0 M/Z (5%), 45.0 M/Z (40%), and 15.0 M/Z (1%).

At RT value 19.099 min, for 162.19 g/mol, peaks included 163.0 M/Z (4%), 121.0 M/Z (10%), 117.0 M/Z (85%), 115.0 M/Z (100%), 105.0 M/Z (5%), and 91.0 M/Z (50%). For 190.19 g/mol, the peaks observed were 191.0 M/Z (16%), 163.0 M/Z (75%), 139.0 M/Z (1%), 121.0 M/Z (100%), 119.0 M/Z (3%), 95.0 M/Z (20%), 91.0 M/Z (25%), and 69.0 M/Z (5%). Another spectrum for 162.14 g/mol displayed 163.0 M/Z (50%), 121.0 M/Z (75%), and 105.0 M/Z (100%).

At RT value 19.474 min, for 226.35 g/mol, the peaks were observed at 227.0 M/Z (33%), 191.0 M/Z (33%), 149.0 M/Z (15%), 135.0 M/Z (100%), 121.0 M/Z (25%), 107.0 M/Z (23%), and 83.0 M/Z (20%). For 308.42 g/mol, the peaks were 309.0 M/Z (26%), 149.0 M/Z (50%), 137.0 M/Z (4%), 135.0 M/Z (100%), 121.0 M/Z (23%), 117.0 M/Z (4%), and 107.0 M/Z (33%).

At RT value 20.075 min, for 178.30 g/mol, the fragmentation peaks were 178.0 M/Z (2%), 150.0 M/Z (62%), 149.0 M/Z (100%), 148.0 M/Z (4%), 134.0 M/Z (5%), and 122.0 M/Z (2%). Lastly, at RT value 20.438 min, for 230.30 g/mol, the peaks observed were 231.0 M/Z (16%), 149.0 M/Z (100%), 121.0 M/Z (18%), 107.0 M/Z (28%), 93.0 M/Z (33%), 81.0 M/Z (20%), and 79.0 M/Z (6%).

FTIR analysis

The FTIR studies are carried out in KBr pallets. Each of the compounds isolated at Rf values at MG-0.38, MY-0.48 and MO-0.78 on TLC for each of the isolated extracts gave the IR spectra's as shown in fig. 2.1 to 2.3. All the IR spectra of the compounds at the respective Rf values mentioned above are found to be dissimilar.

The wave numbers of some of the important IR peaks along with their intensity, type of vibration and probable groups present in the respective compounds isolated at Rf values MG-0.38, MY-0.48 and MO-0.78 are shown in table 1 to 3.

Table 1: Correlation of IR spectra of the compound isolated from Coral *J. delicata* at Rf value 0. 38

Wavenumber (cm^{-1})	Intensity	Possible functional group	Description
3482	Broad	O–H or N–H stretching	Hydroxyl group or amine
2926	Moderate	C–H stretching	Aliphatic C–H (e. g., $–CH_3$, $–CH_2$)
1600	Sharp	C=C or C=N stretching	Aromatic ring or imine group
1380	Medium	C–N stretching or bending	Amine or imine group
1020	Medium	C–O or C–N stretching	Ether or amine group

Table 2: Correlation of IR spectra of the compound isolated from coral *J. delicata* at Rf value 0. 48

Wavenumber (cm^{-1})	Intensity	Possible functional group	Description
3482	Broad	O–H or N–H stretching	Hydroxyl group or amine
1655	Sharp	C=O or C=N stretching	Carbonyl group (e. g., ketone, amide) or imine group
1089	Medium	C–O or C–N stretching	Ether, ester, or amine
802	Sharp	C–H bending (aromatic)	Aromatic ring presence
464	Sharp	C–S bending or other fingerprint	-

Table 3: Correlation of IR spectra of the compound isolated from coral *J. delicata* at Rf value 0. 78

Wavenumber (cm^{-1})	Intensity	Possible functional group	Description
3466	Broad	O–H or N–H stretching	Hydroxyl group or amine
1707	Sharp	C=O stretching	Carbonyl group (e. g., carboxylic acid, ester, ketone)
1636	Medium	C=C or C=N stretching	Aromatic ring or imine group
1456	Medium	C–H bending (CH_2 or CH_3)	Aliphatic C–H bending
1093	Medium	C–O or C–N stretching	Ether, ester, or amine group
800	Sharp	C–H bending (aromatic)	Presence of an aromatic ring
464	Sharp	C–Cl bending or other fingerprint	Possible halogen (e. g., Cl) presence

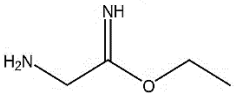
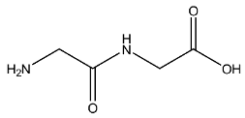
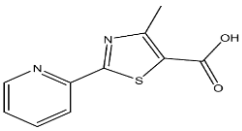
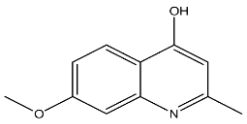
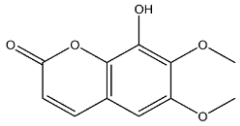
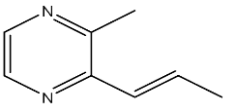
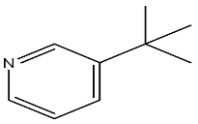
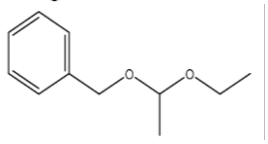
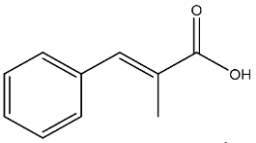
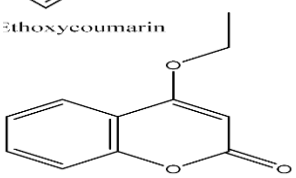
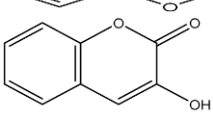
FTIR technique requires very pure samples. Therefore, preparative TLC was carried out to isolate the pure compounds against Coral *J. delicata* at Rf values at MG-0.38, MY-0.48 and MO-0.78, respectively. The IR spectra of these compounds were recorded and are shown in table 1-3 based on the wave number, intensity of IR peaks and the types of vibration of the IR bands, the probable functional groups present in the compounds were evaluated with the help of standard textbooks [14, 15].

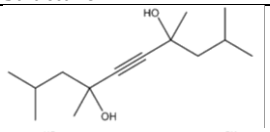
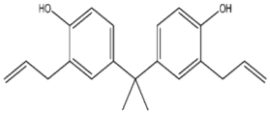
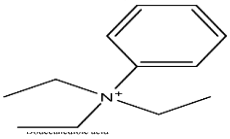
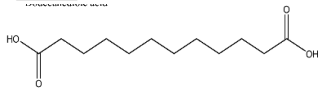
Research conducted by [16] on the gorgonian coral *B. violaceum* contains a new secondary metabolite briarane diterpenoid, namely briaviolides K–N. The coral *P. acerosa* contains pseudopteran diterpenes, pseudopterolides [17]. The coral *P. elisabethae* extract was fractionated with silica gel to produce F-1 pseudopterosins, PsQ, PsS, and PsU, F-2 fraction, amphilectosins A and B, PsG, PsK, PsP, and PsT as well as seco-pseudopterosins seco-PsJ and seco-PsK, and F-3 fraction, elisabethatrienol, 10-acetoxy-9-hydroxy-and 9-acetoxy-10-hydroxy-amphilecta-8,10,12,14-tetraenes and amphilecta-8-11,14-triene-9,10-dione[18]. Coral *Heteroxenia fuscescens* gorgonian contains secondary metabolites of new sterol types, heterofuscesterols A and B, and 3β, 5α, 6β-trihydroxyandrosta-17-one [19]. The gorgonian coral *Rumphella sp.* extracted using acetone as a solvent containing new hydroperoxy steroids called xidaosteroids A and B 5α,8αepidioxyergosta-6,9(11)-diene-3β-ol, 5α,8α-epidioxyergosta-6,9(11)-diene-3β-ol,3β-hydroxy5α,6α-epoxy-7-megastigmen-9-one, grasshopper 3 ketone, (3R)-4-[(2R,4S)-4-acetoxy-2-hydroxy-2,6,6-trimethylcyclohexylidene] but-3-en-2-one [20]. The type of gorgonian coral *V. corona* studied by [21] contains secondary metabolites of-lactone (49),γ-lactone (48), 3β,20R-dihydroxycholest-5,22-dien-24-oic acid γsteroids, namely verrucorosteroid A–F, verrucorosteron, 3β-acetyl-20R-hydroxycholest5,22-dien-24-oic acid suberoretisteroids A–C, (22E)-3β,25-dihydroxycholest-5,22-dien-24-one, 5,6α-epoxy-3βhydroxy-(22E)-ergosta-8,22-dien-7-one, 5,6α-epoxy-3β-hydroxy-(22E)-ergosta-8,22-dien-7-one, (22E,24S)-24-methyl-5α-cholesta-7,22-diene-3β,5,6β,9-tetraol, and (22E,24S)-24-methyl-5αcholesta-7, 22-diene-3β,5,6β-triol. The coral *P. americana* has extracted using methanol, which produced two types of sterols that have rarely found, namely ameristerenol A and B [22]. *Pinnigorgia sp.* obtain 11-acetoxy-9, 11-secosterol, pinnisterol D–J, sterol, and pinnisterol A [23]. *Subergorgia suberosa* coral, based on research by Cheng *et al.* (2016) has reported containing five new pregnan steroid types called subergol T–X and three others known as analogs. The coral *S. rubra* gorgonian has reported containing a new-3-ketosteroid characterized by 9-OH, subergosterone A–C together with five steroids, namely 9αhydroxycholest-1-en-3-one, pregna-1, 4, 20-trien-3-one, cholesta-1,4-dien-3-one, dendronesterone C, and ergosta-1,4-dien-3-one [24]. The coral *Eunicella singularis* has been studied to contain sterols, namely cholest-5-ene-3β,7α-diol; (22E)-cholesta-5, 22-diene-3β,7α-diol; ergosta-5,24 diene-3β,7α-diol; and cholesta-5, 22-diene-3βol [25]. *Echinomuricea sp.* gorgonian contains a new sterol, namely 6-epi-yonarasterol B, which has extracted using methanol–dichloromethane [26]. The coral *D. griffini* was extracted with ethanol; results contained two new sterol compounds, namely griffiniteron and griffinipregnon. Research conducted by [27] on gorgonian coral *Paramuricea clavata* and reported that it contains two new alkaloids, namely 2-bromo-N-methyltryptamine, 3-bromo-N-methyltyramine [28]. Terpenoid briarane Briaviolide K–N contained in gorgonian *B. violaceum* was helpful as a pro-inflammatory inhibitor in iNOS targets with values LPS cells. Briaviolide l effectively reduced iNOS and COX-2 with values. However, it is different from briaviolide K, which is inactive in reducing the two pro-inflammatory enzymes' expression, even though the hydroxy group is very crucial because it plays an important role in providing biological activity [29]. Excavatolide B metabolite was isolated from *B. excavatum* gorgonian coral, which has significant activity in inhibiting iNOS protein expression [30]. Echinolabdane A and 6-epi-yonarasterol B. Echinolabdane A secondary metabolite, have found in *Echinomuricea sp.* which can inhibit superoxide anion derivatives. The secondary metabolite 6-epi-yonarasterol B exhibits a significant inhibitory effect on the superoxide anion derivative and elastase release by human neutrophils [31]. *Caryophyllene sesquiterpenoids* the gorgonian coral of *R. antipathies* showed that the caryophyllene derivatives of the sesquiterpenoid type, rumphellol A and B, had anti-inflammatory effects when tested *in vitro* [32]. *Pseudopteran diterpene* gorgonian coral showed Pseudopterolide can inhibit the production of inflammatory mediators NO, TNF-α, IL-6, IL-1β, and IP-10 induced by LPS a methoxy functional group at C-9 [33]. Diterpenoid type eunicellin Secondary metabolite palmonine F sourced from gorgonian *E. singularis* has anti-inflammatory activity when tested using the carrageenan-induced rat paw edema model and acetic acid writhing test mice [34]. Secondary metabolites *H. fuscescens* have cytotoxic activity [3-(4, 5-dimethylazol-2-il)-2,5-diphenyltetrazolium bromide] with cancer cell lines MCF-7 (human breast adenocarcinoma) and OVK-18 (endometrioid ovarian carcinoma). Heterofusceterpene A shows cytotoxic activity on MCF-7 and OVK-18 [35]. The study carried out by [36] isolated bioactive compounds from two sponges *Dysidea herbacea, Sigmadocia pumila* by using GC-MS techniques. They found different 11 secondary metabolites which are widely used in cosmetics, pharmaceuticals and other industries [37]. Conducted the experiment on the anti-inflammatory effect of lipid extract of sea pen *Virgularia gustaviana*in mice showed strong anti-inflammatory effects even at low dose which is due to the presence of arachidonic acid in the compounds [38]. Reviewed on therapeutic and pharmaceutical effects of coelenterate toxins and they found that the coelenterate toxins have different biological activities such as cytolytic or neurotoxic, hemolytic, anti-parasitic activity, α-amylase inhibitor activity, and analgesic activity, anti-cancerous and antitumor activity, anti-inflammatory and antimicrobial activity. They further suggested that the coelenterate toxins could be used to develop potential therapeutic drugs for various human diseases and disorders. [39] Worked on bioactive compounds from sponge *Suberites carnosus* (Johnston) collected from West coast of Mumbai, India. They isolated ten compounds by using GC-MS and FTIR techniques, these compounds are 6-Fluoro 2-triflurомethylbenzoic acid,2,3-dichlorophenyl ester, Eicosane 3-

cyclohexyl, Phosphine imide, P,P,P,-tris (p-chlorophenyl)-Nphenyl-, Dimethylhyl hexavinyl octasilsesquioxane, Hexanoic acid, hexadecyl ester, Hexadecanoic acid, 2-hydroxy1-(hydroxymethyl)ethyl ester, 9, 19-Cyclolanostan-3-ol, acetate,(3β), Tetracosane, 3-ethyl-, 11, 14-Eicosadienoic acid, methyl ester, Triacontane,11,20-didecyl respectively. They further concluded that these compounds showed biomedical properties such as skin irritant, fatty, metabolite, masking and perfuming agents, highly corrosive and chemotaxonomic significance.

The distinct and well-separated three compounds were isolated from crude extracts of coral *J. delicata.* The preparative HPTLC was performed to isolate pure compounds from the extracts. Analysis of the extracts was performed to find out the nature of compounds by GC-MS and FTIR technique. The results conclude that the compounds isolated at Rf values at MG-0.38, MY-0.48 and MO-0.78 corresponds to the molecular weights of compounds identified as- (Ethyl aminomethyl formimidate); (Gly-Gly); (2-(2-Pyridyl)-4 methylthiazole-5-carboxylic acid); (7-Methoxy-2-methylquinolin-4-ol); (Fraxidin); (2-methyl-3-trans-propenylpyrazine); (3-tert-Butylpyridine); (Acetaldehyde benzyl ethyl acetal); (α-Methylcinnamic acid); (4-Ethoxycoumarin); (3-Hydroxycoumarin); (2, 4, 7, 9-Tetramethyl-5-decyne-4, 7-diol); (2,2-Bis(3-allyl-4-hydroxyphenyl) propane); (Phenyltriethylammonium cation); (Dodecanedioic acid).

Table 4: Showing names of the compounds, their molecular weights, molecular formula, and structures of the compounds isolated from coral *J. delicata*

S. No.	Name of the compound	Molecular weight	Molecular formula	Structure
1.	Ethyl aminomethylformimidate	102.14 g/mol	$C_4H_{10}N_2O$	
2.	Gly-Gly	132.12 g/mol	$C_4H_8N_2O_3$	
3.	2-(2-Pyridyl)-4 methylthiazole-5-carboxylic acid	220.25 g/mol	$C_{10}H_8N_2O_2S$	
4.	7-Methoxy-2-methylquinolin-4-ol	189.21 g/mol	$C_{11}H_{11}NO_2$	
5.	Fraxidin	222.19 g/mol	$C_{11}H_{10}O_5$	
6.	2-Methyl-3-trans-propenyl pyrazine	134.09 g/mol	C_8H10N_2	
7.	3-tert-Butylpyridine	135.21 g/mol	$C_9H_{13}N$	
8.	Acetaldehyde benzyl ethyl acetal	180.25 g/mol	$C_{11}H_{16}O_2$	
9.	α-Methylcinnamic acid	162.19 g/mol	$C_{10}H_{10}O_2$	
10.	4-Ethoxycoumarin	190.19 g/mol	$C_{11}H_{10}O_3$	
11.	3-Hydroxycoumarin	162.14 g/mol	$C_9H_6O_3$	

S. No.	Name of the compound	Molecular weight	Molecular formula	Structure
12.	2,4,7,9-Tetramethyl-5-decyne-4,7-diol	226.35 g/mol	$C_{14}H_{26}O_2$	
13.	2,2-Bis(3-allyl-4-hydroxyphenyl) propane	308.42 g/mol	$C_{21}H_{24}O_2$	
14.	Phenyltriethylammonium cation	178.30 g mol	$C_{12}H_{20}N^+$	
15	Dodecanedioic acid	230.30 g/mol	$C_{12}H_{22}O_4$	

CONCLUSION

From the above results, it is concluded that the GC-MS and FTIR analysis of *J. delicata* extracts has revealed a comprehensive chemical profile, highlighting distinct fragmentation patterns, functional groups, and promising biological activities. These findings emphasize the potential of this coral as a valuable source of bioactive compounds for pharmaceutical and therapeutic applications. Further studies, including detailed structural elucidation, bioassays, and molecular-level research, are necessary to confirm their mechanisms of action and clinical relevance. Additionally, safety and efficacy assessments are crucial to support the development of new pharmaceutical products aimed at improving human health.

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ETHICAL STATEMENT

Principal Chief Conservator of Forest, Nagpur (Desk-22(8)/Res/CR-25(22-23)/1431/(22-23) and final approval was taken from the Maharashtra State Biodiversity Board, Nagpur (MSBB/Desk-5/825/2022-23) for collection of *J. delicata* samples.

AUTHORS CONTRIBUTIONS

Meenakshi Prakash Borate: data collection, analysis and writing. Prof. Dr. G. V. Zodape: Conceptualization and supervision.

CONFLICT OF INTERESTS

Authors have no conflict of interest

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