APPENDIX

Appendix I
Phytochemical screening (Harbone, 1973)

Detection of alkaloids: Extracts were dissolved individually in dilute Hydrochloric acid and filtered.

- **Dragendroff's Test:** Filtrates were treated with Dragendroff's reagent (solution of Potassium Bismuth Iodide). Formation of red precipitate indicates the presence of alkaloids.
- **Hager's Test:** Filtrates were treated with Hager's reagent (saturated picric acid solution). Presence of alkaloids confirmed by the formation of yellow coloured precipitate.

  Detection of carbohydrates: Extracts were dissolved individually in 5 ml distilled water and filtered. The filtrates were used to test for the presence of carbohydrates.
- **Molisch's Test:** Filtrates were treated with 2 drops of alcoholic α-naphthol solution in a test tube. Formation of the violet ring at the junction indicates the presence of Carbohydrates.
- **Benedict 's test:** Filtrates were treated with Benedict's reagent and heated gently. Orange red precipitate indicates the presence of reducing sugars.

Detection of glycosides: Extracts were hydrolysed with dil. HCl, and then subjected to test for glycosides.

- **Legal's Test:** Extracts were treated with sodium nitropruside in pyridine and sodium hydroxide. Formation of pink to blood red colour indicates the presence of cardiac glycosides.

Detection of saponins:

- **Froth Test:** Extracts were diluted with distilled water to 20ml and this was shaken in a graduated cylinder for 15 minutes. Formation of 1 cm layer of foam indicates the presence of saponins.
- **Foam Test:** 0.5 gm of extract was shaken with 2 ml of water. If foam produced persists for ten minutes it indicates the presence of saponins.

Detection of phytosterols:

- **Salkowski's Test:** Extracts were treated with chloroform and filtered. The filtrates were treated with few drops of conc. sulphuric acid, shaken and allowed to stand. Appearance of golden yellow colour indicates the presence of triterpenes.

- **Liebermann Burchard's test:** Extracts were treated with chloroform and filtered. The filtrates were treated with few drops of acetic anhydride, boiled and cooled. conc. sulphuric acid was added. Formation of brown ring at the junction indicates the presence of phytosterols.

Detection of phenols:

- **Ferric Chloride Test:** Extracts were treated with 3-4 drops of ferric chloride solution. Formation of bluish black colour indicates the presence of phenols.

Detection of tannins:

- **Gelatin Test:** To the extract, 1% gelatin solution containing sodium chloride was added. Formation of white precipitate indicates the presence of tannins.

Detection of flavonoids:

- **Alkaline Reagent Test:** Extracts were treated with few drops of sodium hydroxide solution. Formation of intense yellow colour, which becomes colourless on addition of dilute acid, indicates the presence of flavonoids.
- **Lead acetate Test:** Extracts were treated with few drops of lead acetate solution. Formation of yellow colour precipitate indicates the presence of flavonoids.

Detection of proteins and aminoacids:

- **Xanthoproteic Test:** The extracts were treated with few drops of conc. Nitric acid. Formation of yellow colour indicates the presence of proteins.
- **Ninhydrin Test:** To the extract, 0.25% w/v ninhydrin reagent was added and boiled for few minutes. Formation of blue colour indicates the presence of amino acid.

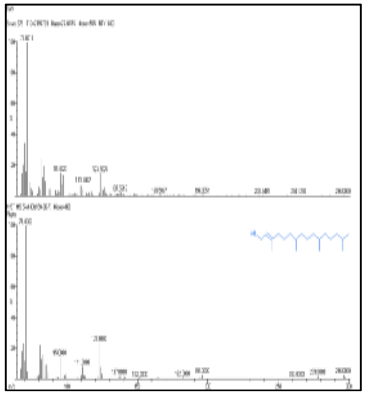
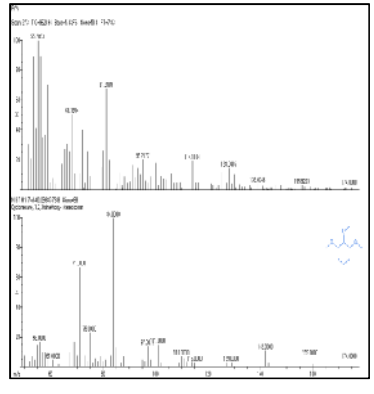
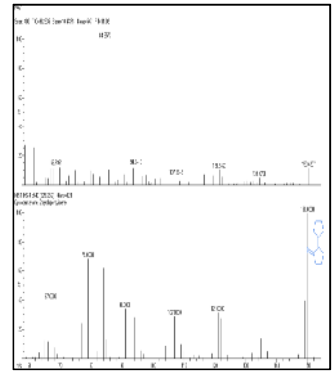
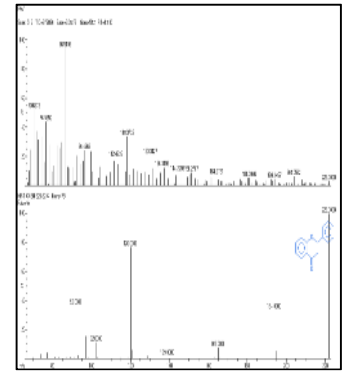
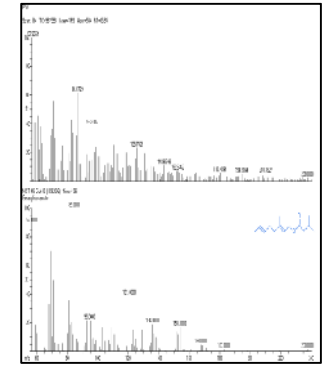
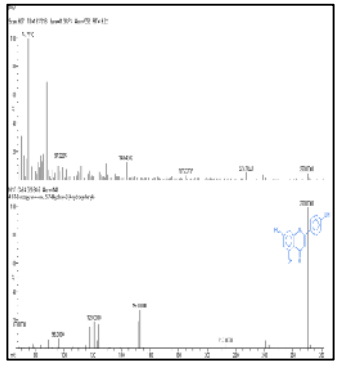
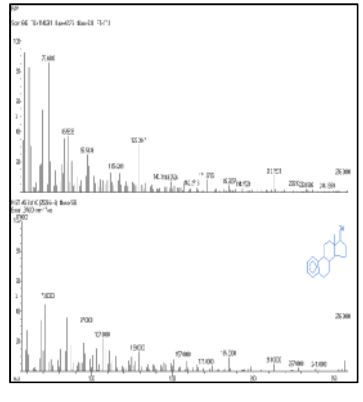
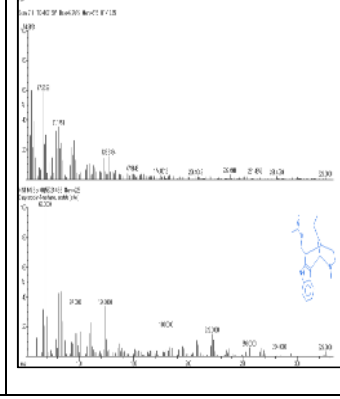
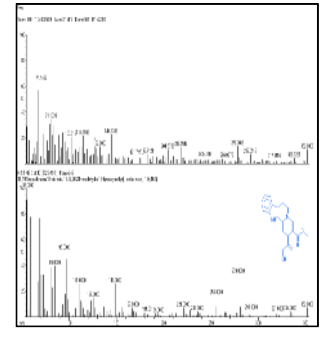
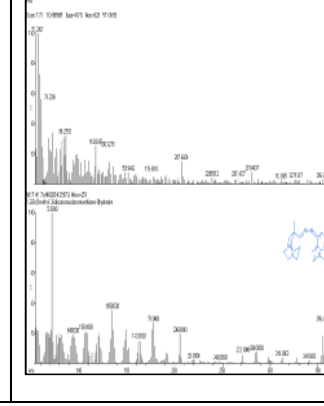
Detection of diterpenes:

Copper acetate Test: Extracts were dissolved in water and treated with 3-4 drops of copper acetate solution. Formation of emerald green colour indicates the presence of diterpenes.

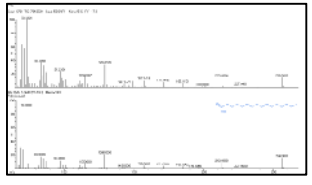
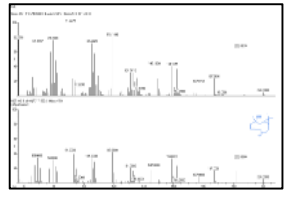
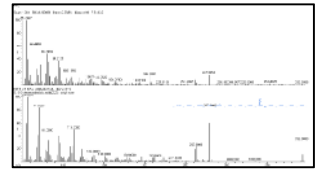
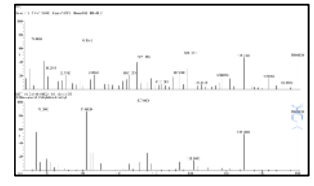
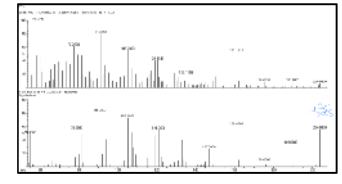
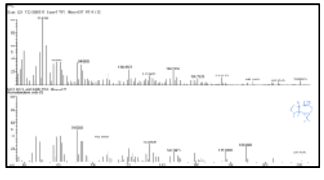
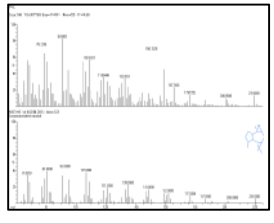
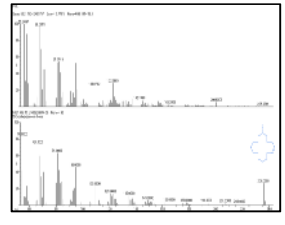
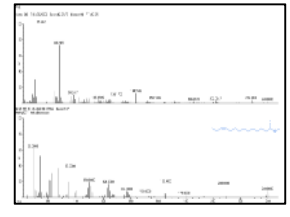
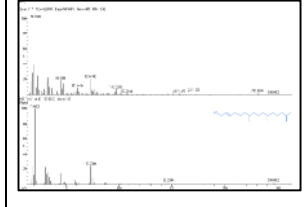
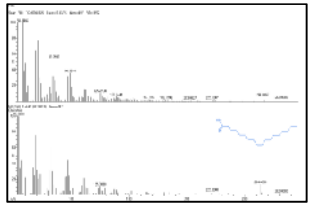
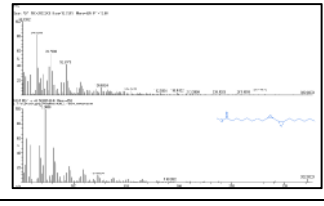
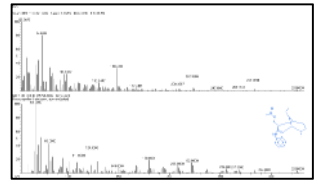
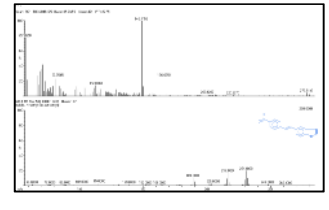
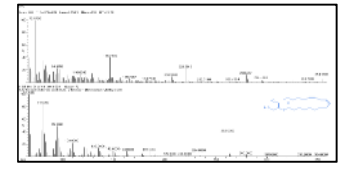
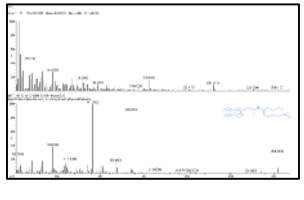
Appendix - II

Fragmentation Pattern for the Investigated Inhibitors

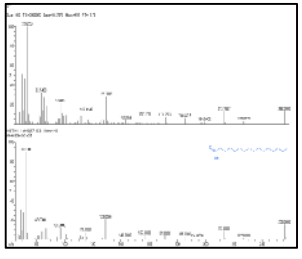
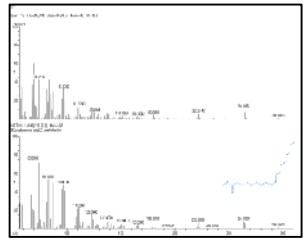
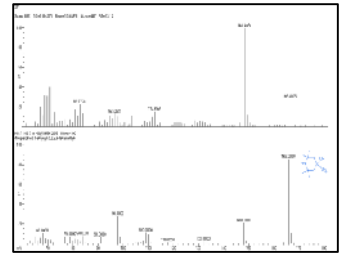
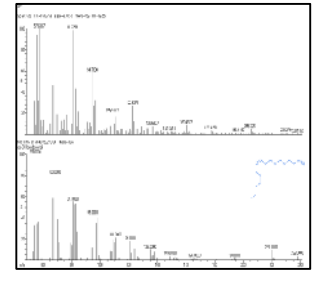
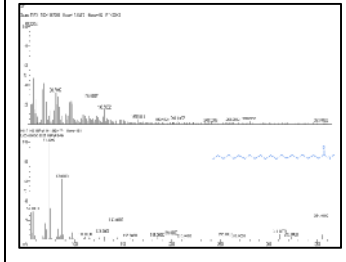
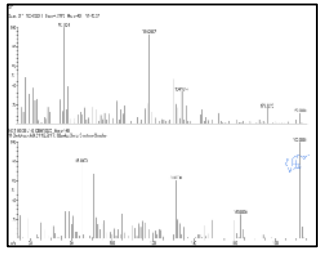
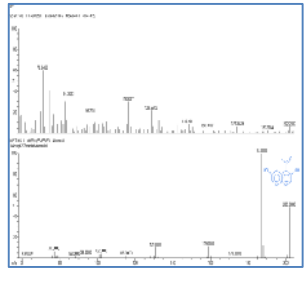
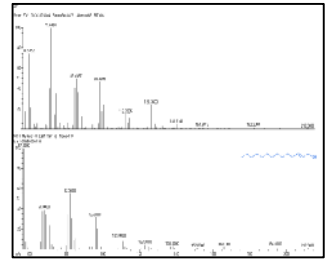
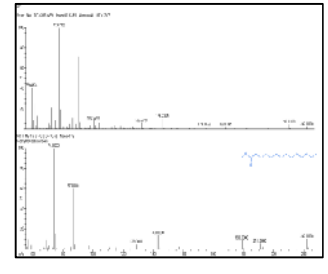
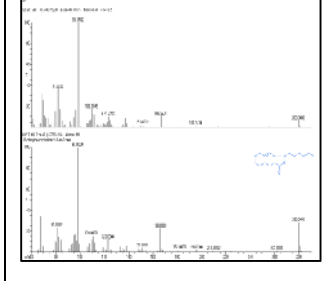
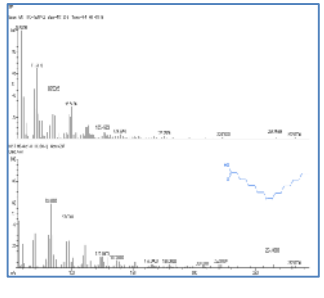
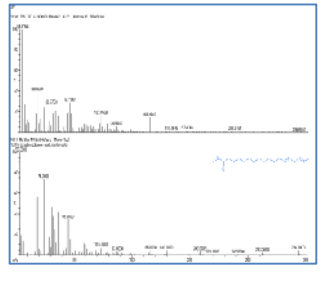
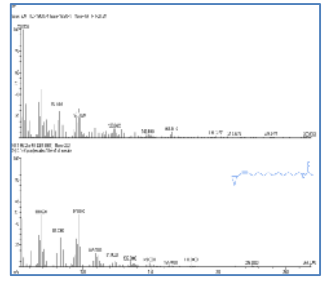
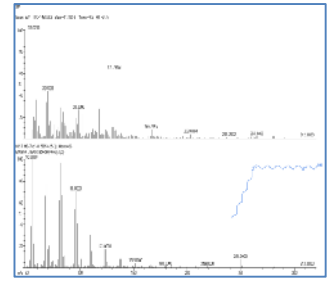
PAVL

Phytol 	**Cyclohexane, 1, 2, 3 – trimethoxy stereoisomer** 	**Cyclopentanone, 2-cyclopentylidene** 	**Flavone** 	**Geranyl isovalerate** 
4H-1-1-Benzopyran-4-one, 5,7-dihydroxy-2(-4-hydroxy phenyl) 	**Estra-1, 3, 5 (10) trien-17a –ol** 	**Dasycarpidan-1-methanol, acetate (ester)** 	**18, 19 – Secoyohimban – 19 – oic acid 16, 17, 20, 21 – tetra dehydro – 16 – (hydroxyl methyl) – methyl ester, (15 a, 16 E)** 	**1, 2 – Bis [1-methyl-3, 6- diaza homo adamantan tylidene-9] hydrazine** 

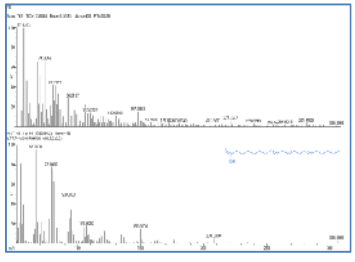
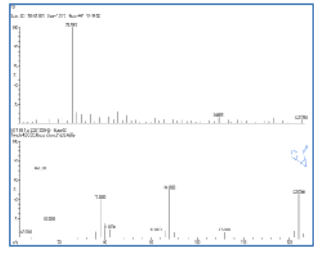
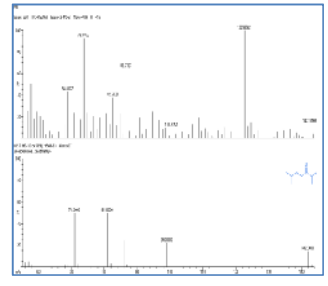
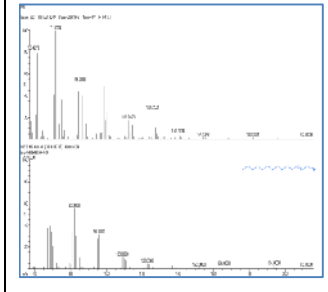
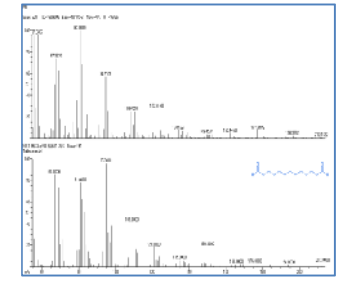
PVL

Palmitic acid 	**(-) Spanthulenol** 	**9, 12-Octadecandienoic acid[z z]-octyl ester** 	**3, 5- Heptadenal, 2-ethylidene-6-methyl** 	**Seychellene** 
Aromadendrene oxide-[1] 	**Isoaromadendrene epoxide** 	**5-cyclohexadecen-1-one** 	**Methyl z-11-tetradecenoate** 	**Phytol** 
Oleic acid 	**[1,1'-Bicyclopropyl]-2-octanoic acid, 2'-hexyl-, methyl ester** 	**Dasycarpidan-1-methano acetate ester** 	**Indole, N-methyl-5-(4-nitro styryl]-** 	**9, 12-Octadecadienoic acid [z, z]-2-hydroxy-1-[hydroxyl methyl] ethyl ester** 
Naphthalene-2-yl-acetic acid-6-hydroxy-6-methyl-cyclodecyl ester 				

SP

n- Hexadeconic acid 	9-Octadecenoic acid[z]-methyl ester 	4-Piperidinol, 4-ethynyl, 2,2, 6,6-tetramethyl 	Cis 9-Hexadecennal 	Docosanoic acid, methyl ester 
11-Oxatetra cyclo(4.2.1.1[2,5] 1[7,10]) undec-3-ene, 9-methoxy-9 methyl 	1-Acetyl-2,7-naphthalenediol 	E-2-Tetradecen-1-ol 	Methyl tetradecanoate 	13-Hexyloxacyclotridec-10-en-2-one 
Oleic acid 	13, 16-Octadecadenic acid, methyl ester 	Z-[13, 14-Epoxy tetradec-11-en-11-ol acetate 	Ethanol, 2-[9-Octadecenyl oxy]-z- 	

PB

8, 11, 14-Eicosatrienoic acid[zzz]	**Tricyclo[4 2 0 0 [2, 4] octan-5-one, [1a, 2a, 4a, 6a]**	**3-Heptanone-2, 6-di methyl**	**E-2-Tetradecen-1-ol**	**Tridecanedial**
				
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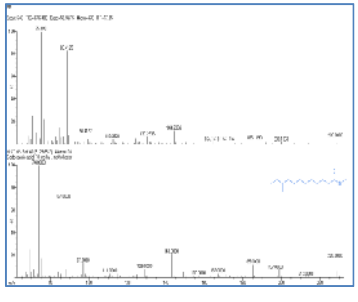
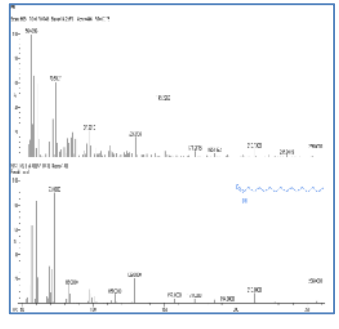
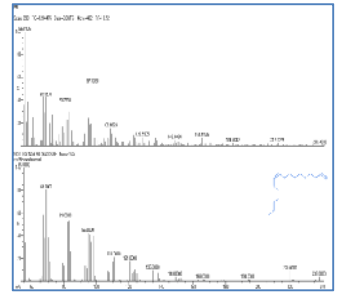
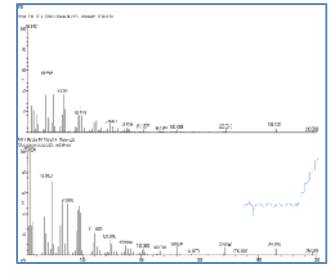
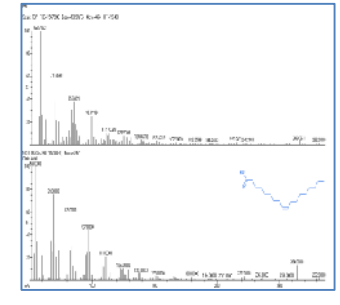
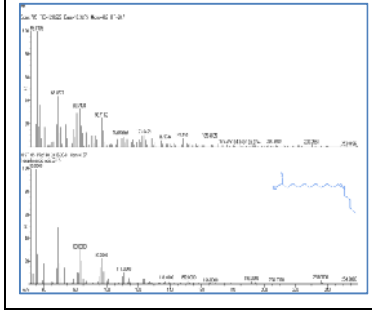
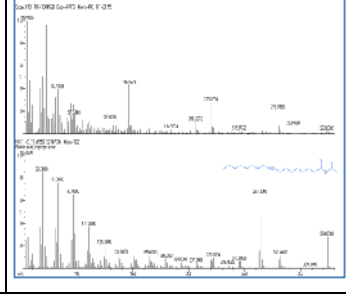
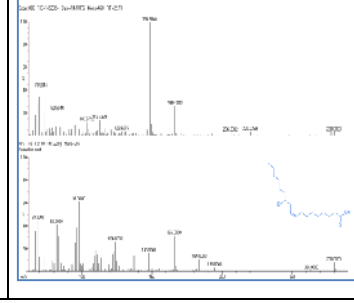
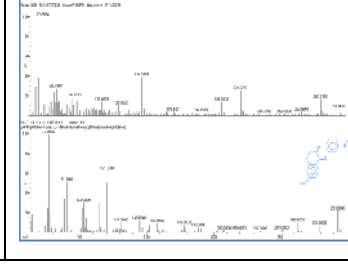
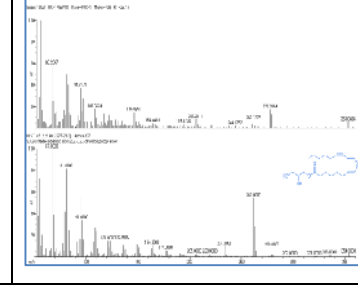
				
Hexa decenoic acid, z-11	**Elaidic acid, isopropyl ester**	**Ricinoleic acid**	**2-H-Naphthalen-1-one,3, 4-dihyro-6-methoxy-2-(4-methoxybenzylideno)-**	**9, 12-Octadecadienoic acid[zz]-2, 3 dihyroxy propyl ester**
				

PUBLICATIONS

1 Thilagavathi, R., Prithiba, A. and Rajalakshmi, R. (2018). Corrosion Inhibition of Mild Steel in acid medium using *Ulva reticulata* as Green Corrosion Inhibitor, International Journal of Green and Herbal Chemistry, Sec-A, 7(1), 095-113.

2 Thilagavathi, R., Prithiba, A. and Rajalakshmi, R. (2019). Assessment of *Passiflora vitifolia* leaves extract as a Potential Inhibitor for Mild Steel acid Corrosion, Rasayan Journal of Chemistry, 12(2), 431-449.

3 Thilagavathi, R., Prithiba, A. and Rajalakshmi, R. (2019). Performance Evaluation of *Sargassum Polycystum C. Agardh* Seaweed extract as Green Inhibitor for Acid Corrosion of Mild Steel, Oriental Journal of Chemistry, 35(1), 241-254.

SEMINARS / CONFERENCES ATTENDED

4 Attended and Presented a paper entitled "Corrosion Inhibition of Mild Steel in acid media using *Cocos nucifera* shezthe bowl extract as green inhibition", in the National seminar on Recent Innovations in Science and Technology organized by Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore on 23rd February 2018.

5 Attended Research convention on "Scientific Strategies for Quality Research" organized by Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore on 28th February 2018

.

6 Attended and presented a paper entitled "Application of *Ipomea staphylina* leaf as an eco-friendly biomass for the corrosion inhibition of mild steel in 1M HCl", in the International conference on Advanced Materials for Technological Applications organized by PSGR Krishnammal College for women Coimbatore during 3rd - 5th January 2018.

7 Attended and presented a paper entitled "Phytochemical screening UV and FT-IT Analysis of *Jacobina leaves*", in the International conference on Herbal and Natural Components as the Future of Pharmacology and 7th Annual Meet of the National Society of Ethnopharmacology organized by Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore during 27th February to 1st March 2017.

8 Attended and presented a paper entitled "Environmentally Benign Coconut Buttons Extract as Corrosion Inhibitor for Mild Steel in Acid Medium", in the National conference on Meeting the challenges of corrosion organized by Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore on 7th December 2017.

9 Attended and presented a paper entitled "Adsorption characteristics of *Croton Sparsiflorus* leaves extract on corrosion of mild steel in acidic media", in the Eighteenth National Congress on Corrosion Control organized by National Corrosion council of India, Karaikudi during 24th – 26th Febuary 2016.

10 Attended Research convention on "Research Ethics, Methods and Post Research Methods" organized by Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore during 18th – 20th February 2016.

11 Attended International Seminar on "Novel Approaches in Chemistry and its Environmental Impacts" organized by KPR Institute of Engg and Technology, Coimbatore on 26th September 2015.

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Section A: Green Chemistry

Research Article

CODEN (USA): IJGHAY

Corrosion Inhibition of Mild Steel in acid medium using *Ulva reticulata* Seaweed as Green corrosion Inhibitor

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Abstract: *Ulva reticulata* seaweed extract was tried as a corrosion inhibitor for mild steel in acid medium using electrochemical impedance, potentiodynamic polarisation and mass loss studies. At optimum concentration, the extract showed appreciable inhibition efficiency. This system obeyed Langmuir adsorption isotherm and this confirmed the adsorption of the inhibitor on mild steel. The mixed type of the inhibitor was reflected by Potentiodynamic polarization study. The results of electrochemical impedance studies inferred that on increasing concentration of the inhibitor, the charge transfer resistance of the mild steel increased and double layer capacitance decreased. The inhibitive nature of *Ulva reticulata* seaweed was reaffirmed by surface analytical study.

Keywords: Mild steel, *Ulva reticulata* seaweed, HCl, Corrosion, eco-friendly inhibitor

1. INTRODUCTION

The enhanced practice of aggressive acids in several industrial processes inevitably leads to corrosion of metals. A serious environmental problem, corrosion has been given much attention recently. Due

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ASSESSMENT OF *Passiflora vitifolia* LEAVES EXTRACT AS A POTENTIAL INHIBITOR FOR MILD STEEL ACID CORROSION

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ABSTRACT

The present study is focused on the application of *Passiflora vitifolia* leaves to extract as an inhibitor for corrosion of mild steel in 1M hydrochloric acid solution. Mass loss measurements reflect an inhibition efficiency of 97.1% at 12h of immersion and electrochemical measurement afforded a protection efficiency of 89.8% at 0.7% concentration of the inhibitor. The adsorption of the *Passiflora vitifolia* leaves extract onto the mild steel surface obeyed Langmuir adsorption isotherm. Thermodynamic parameters were also calculated and discussed. Potentiodynamic polarization implied that *Passiflora vitifolia* leaves extract in 1M HCl behaved as mixed type inhibitor. The Nyquist plots reflected an increase in charge transfer resistance and decreased double layer capacitance with an increase in additive dosage. Surface morphological studies further implied the effectiveness of the inhibitor under study.

Keywords: *Passiflora vitifolia* Leaves, Corrosion Inhibition, Mass Loss, Electrochemical Study, Surface Morphology.

INTRODUCTION

The serious consequences of corrosion, a naturally occurring phenomenon, tend to jeopardize the safety of metals and inhibit technology progress as metals place a vital role in the world economy. Among the acidic solutions, hydrochloric acid is the commonly used agent[1]- in industries to remove rust from the mild steel surface. This tends to considerable damage to the metal surface. Literature reports that several synthetic compounds have shown good anticorrosive activity but these inhibitors may cause reversible and irreversible damage to organ system viz., kidneys or liver, or to disturb a biochemical process or to disturb an enzyme system at some site in the body[2]. The toxicity may manifest either during the synthesis of the compound or during its applications. These toxic effects have led to the use of natural products as anti-corrosion agents which are eco-friendly and harmless. For this reason, plant extracts have attracted the attention of researchers as ecologically acceptable corrosion inhibitors. Hence the present work is proposed to evaluate the inhibitive nature of the selected plant extracts as an inhibitor for mild steel corrosion in 1M HCl. Our research team has carried out several studies successfully in utilizing natural products for mild steel corrosion inhibitor[3-15].

Passiflora species have been widely investigated for the presence of bioactive compounds in all the plant organs, including leaves, flowers, fruits and seeds, and a series of flavonoids, glycosides, alkaloids, and phenols have been reported[16-29]. Based on the above literature survey, the present study focuses on corrosion mitigation of MS in 1M HCl using *Passiflora vitifolia* leaves extract.

EXPERIMENTAL

Material Selection

The selected MS specimen for the present study comprised of (weight %) - carbon 0.019%, manganese 0.352%, silicon 0.049%, phosphorus 0.019%, sulphur 0.013%, chromium 0.010%, molybdenum 0.008%,

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Performance Evaluation of *Sargassum Polycystum C. Agardh* Seaweed Extract as Green Inhibitor for Acid Corrosion of Mild Steel

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ABSTRACT

The inhibition for the corrosion of mild steel in acid solution by the extract of *Sargassum polycystum* seaweed was studied using electrochemical technique and mass loss method. The results obtained show that the seaweed extract could serve as an effective inhibitor for the corrosion of mild steel in acidic medium. It was noticed that the inhibitor concentration, immersion time and temperature influenced the IE. The adsorption of the *Sargassum polycystum* extract molecules onto the metal surface obeyed Langmuir adsorption isotherm. Surface topography studies suggested the protection of MS surface from corrosion by the adsorption of inhibitor molecules onto the MS surface.

Keywords: *Sargassum polycystum*, Corrosion Inhibition, Potentiodynamic polarization, and Electrochemical Impedance spectra.

INTRODUCTION

Mineral acids are used in several industrial processes for processing like pickling, acid cleaning, and acid de-scaling etc, Mild steel (MS) is widely used in engineering materials particularly for the structure and automobile applications due to low cost and easy availability[1]. MS in acidic environment is severely affected by corrosion and it needs to be protected. Environmental regulations in industrialized countries have forced researchers globally to focus on green technological innovations. Green inhibitors are effective from an ecological and environmental perspective and can play a key role over toxic inhibitors. It is still amazing that the anticorrosion efficiency of green inhibitor is more or less equal to synthetic inhibitors[2]. Natural compounds have emerged as effective corrosion inhibitors due to the presence of complex organic compounds and biodegradable nature. Our research group have successfully investigated utilisation of several natural products against corrosion of MS in acidic environment and similar studies are also reported[3-15]. *Sargassum polycystum C. Agardh* is a dark brown colour and combined with rocks. *Sargassum polycystum C. Agardh* belongs to sargassaceae family. It is available in tropical region of western Pacific, Philippines, China, Japan,

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1.	Name of the Research Scholar	**R. Thilagavathi**
2.	Roll No. and Year of Registration	15PHCHF001 , 2015
3.	Department	Chemistry
4.	Name of the Research Guide	Dr. R. Rajalakshmi
5.	Title of the Thesis / Dissertation	Inhibitive performance of selected biomass- *Passiflora vitifolia, Pyrostegia venusta* and marine algae- *Sargassum polycystum and Padina boergesenii* on acid and alkali corrosion of Mild steel and Aluminum alloy –Experimental and Theoretical approach
6.	Similarity Content (%) Identified	**2%**
7.	Software Used	Turnitin
8.	Date of Verification	17/07/2019

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Date: 17-07-2019

Inhibitive Performance of selected biomass-Passiflora vitifolia,Pyrostegia venusta & marine algae-Sargassum polycystum & Padina boergesenii on acid/alkali corrosion of MS/AA-Exp. & theorical approach

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