SUBMISSION OF PROJECT REPORT
FOR
MINOR RESEARCH PROJECT

A Novel Electrochemical approach to corrosion control

Submitted to

University Grants Commission

South Eastern Regional Office

Chirag Ali Lane

Hyderabad-500001

Submitted by

C. RAJARATHINAM

UGC-SANCTION NO: F.MRP-5597/15(SERO/UGC)
(Link no: 5597, Comcode: TNBD007, DATE: JAN 2015)

Assistant Professor

Department of Chemistry

St. Joseph's College (Autonomous)

Tiruchirappallli-620 002

From

C. RAJARATHINAM
Assistant Professor, Department of Chemistry
St. Joseph's College (Autonomous)
Tiruchirappallli-620 002

Tiruchirappalli-2
10.06.2019

TO

The Joint Secretary
University Grants Commission
South Eastern Regional Office, Chirag Ali Lane
Hyderabad-500 001

Respected Sir,

Sub: Submission of Project Report of C. Rajarathinam

Dept: Chemistry, File No: F.MRP-5597/15 (SERO/UGC) LINK No: 5597

I am sending the following documents with regard to minor research project titled "A Novel Electrochemical approach to corrosion control" for your kind consideration.The total amount spent towards the minor project was Rs. 1,91,027.00 out of grant releasing the UGC of Rs:1,77,500.00. Hence, I kindly request you to be kind enough to reimburse the remaining amount of Rs. 13,527.00which was spent for the project.

Thanking you

Yours Sincerely

(C. Rajarathinam)

List of Enclosure

1. Consolidated Statement of Expenditure
2. Audited Utilization Certificate
3. Asset & Accession Certificate
4. Technical Report of Research Work
5. Project Uploaded Certificate

Copy to

1. Principal, St. Joseph's College, Trichy-02

Forwarder by

(Rev. Fr. Principal)
PRINCIPAL
St. JOSEPH'S COLLEGE
(AUTONOMOUS)
TIRUCHIRAPPALLI 620 002

ST. JOSEPH'S COLLEGE (Autonomous) Tiruchirappalli-2

UNIVERSITY GRANTS COMMISSION
SOUTH EASTERN REGIONAL OFFICE
CHIRAG ALI LANE, HYDERABAD-500 001

Utilization certificate

1. UGC Reference letter No. : F. MRP-5597/15 (SERO/UGC); Link No: 5597
2. Name of Principal Investigator : C. RAJARATHINAM
   Assistant Professor
   Department of Chemistry
   St. Joseph's College (Autonomous)
   Tiruchirappallli-620 002
   TamilNadu, India

Project title : **"A Novel electrochemical approach to corrosion control "**

Certified that an amount of Rs.1,91,027.00 (Rs. One lakh ninety one thousand and twenty seven only) was spent towards the minor research project. The total amount received for the project was only 1,77,500 out of sanctioned amount of Rs: 2,45,000. An amount of Rs: 1,77,500 sanctioned by the University Grants Commission vide UGC letter No. F. MRF-5597/15 (MRP/UGC-SERO), dated January 2015, towards minor research project has been utilized for the purpose for which it was sanctioned and in accordance with the terms and conditions laid by the commission. If a result of a check on audit, some irregularity is noticed at a later stage, action will be taken to refund, adjust or regularize the object amount. The balance amount of Rs.13,527.00 may be released by the UGC.

Signature of the
Principal Investigator

C. RAJARATHINAM, M.Sc.,M.Phil.,SET.,
Assistant Professor
Department of Chemistry
St. Joseph's College (Autonomous,
Tiruchirappalli - 620 002.

Signature of the
Principal

PRINCIPAL
St. JOSEPH'S COLLEGE
(AUTONOMOUS)
TIRUCHIRAPPALLI 620 002

Signature of the
Statutory Auditor

ROY JOHN THOMAS, B.Com.,F.C.A.,
CHARTERED ACCOUNTANT
M.No. 200 / 25188

ROY JOHN THOMAS, B.Com.,F.C.A.
D-4, BISHOP COMPLEX,
12-A, CONVENT ROAD,
MELAPUDUR,
TRICHY - 620 001.
CHARTERED ACCOUNTANT

DETAILED STATEMENT OF EXPENDITURE FOR MINOR RESEARCH PROJECT FROM MARCH 2014 TO APRIL 2017

1. UGC approval letter No. & Date : No.F. MRP-5597/15 (SERO/UGC) Dated January 2015
2. Name of Principal Investigator : C. Rajarathinam
3. Dept. of Principal Investigator : Chemistry
4. Title of the research project : "A Novel electrochemical approach to corrosion Control".
5. a. Period of expenditure : March 2015 to April 2017

   b. Details of expenditure

S. No	Item	Amount Allocated (Rs)	Amount sanctioned		Total expenditure Incurred (Rs)	Remarks	Due from the UGC
			1st Installment	2nd Installment			
Nonrecurring Items							
i	Books & Journals	10,000	10,000	-	10,083	Rs. 411 excess amount spent by P.I	
ii	Equipments	1,00,000	1,00,000	-	1,00,328		
Total:(Nonrecurring Items)		1,10,000	1,10,000	-	1,10,411		
Recurring Items							
iii	Field work/Travel	15,000	7,500	--	10200	Rs. 13,116 excess amount spent by P.I	13,527
iv	Chemicals & glassware's	1,00,000	50,000	--	51,316		
v	Contingency	10,000	5,000	--	5350		
vi	Hiring services	10,000	5,000	--	13750		
Total:(Recurring Items)		1,35,000	67,500	--	80,616.00		

Due from UGC :Rs. 13,527

ROY JOHN THOMAS F.C.A TRICHY

Certificate

Certified that the above grant has been utilized for the purpose for which it was sanctioned and in accordance with the terms and condition attached to the grant.

If a result of a check on audit, some irregularity is noticed at a later stage, action will be taken to refund, adjust or regularize the object amount.

Signature of the
Principal Investigator

C. RAJARATHINAM, M.Sc.,M.Phil.,SET..
Assistant Professor
Department of Chemistry
St. Joseph's College (Autonomous,
Triuchirappalli - 620 002.

Signature of thePrincipal

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TIRUCHIRAPPALLI 620 002

St. JOSEPH'S COLLEGE (Autonomous) Tiruchirappalli-2

Signature of the
Statutory Auditor

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D-4, BISHOP COMPLEX,
12-A, CONVENT ROAD,
MELAPUDUR
TRICHY - 620 001.
CHARTERED ACCOUNTANT

UNIVERSITY GRANTS COMMISSION

BAHADUR SHAH ZAFAR MARRG, NEW DELHI-110002

ACCESSION CERTIFICATE

This is to certify that **Mr. C. Rajarathinam (No.F: MRP-5597/15(SERO)/UGC dated January 2015) Department of Chemistry, St. Joseph's College (Autonomous), Tiruchirappalli-620002** has handed over the following books (15 books) purchased under the scheme of Minor Research Project to the Library, St. Joseph's college (Autonomous),Tiruchirappalli.

Signature of the
Principal investigator

C. RAJARATHINAM, M.Sc.,M.Phil.,SET.
Assistant Professor
Department of Chemistry
St. Joseph's College (Autonomous,
Tiruchirappalli - 620 002.

Signature of the
Librarian

Dr.M. DORAIRAJAN
LIBRARIAN
St. Joseph's College (Autonomous)
Tiruchirapalli-620 002.

Signature of the
principal

PRINCIPAL
St. JOSEPH'S COLLEGE
(AUTONOMOUS)
TIRUCHIRAPPALLI 620 002

ASSETS CERTIFICATE

This is to certify that **Mr. C. Rajarathinam (No.F: MRP-5597/15(SERO)/UGC dated January 2015) Department of Chemistry, St. Joseph's College (Autonomous), Tiruchirappalli-620002** has handed over the following equipments purchased under the scheme of Minor Research Project to the Library, St. Joseph's college (Autonomous), Tiruchirappalli-620002.

S.No	Particulars	Company	Date	Amount (in Rs.)
1.	Digital top pan balance	Infra make	05-05-2015	81200.00
2.	Digital pH meter with electrode		05-05-2015	14350.00
			VAT 5 %	4777.50
			Total amount	100328.00

Signature of the
Principal investigator

C. RAJARATHINAM, M.Sc.,M.Phil.,SET.
Assistant Professor
Department of Chemistry
St. Joseph's College (Autonomous,
Tiruchirappalli - 620 002.

Signature of the
Head of the Department

Head
PG & Research Dept. of Chemistry
St.Joseph's College (Autonomous)
Tiruchirappalli - 620 002

Signature of the
principal

PRINCIPAL
St. JOSEPH'S COLLEGE
(AUTONOMOUS)
TIRUCHIRAPPALLI 620 002

ST. JOSEPH'S COLLEGE (AUTONOMOUS) Tiruchirappalli-2

CONSOLIDATED STATEMENT OF EXPENDITURE INCURRED ON THE MINOR RESEARCH PROJECT FOR THE PERIOD OF JANUARY 2015 TO APRIL 2017

Name of P.I & Dept. : C. Rajarathinam & Chemistry

Title of the research project : "A Novel electrochemical approach to corrosion Control".

UGC approval letter No. & Date : No.F. MRP-5597/15 (SERO/UGC), Dated January 2015

BOOK & JOURNALS

S. No	Title of the books	Bill No &Date	Amount (in Rs.)	Accn.No.
1.	Organic chemistry-Morrison and Boyd	1289, 23/03/15	850.00	173939
2.	Concise of Inorganic chemistry –Lee	1289, 23/03/15	950.00	173940
3.	Advanced organo chemistry- March	1289, 23/03/15	850.00	173941
4.	Organic chemistry –IL Finar	1289, 23/03/15	920.00	173942
5.	Chemical sciences-UGC-CSIR book	1296 27/07/15	775.00	173943
6.	Inorganic chemistry-RL Madan	1291, 13/08/15	525.00	173944
7.	Organic chemistry – RL Madan	1291, 13/08/15	550.00	173945
8.	Physical chemistry –RL Madan	1291, 13/08/15	425.00	173946
9.	Modern inorganic chemistry	1292, 16/10/15	495.00	173947
10.	Photochemistry and pericyclic reaction	129, 16/10/15	300.00	173948
11.	Modern Methods Of Org. Synthesis Caruthers	Order ID 402 25/11/15	495.00	173949
12.	Elementary organic spectroscopy , Y R Sharma	Order ID 402 25/11/15	380.00	173950
13.	Organic chemistry – Clayden	Order ID 402 25/11/15	1940.00	173951
14.	Stere. Conformation and mechanism. Kalsi	Order ID 171 07/03/16	357.00	173952
15.	Principal and prevention of corrosion- Angel	Order ID 403 08/03/16	271.00	173953
	Total Amount (in Rs.)		10083	

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Chemicals & Glassware

S.No	Name of the chemicals	Bill No & Date	Rs
1	Potassium dihydrogen orthophosphate -500 gm	212 & 18-01-2016	560
2	di- Potassium dihydrogen orthophosphate-500gm		650
3	Sodium dihydrogen orthophosphate-500 gm		490
4	di- sodium dihydrogen orthophosphate		600
5	Zinc sulphate -500 mg		320
6	Copper sulphate -500 gm		650
7	Magnesium sulphate -500 gm		200
8	Sodium gluconate -500 gm		350
9	Potassium sodium tartrate -500 gm		1060
10	Acetone -2.5 lit		2520
11	Trisodium citrate -500 gm		390
12	Sodium hydroxy pellets -500 gm		300
13	1-hydroxyethylidenediphosphonic acid -100 gm		6000
14	3-aminopropylphosphonic acid -1 gm		19000
15	Cetyl pyridinium chloride -100 gm		800
16	Sodium lauryl sulphate -500 gm		600
17	Benzyl trimethyl ammonium chloride- 100 gm		1900
18	N,N-cetl trimethyl ammonium bromide -100 gm		600
		VAT 5%	1849
		Total	**38840**

Chemicals & Glassware

19	Beaker -100 mL -30 Nos	198 & 21-12-2015	1500
20	Beaker -250 mL -5 Nos		275
21	Beaker -500 mL -5 Nos		490
22	Standard flask 10 mL-2 Nos		340
23	Standard flask 25 mL-2 Nos		340
24	Standard flask 50 mL-2 Nos		360
25	Standard flask 100 mL-2 Nos		1000
26	Standard flask 250 mL-5 Nos		480
27	Standard flask 500 mL-2 Nos		640
28	Standard flask 1000 mL-1 Nos		465
29	Conical flask 250 mL-3 Nos		255
30	Conical flask 100 mL-3 Nos		177
31	Pipette graduated 1 mL -3 Nos		285
32	Pipette graduated 2 mL -3 Nos		285
33	Pipette graduated 5 mL -3 Nos		330
34	Pipette graduated 10 mL -3 Nos		330
35	Pipette graduated 120 mL -3 Nos		330
36	Measuring jar 100 mL -2 Nos		580
37	Measuring jar 250 mL -2 Nos		1000

JOHN THOMAS ROY F.C.A TRICHY

38	Burette 50 mL-2 Nos		600
39	Burette 100 mL-2 Nos		900
40	Test tube 20 Nos		180
41	Burette stand with clamp -2 Nos		600
42	Test tube stand 4 Nos		140
		VAT 5%	594
		Total	12476

STATEMENT OF EXPENDITURE INCURRED ON FIELD WORK

Name of the Principal Investigator: **C. Rajarathinam**

Name of the Place Visited	Duration of Visit		Mode of Travel	Expenditure Incurred (Rs)
	From	To		
Central Electrochemical Research Institute Karaikudi (Corrosion unit)	15/05/15 (One day)		Car	1500
Corrosion Research Centre, G.T.N. Arts College, Dindigul	10/10/15(One day)		car	1200
Indian Institute of Technology, Chennai	29/11/15 (One day)		Bus	1000
Central Electrochemical Research Institute Karaikudi (Corrosion unit)	27/01/16 (One day)		car	1500
Indian Institute of Technology, Chennai	29/10/16(One day)		Bus	1000
Central Electrochemical Research Institute Karaikudi (Corrosion unit)	27/01/16(One day)		car	1500
Corrosion Research Centre, G.T.N. Arts College, Dindigul	04/02/16(One day)		car	1500
Corrosion Research Centre, G.T.N. Arts College, Dindigul	7/03/16(One day)		car	1000
			Total	10200

ROY JOHN THOMAS F.C.A TRICHY

STATEMENT OF EXPENDITURE INCURRED ON FIELD WORK

Name of the Principal Investigator: **C. Rajarathinam**

Contingency:

S. No	Name of the Expenditure	**Bill & Date**	**Amount**
1	Xerox and print out	10/06/15	450
2	IR,UV spectra	1741: 20/7/15	450
3	IR,UV spectra	1918: 25/7/15	700
4	SEM and AFM	1962: 5/10/15	500
5	SEM and AFM	1950: 6/5/16	1000
6	Xerox and communication	10/12/15	750
7	Polarization studies	4/11/15	1500
8	Chartered account fees	250, 12/8/17	500
		Total	5350

Hiring Services:

S.No	Item	Bill and date	Rs
1	Hiring the buffing machine for two months	20-01-2016 to 20-3-2016, Voucher	5000
2	Metals and hooks	Voucher	8400
Total			13750

All the expenditure incurred under the above approved Minor Research Project is according to rules, items & conditions laid by UGC only.

Signature of the
Principal Investigator

C. RAJARATHINAM, M.Sc.,M.Phil.,SET.
Assistant Professor
Department of Chemistry
St. Joseph's College (Autonomous)
Tiruchirappalli - 620 002.

Signature of the
Principal

PRINCIPAL
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(AUTONOMOUS)
TIRUCHIRAPPALLI 620 002

Signature of the
Statutory Auditor

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M.No. 200 / 25188

ST. JOSEPH'S COLLEGE (Autonomous) Tiruchirappalli-2

ROY JOHN THOMAS B.Com.,F.C.A. CHARTERED ACCOUNTANT
04, BISHOP COMPLEX, 12-A, CONVENT ROAD, MELAPUDUR, TRICHY - 620 001.

Minor Research Project-Final Report

(March 2015-April 2017)

Principal Investigator	**: C Rajarathinam**
MRP Period	**: March 2015-April 2017**
UGC Reference No:	**: NoF MRP-5597/15(SERO/UGC) dated Jan 2015**
Department	**: Chemistry**
College	**: St. Joseph's College, Tiruchirappalli-620 002**

Introduction

In day today life metals are used almost in all fields of technology and industries. Metallic corrosion is the progression of vicious attack on the metal surface through the contact with the environment. Corrosion is a natural deterioration progression which can be restricted but cannot be completely prevented. In past years, chemical inhibitors were used to control corrosion. Later it was found that the chemical inhibitors were dangerous and venomous. So eco-friendly, non–venomous chemical inhibitors were used. In recent days, green inhibitors from natural products have been used as inhibitors which are eco-friendly and completely non-hazardous[1-3]. The leaf is trifoliate each leaflet has dimensions about 5-14 x 2–6 cm. The shape of the leaves was found to be ovate with pointed tip and rounded base. Young leaves are pale green or pink in color. Each leaf has 4-12 pairs of side veins which are joined at the margin.

The present determination is done,

- To estimate the anticorrosion ability of *Aegle marmelos* (AM) from the determined corrosion inhibition efficiencies of AM and AM-Zn^{2+} systems on carbon steel in acidic environment.
- To identify the phytochemicals and GC-MS for the ethanolic extracted AM.
- To confirm the formation of protective film on the metal surface by FT-IR, UV spectra and SEM analysis.

removed and then washed with deionised water, dried and reweighed. The average weight loss of two parallel specimens were determined and the corrosion rate was calculated as follows.[6]

$$\text{Corrosion Rate} = \frac{87.6 \times W}{A \times T \times D} \quad \text{(mpy)}$$

W = Loss in weight in mg

A = Surface area of the specimen (cm^2)

T = Time in hours

D = Density ($7.2 g/cm^3$)

Corrosion Inhibition Efficiency (IE) was then calculated using the equation

$$IE = 100[1-(W_2/W_1)]\ \%$$

Where,

W_1 = Corrosion rate in the absence of inhibitor and

W_2 = Corrosion rate in the presence of inhibitor

Infra-Red (IR) Spectroscopy

Infrared spectroscopy is a well-developed technique to identify chemical compounds. The specimens were suspended by means of hooks in solution having with and without inhibitor for 72 hours. After 72 hours the specimen were taken out. Then the film formed on the metal surface was scratched off and taken for FT-IR spectral study.

SEM Analysis

A Scanning Electron Microscope (SEM) is an electron microscope which gives information about the sample's surface morphology. The specimens were suspended by means of hooks in solution in the presence and in the absence of inhibitor for 72 hours. Then the specimens were taken out and the metal specimen was analyzed.

Results and Discussion

Qualitative preliminary phytochemical screening

The active phytoconstituents such as alkaloids, terpinoids, saponins, flavanoids and proteins are present except tannins, non-reducing sugar and cyanogenic glycosides that are tabulated in Table (1). These active phyto constituents are responsible for the inhibitive nature of AM plant extract.

Table (1): Qualitative preliminary phytochemical screening of ethanolic extract of *Aegle marmelos* (AM)

Phyto-constituents	**Inferrence**	**Phyto-constituents**	**Inferrence**
Anthraquinone Glycosides	+	Carbohydrates	+
Reducing Sugar	+	Saponin Glycosides	+
Alkaloids	+	Cyanogenic Glycosides	-
Non-Reducing Sugar (Starch)	-	Hexose Sugar	+
Terpenoids	+	Tannins	-
Amino Acids	+	Phenolic Compounds	+
Tyrosine	+	Steroids	+
Saponins	+	Proteins	+
Glycosides	+	Flavonoids	+

Gas Chromatography- Mass Spectrum Study (GC-MS)

The GC-MS chromatogram of the AM extract showed twenty peaks which indicate the presence of twenty chemical constituents (Fig.3). The retention time (RT) and peak area (%) of AM extract are tabulated.

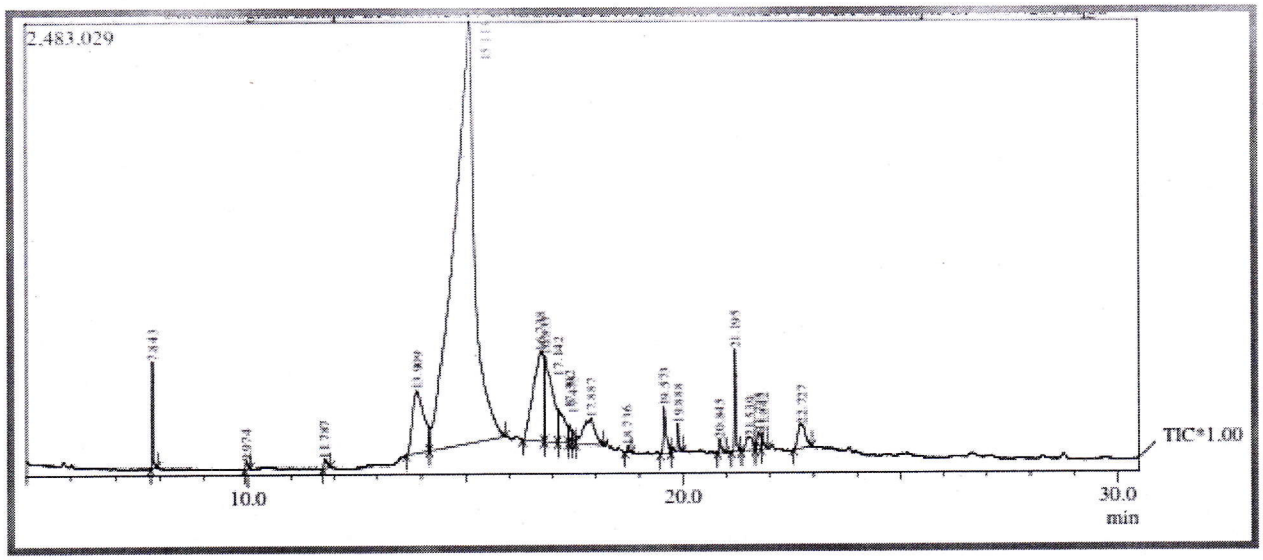
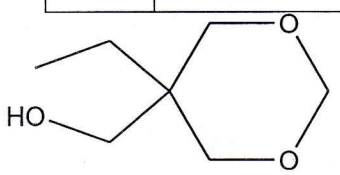


Fig (2): GC-MS chromatogram of the ethanolic leaves extract of *Aegle marmelos* (AM)

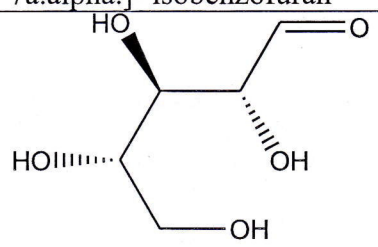
Table (2) – Chemical components identified in the ethanolic extract of the leaves of *Aegle marmelos* (AM) by GC-MS

Sl.No	Rt (min)	Name of the Compound	Peak Area %
1	7.843	1,1,3-triethoxy- propane	1.06
2	9.974	1-methoxy-4-(2-propenyl)- benzene	0.12
3	11.787	2-Methoxy-4-vinylphenol	0.24
4	13.909	1,2,3,4-Cyclohexanetetrol	5.57
5	15.113	5-ethyl-1,3-Dioxane-5-methanol	69.29
6	16.738	L-Lyxose	7.40
7	16.833	1-deoxy- Inositol	5.25
8	17.142	4-butoxy-butanoic acid	1.79
9	17.392	decanoic acid	0.37
10	17.392	2-butyl- 1-Octanol	0.27

11	17.887	mome inositol	2.43
12	18.736	tetradecyl- oxirane	0.09
13	19.573	9-octadecenoic acid	1.06
14	19.888	ethyl pentadecanoate	0.48
15	20.845	1-Hexadecanol	0.24
16	21.195	[R-[R*,R*-(E)]]- 3,7,11,15-tetramethyl-2-hexadecen-1-ol,	1.38
17	21.539	cis,cis,cis-7,10,13-hexadecatrienal	0.72
18	21.735	(Z,Z)-9,12-Octadecadienoic acid	0.51
19	21.842	ethyl (9Z,12Z)-9,12-octadecadienoate	0.29
20	22.727	1,3,3a,4,5,7a-hexahydro-5-methyl-4-(1 propenyl)[3a.alpha.,4.alpha.(Z),5.beta., 7a.alpha.]- isobenzofuran	1.43



5-ethyl-1,3-Dioxane-5-methanol



L-Lyxose

Fig.3: Predominant phytoconstituents present in *Aegle marmelos* (AM)

Weight-loss Method

Inhibition efficiency of carbon steel with various concentration of AM extract in 0.5M HCl at 25°C is tabulated in Table (3). From the results, it is clear that the corrosion inhibition enhances with the inhibitor concentration. It was found that at AM-Zn^{2+} (50:25) and AM-Zn^{2+} (50:50) the inhibition efficiencies were 64 and 72% respectively for 72 hours.

Table (3): Inhibition efficiencies and corrosion rates of carbon steel in

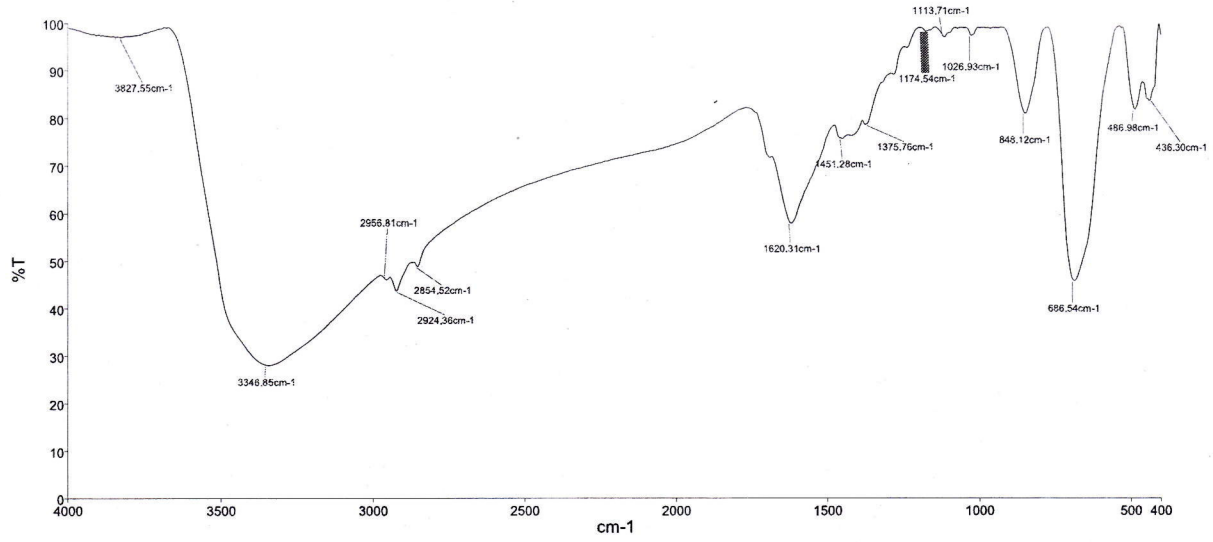
AM-Zn^{2+} in 0.5M HCl

Immersion Period = 72 h

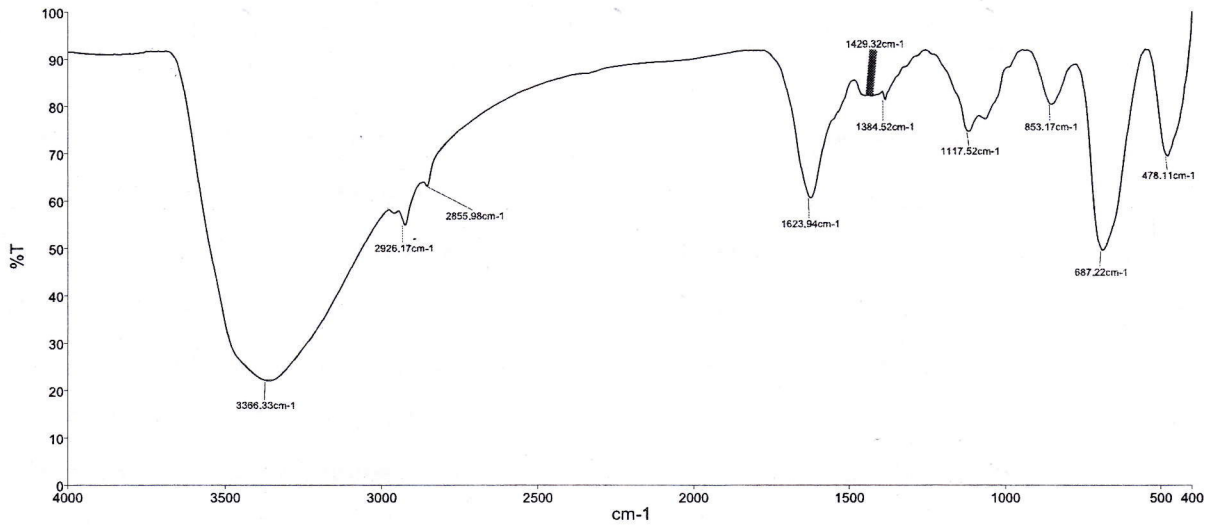
Conc. of AM (ppm)	Conc. of Zn^{2+} ion (ppm)					
	0		25		50	
	IE%	CR (mpy)	IE%	CR (mpy)	IE%	CR (mpy)
10	42	3.6	48	2.1	64	1.9
20	48	3.2	58	2.0	59	2.7
30	47	2.4	55	2.8	68	1.9
40	48	2.2	61	2.3	70	1.7
50	56	2.7	64	1.4	72	1.1
Blank		8.5		8.5		8.5

Analysis of FTIR

FTIR spectroscopy has been used to determine the functional groups of the protective film formed on the metal surface.[7-8] FTIR spectrum of the AM extract and AM-Zn^{2+} as inhibitors are depicted in Figs.(4 a & b). For the pure extract as inhibitor the band observed at 3346.85cm^{-1}. There is a decrease in the frequency from 3600.00 cm^{-1} to 3346.85cm^{-1}. Similar decrease pattern is observed for AM-Zn^{2+} (50 ppm) the band was observed at 3366.33 cm^{-1} respectively. The bands at 1620.31 cm-1 and 1451.28 cm-1 which are due to the coupling of -C-O stretching and -C-O-H in-plane bending of the carboxylate anion are shifted to 1623.94 cm^{-1} and 1384.54cm^{-1} in AM-Zn^{2+}. The bands at 1113.71cm^{-1} and 848.12 cm^{-1} (due to the ring oxygen and metal oxygen bond) are shifted to 1117.52 and 852.17cm^{-1}. This type of shift reveals the interaction between the metal and the active phytoconstituents [9].



(a)



(b)

Fig.4: IR Spectra of

(a) *Aegle marmelos* as inhibitor

(b) *Aegle marmelos* and Zn^{2+} (50:50) as inhibitor

Scanning Electron Microscope (SEM) Analysis

The texture and pore structure of the inhibited and uninhibited surface in acidic medium are shown in Fig.(5 & 6). It is confirmed that the inhibitor systems has formed a dense film over the metal surface[10].

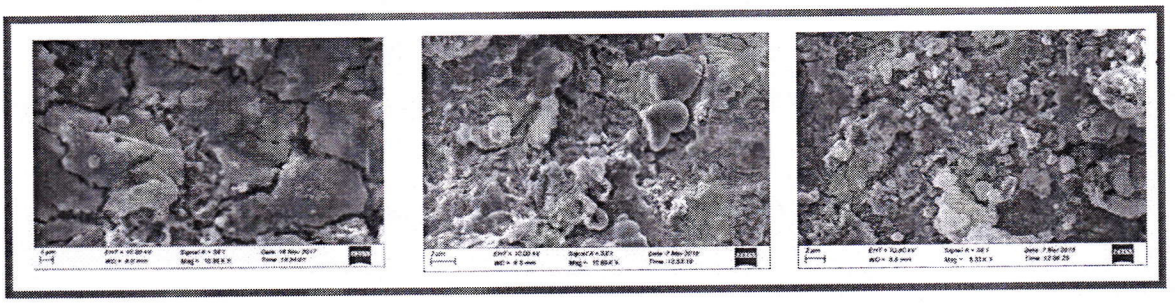


Fig. (5) SEM images of blank (0.5M HCl)

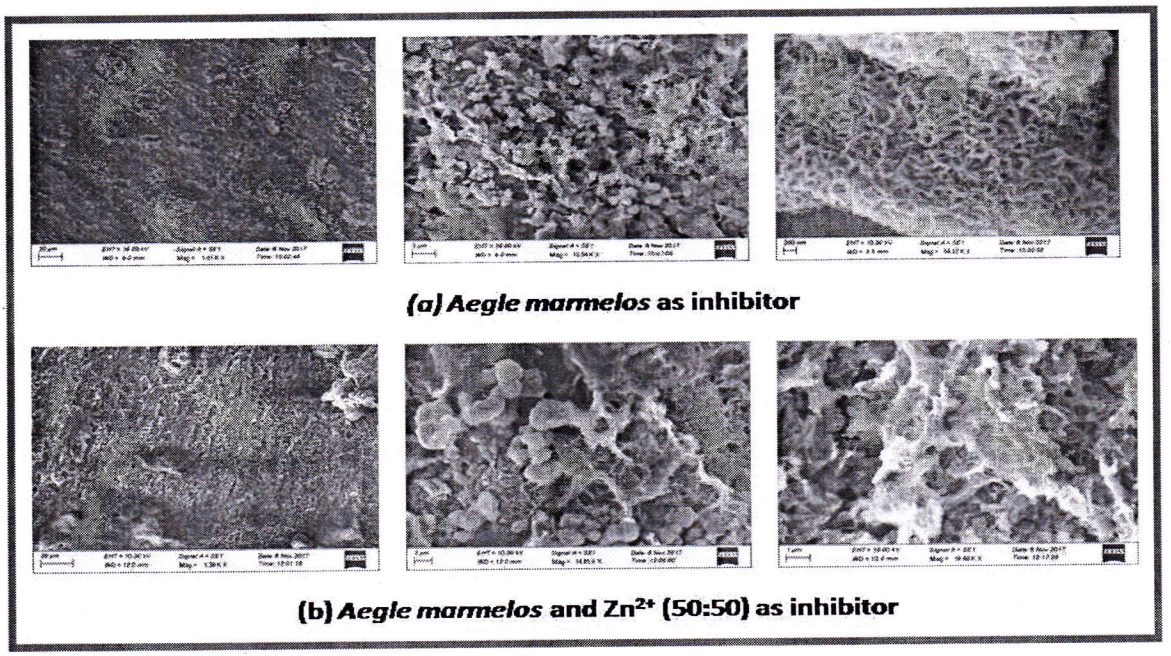


Fig.6: SEM images

Conclusions

The present investigation is concluded that,

- *Aegle marmelos* has a good inhibiting ability against corrosion for carbon steel in 0.5 M HCl is due to the active phytoconstituents present in the plant.
- The maximum inhibition efficiency of AM - Zn^{2+}(50:50) was found to be 72%.
- The shift observed in FT-IR bands confirms the protective film formed on the surface of the metal.
- The surface of the film formed on the metal is found to be denser by the SEM analysis.

Reference

1. Kilbourn BT, Cer. Eng. Sci. Proc. **6** (1985) 1331.
2. Bethencour M., Botana FJ, Calvino JJ, Marcos M, Corros. Sci. **40** (1998) 1803.
3. Arenas MA, Conde A, de Damborenea J, Corros. Sci. **44** (2002) 511.
4. Nganga, M.M., Chhabra, S., Thoruwa, C.L., Hussain, H., and Krohn, K.Chemical constituents from the leaves of *Drypetesgerrardii*. Biochem. Syst. Ecol. **36**(2008) 320
5. Bharath Kumar R, Suryanarayana B Promising antidote plant species from the tribals of Sriharikota Island, Andhra Pradesh. Life Sciences Leaflets 2011;**19**: 769-779.
6. Alphonsa Juliet Helina J K, DayanaJayaleela G, and Alex Ramani V, *World Journal of Pharmacy and Pharmaceutical Sciences,* **4**, 717-726.
7. Rajendran S, Apparao B.V and Palanisamy N, *Proc. 8th Europ. Symp. Corros. Inhibitors*, Ferrara, Italy,**1**(1995) 465.
8. Kalaivani, R., Narayanasamy, B., Selvi, J. A., Amalraj, A., Jayasundari, J. and Rajendran, S., *Portugaliae Electrochimica Acta*. **27**(2009), 177.
9. Vera, R., Schrebler, R., Cury, P., Del Reo, R. and Romero, H., *J. Appl. Electrochem.*, **37**(2007), 519-525.
10. Epshiba R., Peter Pascal Regis A., Rajarathinam C., Betsy Clarebel R., Philomena Mary S. andAlphonsa Juliet Helina J.K, *World Journal of Pharmacy and Pharmaceutical Sciences***5**, 921.

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Urkund Analysis Result

Analysed Document:	A Study on Anti-corrosion ability of Aegle marmelos on Carbon Steel in Acidic Medium.docx (D53679678)
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Sources included in the report:

https://en.wikipedia.org/wiki/Aegeline
http://peacta.org/articles_upload/PEA_31_3_2013_141_155.pdf
e010f61e-75e5-4133-ad80-4e02782a130a

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