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## Corrosion Inhibition Effect of Arial Parts of Euphorbia Caducifolia for Aluminium in HCl

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## ABSTRACT

Corrosion is one of the most damaging and costly naturally occurring events seen today. The most common kinds of corrosion result from electrochemical reactions. It can be prevented if the metal is coated with something which does not allow moisture and oxygen to react with it. It can be controlled by either alloying or by anti rust solutions. The naturally occurring plant products are eco-friendly, compatible, nonpolluting, less toxic, easily available, biodegradable and economic to be used as corrosion inhibitor. Euphorbia caducifolia has been selected to study its corrosion inhibition efficiency. It is easily available in any season. It is native to Thar Desert of India and located on rocky terrain, hills. It is used for treatment of bleeding wound, cutaneous eruption, urinary problems, kidney stones, rheumatic pain, bronchitis, jaundice, diabities, stomach pain, hernia etc. It is also called "Thor" and "Danda-thor". It contains caudicifolin) norcycloartane type triterpene, cyclocaducinol, triterpenes euphol, tirucallol and cycloartenol. Corrosion inhibition efficiency of arial parts of Euphorbia caducifolia was studied for aluminium in HCl. Maximum inhibition efficiency was found 99.47% in 1N HCl acid with 0.8% leaf corrosion inhibitor whereas it was 94.21% for stem and 90.51% for flower with same concentration of inhibitor i.e. 0.8%. Inhibition efficiency was studied in different concentration of acid (1N, 1.5N, 2N and 2.5N) with different concentration of inhibitor (0.2%, 0.4%, 0.6% and 0.8%). Weight loss and thermometric methods were used. Inhibition efficiency was found to be increase with increase in concentration of inhibitor and decrease with increase in acid strength.

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## Introduction

Corrosion is one of the most damaging and costly naturally occurring events seen today. The most common kinds of corrosion result from electrochemical reactions. It affects almost all the metals and decays the metallic properties of metals. It is unavoidable process but it can be prevented if the metal is coated with something which does not allow moisture and oxygen to react with it. It can be controlled by either alloying or by using corrosion inhibitors (anti-rust solution)<sup>1</sup>.

By mass, aluminium makes up about 8% of the earth's It is the third most abundant crust. element after oxygen and silicon and the most abundant metal in the crust. Aluminium is remarkable for the metal's low density and its ability to resist corrosion through the phenomenon of passivation. Aluminium and its alloys are vital the aerospace industry and important to in transportation and building industries, such as building facades and window frames. The oxides and sulfates are the most useful compounds of aluminium.

In the acid, oxidation of metal occurs and hydrogen gas evolved. In the environment so many harmful gases and acids are present in the air which disintegrate and degrade the metal and alloy by corrosion. In industries acids are widely used in many processes so we need to use corrosion inhibitors which prevent or decrease the loss of metal.

A number of N and S containing ligands have been synthesized  $^{2\text{-}5}\text{which}$  are found as effective corrosion

inhibitors. Some heterocyclic compounds and their derivatives have been also used for metals as corrosion inhibitors in acidic media<sup>6-9</sup>. Epoxy esters inhibit the corrosion of aluminium and reduce evolution of hydrogen gas in aqueous solution of alkaline media<sup>10.</sup> Schiff bases are good corrosion inhibitors<sup>11-14</sup>. Mannich bases are also investigated as good corrosion inhibitor<sup>15-17</sup>. All the above components are good corrosion inhibitors but these are costly, toxic, pollutant and harmful so we need eco-friendly inhibitors.

The naturally occurring plant products are eco-friendly, compatible, nonpolluting, less toxic, easily available, biodegradable and economic to be used as corrosion inhibitor. A number of natural products extracted from plants are also found effective corrosion inhibitor like: *Argemone mexicana*<sup>18</sup>, *Withania somnifera*<sup>19</sup>, *Holly Basil*<sup>20-21</sup>, *ocimum sanctum*<sup>22</sup> etc.

*Euphorbia caducifolia* is a Euphorbiaceae species native to Thar Desert of India, where latex of *E. caducifolia* (ECL) is used by the local inhabitants for treatment of bleeding wound, cutaneous eruption and other skin diseases<sup>23</sup>. Isolated fraction of E. caducifolia (IFEC) and latex of E. caducifolia (ECL) were tested against S. aureus, M. luteus, B. subtilis, E. coli, S. typhi, A. niger and C. albicans<sup>24</sup>. Flower extract of *Euphorbia caducifolia*<sup>25</sup>is found effective corrosion inhibitor for iron in different acidic media like sulphuric acid, nitric acid and hydrochloric acid. In the proposed investigation *Euphorbia caducifolia* extract will be used as corrosion inhibitor in hydrochloric acid on aluminium.

## **Plant Description**

*Euphorbia caducifolia* is native to Thar desert of India and located on rocky terrain, hills. It is also called "Thor" and "Danda-thor".

Extract of *euphorbia caducifolia* is widely used in medicines. It is used for treatment of bleeding wound, cutaneous eruption, urinary problems, kidney stones, rheumatic pain, bronchitis, jaundice, diabetes, stomach pain, hernia etc.



It contains caudicifolin<sup>26</sup> (8,14-epoxy-17-hydroxy-11,13(15)-abietadien-15,12-olide) norcycloartane type triterpene, cyclocaducinol, triterpenes euphol, tirucallol and cycloartenol<sup>27</sup>.



#### **Experimental**

Square specimen of iron of dimension 2.5x2.5 cm<sup>2</sup> containing a small hole of about 2mm diameter near the upper edge were used for studying of corrosion. Different solutions of HCl were prepared using double distilled water.

Each specimen was suspended by a V shaped glass hook made of fine capillary tube and immersed in the beaker containing 100 ml of uninhibited and different concentration of inhibited test solutions. After the sufficient exposure, the specimen were taken out, washed thoroughly with running water and then dried with hot air dryer and then the final weight of each specimen was taken.

The percentage inhibition efficiency was calculated<sup>28</sup> as

$$\eta\% = \frac{\Delta \mathbf{w}_{\mathbf{u}} - \Delta \mathbf{w}_{\mathbf{i}}}{\Delta \mathbf{w}_{\mathbf{i}}} \times 100$$

and surface coverage ( $\theta$ ) was calculated as

$$\boldsymbol{\Theta} = \frac{\Delta \mathbf{W}_{\mathbf{u}} - \Delta \mathbf{W}_{\mathbf{j}}}{\Delta \mathbf{W}_{\mathbf{i}}}$$

Where  $\Delta W_u$  is weight loss of metal in acid solution in the absence of inhibitor and  $\Delta W_i$  is weight loss of metal in acid solution in the presence of known amount of inhibition.

The Corrosion rate (CR) in mm/yr can be obtained by following equation

$$R_{corr.} = \frac{\Delta W \ge 87.6}{D \ge A \ge T}$$

Where  $\Delta$  W = weight loss in milligrams, D = metal density in g /cm<sup>3</sup>, A = area of sample in cm<sup>2</sup>, T= time of exposure of the metal sample in hours.

Inhibition efficiency was also determined by thermometric method. In this method a specimen was immersed in a reaction chamber containing 100ml of solution at an initial temperature of 25°C. Temperature change were measured using a thermometer. Initially temperature increased slowly, then rapidly and attain a maximum value before falling. The maximum temperature was recorded. Percentage inhibition efficiency were calculated as

$$\eta\% = \frac{RN_f - RN_i}{RN_f} \times 100$$

Where  $RN_{\rm f}$  and  $RN_{\rm i}$  are the reaction number in the absence and presence of inhibitor respectively and reaction number is defined as

$$RN = \frac{T_m - T_i}{t}$$

Where  $T_m$  and  $T_i$  are maximum and initial temperature and t is the time (in minutes) required to reach the maximum temperature.

#### **Result and Discussion**

Weight loss, percentage inhibition efficiency, surface coverage and corrosion rate in 1N, 1.5N, 2N and 2.5N HCl solution with different concentration of leaf, stem and flower extract inhibitor are given in table1 and table 2.

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Cyclocaducinol

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# Table 1. Weight loss data ( $\Delta W$ ) and percentage inhibition efficiency (%) for aluminium in1N and 1.5N HCl with inhibitor of leaf, stem and flower extract.

	Area of Specimen : $13 \text{ cm}^2$											
1N HCl (35 min)						1.5N HCl (20 min)						
Conc. Of inhibitor (%)	<b>Δ</b> W (g)	I.E. (η%)	Surface Coverage (θ)	Corrosion Rate	Log (θ/1-θ)	Conc. of inhibitor (%)	<b>⊿</b> W(g)	I.E. (η%)	Surface Coverage (θ)	Corrosion Rate	Log (θ/1- θ)	
Leaf						Leaf						
Uninhibited	0.5120			2.1905		Uninhibited	0.5365			4.0168		
0.2	0.0425	91.69	0.9169	0.1818	1.0427	0.2	0.0636	88.14	0.8814	0.4761	0.8710	
0.4	0.0303	94.07	0.9407	0.1296	1.2003	0.4	0.0498	90.71	0.9071	0.3728	0.9896	
0.6	0.0162	96.83	0.9683	0.0693	1.4849	0.6	0.0324	93.95	0.9395	0.2425	1.1911	
0.8	0.0027	99.47	0.9947	0.0115	2.2734	0.8	0.0071	98.66	0.9866	0.0531	1.8670	
Stem						Stem						
0.2	0.0518	89.87	0.8987	0.2216	0.9480	0.2	0.0724	86.49	0.8649	0.5420	0.8063	
0.4	0.0488	90.46	0.9046	0.2087	0.9769	0.4	0.0582	89.15	0.8915	0.4357	0.9146	
0.6	0.0351	93.14	0.9314	0.1501	1.1329	0.6	0.0469	91.24	0.9124	0.3511	1.0176	
0.8	0.0296	94.21	0.9421	0.1266	1.2114	0.8	0.0407	92.41	0.9241	0.3047	1.0854	
Flower						Flower						
0.2	0.0759	85.16	0.8516	0.3247	0.7588	0.2	0.0949	82.31	0.8231	0.7105	0.6677	
0.4	0.0658	87.14	0.8714	0.2815	0.8309	0.4	0.0898	83.25	0.8325	0.6723	0.6963	
0.6	0.0599	88.29	0.8829	0.2562	0.8773	0.6	0.0699	86.97	0.8697	0.5233	0.8244	
0.8	0.0485	90.51	0.9051	0.2074	0.9794	0.8	0.0633	88.19	0.8819	0.4739	0.8731	







Fig.2.Variation of inhibition efficiency with concentration of leaf, stem and flower extract for aluminium in 1.5N HCl.

# Table 2. Weight loss data ( $\Delta$ W) and percentage inhibition efficiency (%) for aluminium in 2N and 2.5N HCl with inhibitor of leaf, stem and flower extract.

	$25 \pm 0.1^{\circ} C$	Area of Specimen : $13 \text{ cm}^2$									
2N HCl (12 min)						2.5N HCl (7 min)					
Conc. of inhibitor (%)	<b>⊿W</b> (g)	I.E. (η%)	Surface Coverage (θ)	Corrosion Rate	Log (θ/1-θ)	Conc. of inhibitor (%)	<b>⊿</b> W (g)	I.Ε (η%)	Surface Coverage (θ)	Corrosion Rate	Log (θ/1- θ)
Leaf		Leaf									
Uninhibited	0.5150			6.4264		Uninhibited	0.5215			9.7613	
0.2	0.0603	88.29	0.8829	0.7524	0.8773	0.2	0.0707	86.43	0.8643	1.3232	0.8040
0.4	0.0442	91.41	0.9141	0.5515	1.0270	0.4	0.0639	87.73	0.8773	1.1960	0.8543
0.6	0.0338	93.43	0.9343	0.4217	1.1529	0.6	0.0555	89.35	0.8935	1.0387	0.9237
0.8	0.0182	96.45	0.9645	0.2271	1.4340	0.8	0.0408	92.16	0.9216	0.7636	1.0702
Stem						Stem					
0.2	0.0950	81.54	0.8154	1.1854	0.6451	0.2	0.1322	74.64	0.7464	2.4743	0.2738
0.4	0.0851	83.47	0.8347	1.0619	0.7032	0.4	0.1138	78.16	0.7816	2.1299	0.5537
0.6	0.0656	87.26	0.8726	0.8185	0.8356	0.6	0.0971	81.38	0.8138	1.8174	0.6405
0.8	0.0466	90.95	0.9095	0.5814	1.0021	0.8	0.0821	84.25	0.8425	1.5366	0.7282
Flower						Flower					
0.2	0.1172	77.24	0.7724	1.4624	0.5306	0.2	0.1499	71.24	0.7124	2.8056	0.3939
0.4	0.1009	80.39	0.8039	1.2590	0.6127	0.4	0.1256	75.91	0.7591	2.3508	0.4984
0.6	0.0918	82.16	0.8216	1.1455	0.6632	0.6	0.1009	80.65	0.8065	1.8885	0.6199
0.8	0.0745	85.53	0.8553	0.9296	0.7716	0.8	0.0922	82.31	0.8231	1.7257	0.6677



Fig.3. Variation of inhibition efficiency with concentration of leaf, stem and flower extract for aluminium in 2N HCl.



Fig.4. Variation of inhibition efficiency with concentration of leaf, stem and flower extract for aluminium in 2.5N HCl.

Conc.	2N HCl		<b>3N HCl</b>		4N HCl						
	RN	<b>I.E.</b> (%)	RN	<b>I.E.</b> (%)	RN	<b>I.E.</b> (%)					
Leaf											
Uninhibited	1.2486		1.7854		2.1457						
0.2	0.3469	72.21	0.6184	65.36	0.9617	55.18					
0.4	0.2528	79.75	0.5384	69.84	0.8172	61.91					
0.6	0.2078	83.35	0.4933	72.37	0.7428	65.38					
0.8	0.1478	88.16	0.3867	78.34	0.6078	71.67					
Stem											
0.2	0.3790	69.64	0.6973	60.94	1.0565	50.16					
0.4	0.3226	74.16	0.6377	64.28	0.9456	55.93					
0.6	0.2699	78.38	0.5507	69.15	0.8252	61.54					
0.8	0.2341	81.25	0.4349	75.64	0.6810	68.26					
Flower											
0.2	0.4464	64.24	0.8166	54.26	1.1013	48.67					
0.4	0.3881	68.91	0.6991	60.84	0.9889	53.91					
0.6	0.3290	73.65	0.6381	64.26	0.8902	58.51					
0.8	0.2833	77.31	0.5466	69.38	0.8306	61.29					

 Table 3. Reaction number (RN) and inhibition efficiency (%) for iron in 2N, 3N and 4N HCl with inhibitor of leaf, stem and flower extract.



Fig.5. Variation of reaction number with concentration of leaf, stem and flower extract for aluminum in 2N HCl.



Fig.6. Variation of reaction number with concentration of leaf, stem and flower extract for aluminum in 3N HCl.



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## Fig.7. Variation of reaction number with concentration of leaf, stem and flower extract for aluminium in 4N HCl.

It can be seen from tables that inhibition efficiency of inhibitor increases with increasing concentration of inhibitor. The Maximum inhibition efficiency 99.47% was obtained in 1N HCl at an inhibitor concentration of 0.8% for flower extract. Maximum inhibition efficiency for stem extract was found 94.21% 1N HCl with 0.8% corrosion inhibitor whereas maximum Inhibition efficiency for flower extract in 1N HClwas obtained 90.51% with 0.8% corrosion inhibitor. The result shows that leaf extract have higher inhibition efficiency in HCl than stem and flower.

The variation of percentage inhibition efficiency with inhibitor concentration is depicted graphically in fig-1, 2, 3 and 4 in 1N, 1.5N, 2N and 2.5N acid strength respectively for leaf, stem and flower extract. It indicates that the inhibition efficiency increases with increasing inhibitor concentration.

From table 1 and table 2 it is clear that the surface coverage increase with increasing concentration of inhibitor and corrosion rate decrease with increasing concentration of inhibitor.

Inhibition efficiencies were also determined by using thermometric method. Thermometric experiments were carried out at higher concentrations of acid i.e. 2N, 3N and 4N because no appreciable changes of temperature were observed at lower concentrations of acid. Results summarized in table 3 show a good agreement with the results obtained by weight loss method. The variation of reaction number (RN) with inhibitor concentration is depicted graphically in fig. 5,6 and 7 for HCl The maximum inhibition efficiency was obtained with the highest concentration of leaf extract inhibitor at lowest concentration of acid. Inhibition efficiency increases with increasing concentration of inhibitor and decreases with increasing concentration of acid. Both methods (weight loss as well as thermometric) show same trends in corrosion efficiency and results are in good agreement with each other's.

## Conclusion

A study of extract of euphorbia caducifolia has shown that to be better corrosion inhibitor for aluminium in HCl.

Weight loss and thermometric methods were shown that inhibition efficiency of plant extract increases with increasing inhibitor concentration over the range 0.2% to 0.8% and and decreases with decreasing concentration of acid. The maximum inhibition efficiency was found up to 99.47% for aluminium in 1N HCl at a concentration of 0.8% for leaf extract whereas it was 94.21% for stem extract and 90.51% for flower extract with same concentration i.e. 0.8%. Thus, it was concluded that leaf extract is a better corrosion inhibitor in HCl than stem and flower extract.

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## BIBLIOGRAPHY

1. D. Kesavan, M. K. Gopirama and N. Sulochana, Che. Sci., Rev. lett. 1(1), (2012), 1-8.

2. H. D. Lece, K. C. Emregül, O. Atakol Corrosion Science, 50(5), (2008), 1460-1468.

3. K. F. Khaled, Corrosion science, 52(9), (2010), 2905-2916.

4. R. Tripathi, A. Chaturvedi and R. K. Upadhyay, Res. J. Chem. Sci., 2(2), (2012), 18.

5. S. M. A. El. Haleem, S. A. El. Wanees, E. E. A. El. Aal and A. Farouk, Corrosion Science, (68), (2013), 1-13.

6. R.K. Upadhyay, S. Anthony and S.P. Mathur, Polish J. of Chem., 43, (2007), 238.

7. T. Sethi, A. Chaturvedi, R.K. Upadhyay and S.P. Mathur, Polish J. of Chem., 82, (2008), 591.

8. F. Bentiss, M. Lagrenée, J. Mater. Environ. Sci., 2(1), (2011), 13-17.

9. Y. ELouadi, F. Abrigach, A. Bouyanzer, R. Touzani, O. Riant, B. ElMahi, A. El Assyry, S. Radi, A. Zarrouk and B. Hammouti, Der Pharma Chemica, 7(8), (2015), 265-275.

10. Yildirim and M. Cetin, Corros. Sci. 50, (2008), 155-156

11.T. Sethi, A. Chaturvedi, R. K. Upadhyay, and S. P. Mathur, J. Chil. Chem. Soc., 53, (2007), 1206-1213.

12.N. Jeengar, A. Chaturvedi and R. K. Upadhyay, International journal of recent scientific research, 4, (2013), 1562-1566

13.S. Safak, B. Duran, A. Yurt, G. Turkoglu. Corrosion Sci. 54, (2012), 251-259.

14.N. Soltani, H. Salavati, N. Rasouli, M. Paziresh and A. Moghadasi, Chemical Engineering Communications, 203(6), (2016), 840-854.

15. P. Thiraviyam, K. Kannan, Journal of the Iranian Chem. Society, 9(6), (2012), 911–921.

16.G. Vishnuvardhanaraja , D. Tamilvendanb and M. Amaladasanc, Der Chemica Sinica, 4(3), (2013), 52-57.

17. P. Sharma, R. K. Upadhyay and A. Chaturvedi, Asian J. of Adv. Basic. Sci, 3(1), (2014), 67-73,

18.P. Sharma, R. K. Upadhyay, A. Chaturvedi and R. Parashar, J.T.R.Chem., 15, (2008), 21

19. J. Dubey, N. Jeenger, R. K. Upadhyay and A. Chaturvedi, Reasearch journal of Recent science, 1, (2012), 73-78

20.N. Kumpawat, A. Chaturvedi and R. K. Upadhyay, Journal of Metal, 2, (2012), 68-73

21.N. Kumpawat, A. Chaturvedi and R. K. Upadhyay, Iranian journal of Material Science and Engineering, 10, (2013)

22. N. Kumpawat., A. Chaturvedi and R. K. Upadhyay, Research journal of chemical science, 2(5), (2012), 51-56

23.M. Goyal, B.P.Nagoriand and D.Sasmal, Journal of Ethnopharmacology 144(3), 18 December (2012), Pages 786-790

24.M. Goyal, D. Sasmal and B. P. Nagori. J Intercult Ethnopharmacol, 1(2), (2012), 119-123.

25. R. Sharma, A. Chaturvedi and R. K. Upadhyay, IOSR Journal Of Pharmacy, 7(8), (2017), 30-37.

26. Satti and N. K. et. al. Phytochemistry, 25, (1986), 1411.

27.N. Afza, A. Q. Khan, A. Malik and Y. Badar. Phytochemistry 28(7), (1989), 1982-1984.

28.J. D. Talati and D. K. Gandhi, Indian J. Tech. 29, (1991), 277.