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PANIALA (*FLACOURTIA JANGOMAS*) PLANT EXTRACT AS ECO FRIENDLY INHIBITOR ON THE CORROSION OF MILD STEEL IN ACIDIC MEDIA

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ABSTRACT

The inhibition of corrosion of mild steel using Paniala *(Flacourtia jangomas)* extract in 1M HCl and 0.5 H_2SO_4 solutions was investigated by weight loss method at 30°C. The result showed that corrosion rate was significantly decreased in presence of the extract and inhibition efficiency increased with increasing the concentration of extract. In case of HCl maximum inhibition efficiency (98%) was noticed at 5% v/v inhibitor concentration and no considerable change in inhibition efficiency was observed after this concentration and in 0.5M H_2SO_4, it was found 95% efficiency at the same concentration of inhibitor. At lower concentration of inhibitor, better inhibition was observed in HCl medium as compared to H_2SO_4. The decreased corrosion rate was due to adsorption of plant extract which was discussed on the basis of Langmuir and Freundlich adsorption isotherm. Adsorption of Flacourtia jangomas depends on its chemical composition which showed the presence of various compounds like flavonoids, steroids, tannins and phenolic compounds etc. which has oxygen atoms with lone pair electrons for co-ordinate bonding with metal.

Key Words: paniala *(Flacourtia jangomas)*, corrosion inhibitor, mild steel, adsorption, weight loss.

INTRODUCTION

The study of corrosion inhibition of iron base alloy in acid medium has been a matter of great industrial and technological significance. Mild steel is extensively used in various service environments like leather, sugar, petrochemical, food, textile and paper-industries. Severe corrosion attack is known to occur on metals in such aggressive environments. Aqueous solutions of acids are among the most corrosive media. The inhibition of corrosion on iron base alloys by organic additives has been studied widely[1-4]. A considerable work has been done on the study of organic compounds as corrosion inhibitors[5,6]. Most acid corrosion inhibitors are nitrogen, oxygen and / or sulfur containing organic compounds[7,8]. But, unfortunately most of them are highly toxic to both human being and environment. Hence use of natural products which are eco-friendly and are being used as corrosion inhibitors has become need of the time. Now the development of corrosion inhibitors of natural source and nontoxic type has been considered more important and desirable[9-18]. Most of the synthetic organic compounds show good anticorrosive activity, which are highly toxic to cause severe hazards to both human beings and the environment during its application[19]. The recent trend is to develop eco- friendly inhibitors. Some investigators studied the plant extract and the derived organic species become more important as an environmentally benign, readily available, renewable and acceptable source for a wide range of inhibitors[20-22]. The plant extract are rich sources of organic molecules which have appreciably high inhibition efficiency and hence termed as Eco friendly or Green Inhibitors[23]**.** These inhibitors are biodegradable and do not contain heavy metals or other toxic compounds [24].

The present paper reports on the corrosion inhibition and adsorption behavior of extracts from Paniala (Flacourtia jangomas) as an environmental benign inhibitor on mild steel corrosion in sulphuric and hydrochloric acid solutions using the weight loss technique. Paniala (Flacourtia jangomas) is a native of India. It is met with in the Northern Uttar Pradesh, Assam, Bihar and Orissa in North India and some

parts of South India. Its common names are coffee plum, Indian plum, Chinese plum, paniala etc. It has got several medicinal values such as the leaves and young shoots, which taste like rhubarb, are astringent and stomachic. The leaves and bark are useful for bleeding gums and toothache. An infusion of the bark is used as a gargle. The fruit is recommended in bilious conditions but corrosion inhibition property has not been yet reported. The chemical tests revealed the presence of major secondary metabolites such as flavonoids, carbohydrate, steroids, tannins and phenolic compounds, saponins etc. in the extract of the leaves and stem of *F. jangomas*[25, 26].

EXPERIMENTAL

Materials and Methods

Alloy Used

Commercially available mild steel (C 0.15% by weight) was used for all experiments. The mild steel sheet of 1 mm thickness was mechanically press-cut into 2.5 × 2.5 cm coupons. Prior to the study, the steel coupons were immersed in 5% HCl as pickling solution to remove rust and sequentially polished using SiC emery papers of grade 220, 400, 600 and 1000, washed thoroughly with distilled water and degreased with acetone, air dried before being immersed in the acid solution.

Chemicals Used

1M HCl and 0.5M H_2SO_4 solutions were prepared using analytical grade concentrated 37% HCl and 95% H_2SO_4 respectively (Merck products) and double distilled water. These acid solutions were used for corrosion analyses and for extract preparation.

Preparation of Plant Extract

Fresh Paniala (Flacourtia jangomas) leaves were collected from Gorakhpur city of India. The leaves of the plant were air-dried and kept in an oven maintained at 50°C for constant weight to remove the moisture. Dried leaves were then ground to make powder. 10 g of dried powder of leaves were digested in 200 mL 1M HCl and kept overnight. Next day it was filtered and the filtrate volume was made up to 200 mL using 1M HCl. Similarly another extract was prepared in 0.5M H_2SO_4 solution. The extracts so prepared were taken as stock solutions from which 0.1, 0.5, 1 and 5 % test solutions were prepared.

Weight Loss Studies

The weight loss studies were carried out at 30°C by immersing previously weighed steel coupons in 100 ml each of blank 1M HCl and 0.5M H_2SO_4 and test solutions of various concentrations of extract for 48 hours. After 48 hours of reaction, the specimens were taken out, washed with water, dried with warm air drier and weighed. Corrosion rates (weight loss per cm^2 per hour) were calculated using following expression.

$$\text{Corrosion Rate (CR)}\ (g.cm^{-2}h^{-1}) = \frac{W_1 - W_2\ (g)}{\text{Surface area}\ (cm^2) \times \text{Time}\ (h)}$$

Where, W_1 = initial weight of coupon, W_2 = weight of coupon after treatment

$W_1 - W_2$ = weight loss (g)

The surface coverage (θ) as a result of adsorption of inhibitor and inhibition efficiency (η%) were calculated from corrosion rate values by using the following equation:

$$\theta = \frac{CR_{blank} - CR_{inhibitor}}{CR_{blank}}$$

$$\eta\ \% = \frac{CR_{blank} - CR_{inhibitor}}{CR_{blank}} \times 100$$

Where, CR_{blank} and $CR_{inhibitor}$ are the corrosion rates in absence and presence of the inhibitor respectively.

RESULTS AND DISCUSSION

The corrosion rate of mild steel in 1M HCl and 0.5M H_2SO_4 solution was studied by weight loss method in absence and presence of extract of *Flacourtia jangomas* plant at 30°C and percent inhibition efficiency was calculate. Table-1 shows the variation of corrosion rate (g cm^{-2} h^{-1}), percent inhibition efficiency (η %) and surface coverage (θ) with varying concentration of inhibitor (in %). From the data it was observed that corrosion rate was significantly lowered down in presence of inhibitor. The corrosion rate was found dependent on the concentration of inhibitor. With the increase in concentration the corrosion rate decreased gradually. Figure-1 shows the variation of percent inhibition efficiency with concentration of inhibitor (in %) and the data revealed that inhibition efficiency increased with increasing the concentration in both the cases of HCl and H_2SO_4. In case of HCl maximum inhibition efficiency (98%) was noticed at 5% v/v inhibitor concentration and no considerable change in inhibition efficiency was observed after this concentration and in 0.5M H_2SO_4, it was found 95% efficiency at the same concentration of inhibitor. At lower concentration of inhibitor, better inhibition was observed in HCl medium as compared to H_2SO_4.

The decreasing corrosion rate and increasing inhibition efficiency was attributed to the fact that the adsorption of inhibitor on the metal surface. Due to adsorption the corrosion sites of metal surface get blocked and adsorbed film of inhibitor acts as physical barrier between metal surface and corrosion medium. Adsorption of Flacourtia jangomas depends on its chemical composition which showed the presence of various compounds like flavonoids, steroids, tannins and phenolic compounds etc. which has oxygen atoms with lone pair electrons for co-ordinate bonding with metal. These molecules possess high molecular weight with complicated structures. Most of the effective organic inhibitors used in industry have heteroatoms such as O, N, S containing multiple bonds in their molecules through which they can adsorb on the metal surface[7, 8].

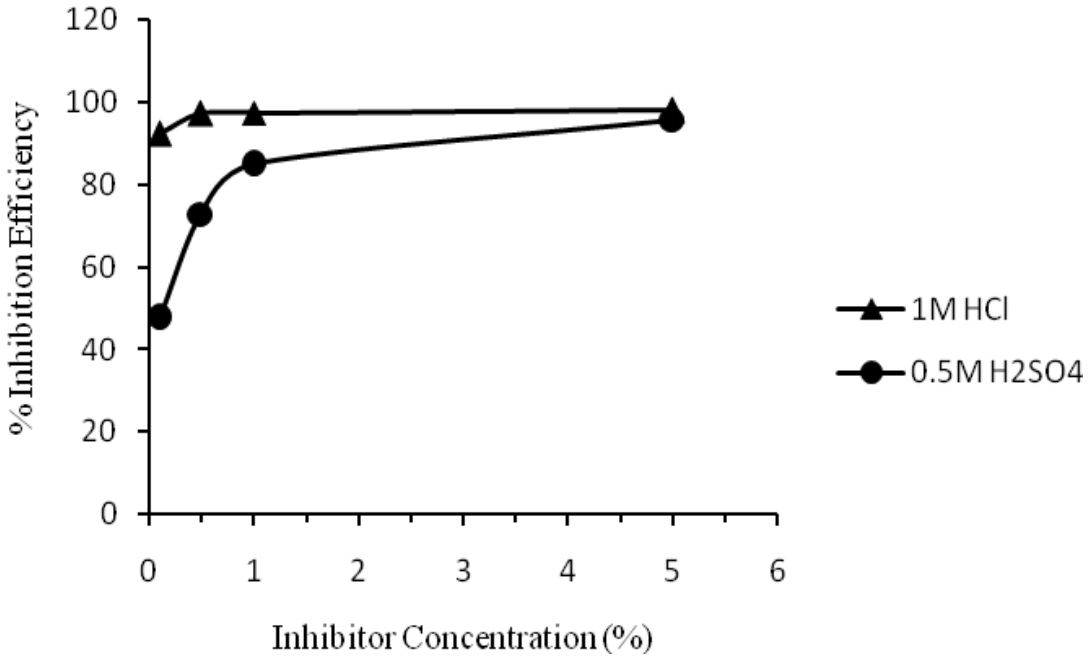

Fig.-1: Variation of percent inhibition efficiency with concentration of *Flacourtia jangomas* (in %) in 1M HCl and 0.5M H_2SO_4 solution

Applicability of adsorption isotherms

The surface coverage (θ) values for different concentrations of the inhibitor in 1M HCl and 0.5M H_2SO_4 have been evaluated from the weight loss data. The data were tested graphically to find a suitable adsorption isotherm. A plot of C/ θ)) against C (Figure-2) showed a straight line indicating that adsorption follows the Langmuir adsorption isotherm and a straight line was also found in the plot between Log θ & log C, this showed that the adsorption obeys a Freundlich adsorption isotherm (Figure-3).

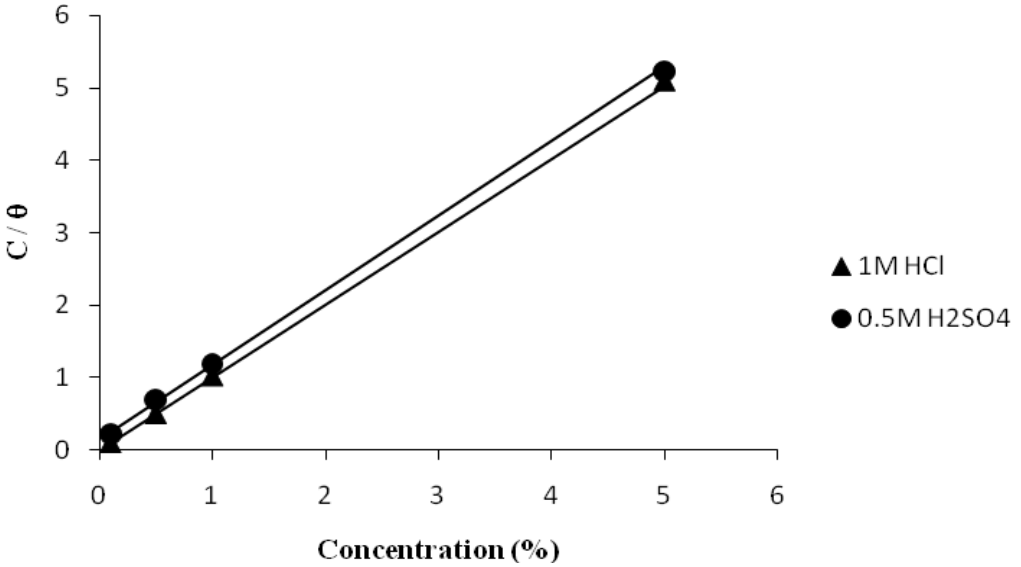

Fig.-2: Langmuir adsorption plots of mild steel in 1M HCl and 0.5M H_2SO_4 containing various concentrations inhibitor at 30°C.

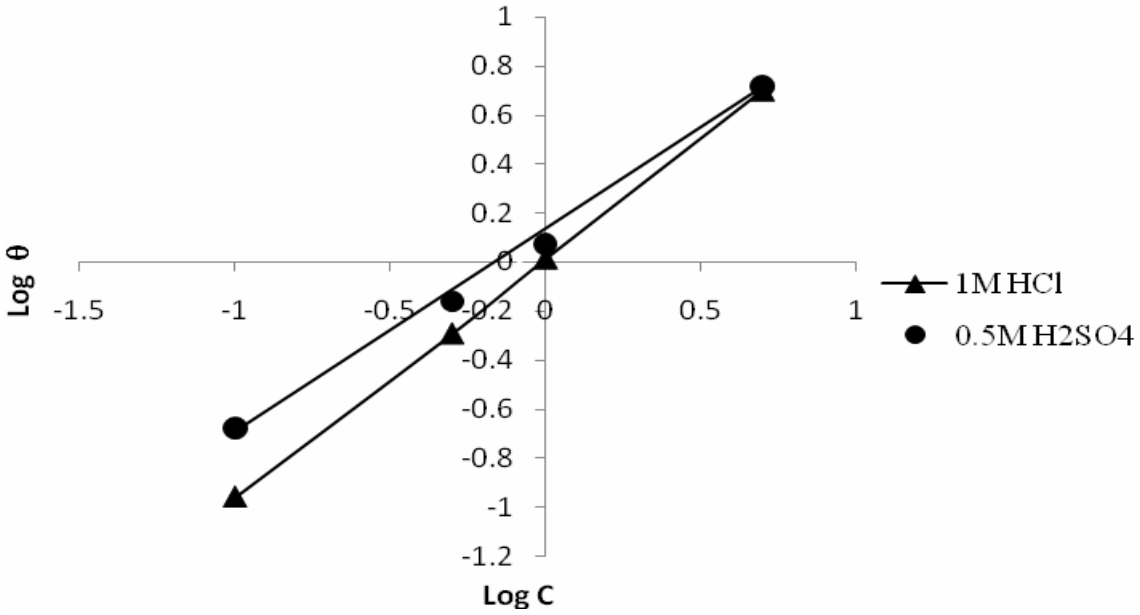

Fig.-3: Freundlich adsorption isotherm of mild steel in 1M HCl and 0.5M H_2SO_4 containing various concentrations inhibitor at 30°C.

Table-1**:** Corrosion rate, % efficiency and surface coverage data obtained from weight loss measurements for mild steel in1M HCl and 0.5M H2SO4 without and with various concentrations of inhibitor.

Inhibitor concentration (%)	Corrosion Rate g/cm^2/h		% Inhibition efficiency (%η)		Surface Coverage (θ)	
	1M HCl	0.5M H_2SO_4	1M HCl	0.5M H_2SO_4	1M HCl	0.5M H_2SO_4
Blank	1.16×10^{-3}	3.75×10^{-3}	--	--	--	--
0.1	8.85×10^{-5}	1.96×10^{-3}	92.4	47.73	0.924	0.477
0.5	3.09×10^{-5}	1.02×10^{-3}	97.3	72.8	0.973	0.728
1.0	2.95×10^{-5}	5.62×10^{-4}	97.5	85.01	0.975	0.85
5.0	2.24×10^{-5}	1.57×10^{-4}	98.0	95.81	0.98	0.958

CONCLUSION

The results showed that the extract of *Flacourtia jangomas* inhibited the corrosion of mild steel in 1M HCl and 0.5M H_2SO_4 solutions significantly. Inhibition efficiency of *Flacourtia jangomas* extract increased with increasing extract concentration. Maximum inhibition efficiency 98% for 1M HCl and 95% for 0.5M H_2SO_4 was reported. The inhibition activity was due to the adsorption ability of the extract which was confirmed by Langmuir and Freundlich adsorption isotherms.

REFERENCES

1. A.Ostovari, S. M.Hoseinieh, M. Peikari, S. R.Shadizadeh and S. J. Hashemi, *Corrosion Science*, **51(9)**, 1935 (2009).
2. JO'M. Bockris, and B. Yang, *J Electrochem Soc.,* **138**, 2237 (1991).
3. G. Schmitt, *Working Party Report – II; Inst. of Materials, London,* 64 (1994).
4. V. Sastri and J.R. Perumareddi, *Corrosion,* **53**, 617 (1997).
5. K. Babi-Samardzija, K. E. Kraaled and N. Hackerman., *Anti- Corrosion Methods and Mat.*, **52**, 11 (2005).
6. B.G. Clubley, *Royal Society of Chemistry, Cambridge*, (1990).
7. M. A.Quraishi, M. A. W.Khan, M. Ajmal, *Anti-Corros. Methods Mater.,* **43(5)**, 5 (1996).
8. S. Murlidharan, and S. V. Iyer, *Anti-Corros. Methods Mater.*, **44**, 100 (1997).
9. J. Sinko, *Prog. Org Coat*., **42**, 267 (2001).
10. L. A. Nnanna, B. N. Onwuagba, I. M. Mejeha and K. B. Okeoma, *African Journal of Pure and Applied Chemistry,* **4(1)**, 011 (2010)
11. P. Nagarajana, J. Morris Princya, J. Christy Ezhilarasia, D. Kavithaa And N. Sulochana , *J. Ind. Council Chem. ,***26(2)**, 153 (2009).
12. P. Deepa Rani and S. Selvaraj, *Journal of Phytology,* **2(11)**, 58 (2010).
13. A. M. Al-Turkustani, *Modern Applied Science*, **4(5)**, May 2010.
14. E. Emeka Oguzie, *Portugaliae Electrochimica Acta*, **26**, 303, (2008).
15. M. Sangeetha, S. Rajendran,T. S.Muthumegala, A. Krishnaveni, *Zaštita Materijala,* **52(1)**, 3 (2011).
16. A.K. Satapathy, G. Gunasekaran, S.C. Sahoo, K. Amit and P.V. Rodrigues, *Corrosion Science,* **51(12)**, 2848 (2009).
17. E. E.Oguzie, *Corrosion,* **March,** 14 (2010).
18. M. B. M. Ali and K. Kannan, *J. Appl. Sci. Environ. Manage*, **13,** 27 (2009).
19. I.B. Obot, N.O. Obi-Egbedi., *Int. J. Electrochem. Sci.*, **4,** 1277 (2009).
20. A. Mesbah, C. Juers, F. Lacouture, S. Mathieu, E .Rocca, M. Francois, J. Steinmetz. *Solid State Sciences*., **9**, 322 (2007).
21. P.C.Okafor, V.I Osabor, E.E. Ebenso., *Pigment and Resin Technology*, **36**, 299 (2007)
22. K. Anuradha, R. Vimala, B. Narayanansamy, J. Arockia Selvi and S. Rajendran. *Chem. Eng. Commun.*, **195**, 352 (2008).
23. P.Bothi Raja and M.G. Sethuraman. *Materials Letters.,* **62**, 113 (2008).

24. S.K. Sharma, A. Mudhoo, G. Jain, J. Sharma., *RASAYAN Journal of Chemistry,* **2**, 332 (2009).
25. A. K. Singh and J. Singh, *Indian J Pharmacol.,* **42(5)**, 301 (2010).
26. J. Ahmad, K. Wizarat, K.M. Shamsuddin, A. Zaman and J. D. Connolly, *Phytochemistry,* **23(6)**, 1269 (1984).

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