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Antibacterial Potential and Corrosion inhibition efficiency of Emblica officinalis (Amla)

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Abstract : Electrochemical corrosion behavior of mild steel has been investigated, in 1.5 M sulphuric acid and hydrochloric acid solutions containing Amla (Emblica officinalis) leaves aqueous extract as corrosion inhibitor. Experiments were performed by weight loss method for different time intervals and at room temperature. Inhibition efficiency was found to increase with increasing concentration of inhibitor (0.2 g /l to 10 g/l) for 6 hour at room temperature. The maximum inhibition efficiency of Emblica officinalis leaves was 52 % in 1N Sulphuric acid and 87 % in 1 N Hydrochloric acid respectively. From the comparative studies, it was investigated that the corrosion inhibition efficiency of Emblica officinalis leaves aqueous extract is greater in hydrochloric acid[1-3]. This may be due to the presence of wide variety of compounds like, tannins, alkaloids and phenols in Emblica officinalis plant. Also, antibacterial activity of Emblica officinalis with 20 mg.ml concentration was studied. In all bacterial strains *Escherichia. Coli* ATCC 632, *Salmonella typhi* ATCC 13311, *Pseudomonas aeruginosa* ATCC 13525, *Bacillus cereus* ATCC 128263 and *Bacillus subtilis* ATCC 128263 the zone of inhibition of test microorganisms was recorded as 7.97 ±0.71, 9.70±0.08, 6.77±0.19, 8.70±0.41and 9.87±0.42 mm.

Keywords: Mild steel; Emblica officinalis leaves extract; Corrosive medium; weight loss method.

Introduction:

The research in field of corrosion inhibition has been addressed towards the goal of using cheap, effective biomasses at low environmental impact. Keeping these factors in mind, several naturally occurring compounds have been selected as corrosion Inhibitors in the different corrosive medium The selected inhibitor is non toxic utilized in food, cheap easily available and effective also. This paper describes the investigation of low toxic easily biodegradable plant Emblica officinalis antibacterial activity and corrosion inhibition efficiencies.

Emblica officinalis belongs to the family Euphorbiaceae possesses anti-viral, antibacterial, anti-cancer, anti-allergy, and anti-mutagenic properties. Amla is one of the most extensively studied plants and it contains tannins, alkaloids, and phenolic compounds. Amla is a rich source of vitamin C contents more than the levels of oranges, tangerines, or lemons[1]. The fruit also contains gallic acid, ellagic acid, chebulinic acid, chebulagic acid, emblicanin A, emblicanin B, punigluconin, pedunculagin, citric acid, ellagotannin, trigallayl glucose, pectin, 1-O- galloyl-b-D-glucose, 3,6-di-O-galloyl-D-glucose, chebulagic acid, corilagin, 1,6-di-O-galloyl-b-D-glucose, 3 ethylgallic acid (3 ethoxy 4,5 dihydroxy benzoic acid), and isostrictiniin[2]. It also contains flavonoids such as quercetin, kaempferol 3 O-a-L (600 methyl) rhamnopyrano- side and kaempferol 3 O-a-L (600 ethyl) rhamnopyranoside[9,10].

Experimental:

Aqueous extracts was prepared by mixing 10 gram of E. officinalis leaves powder in 100 ml of distilled water, filtered. The filtrate was sterilized at 120 ^{0}C for 20 minutes and preserved until further use. Bacterial strains were maintained on tryptophone soy agar (TSA). The antimicrobial assay was performed by agar well diffusion method. A well was prepared in the plates with the help of a cork- borer (0.85 cm). 100 µl of the test compound was introduced in to the well. The inoculated plates were incubated at 35-37 ºC for 24 hours and zone inhibition was measured to the nearest millimeter (mm). The bacteria selected for study were common human pathogens like *Escherichia. Coli* ATCC 632, *Salmonella typhi* ATCC 13311, *Pseudomonas aeruginosa* ATCC 13525, *Bacillus cereus* ATCC 128263 and *Bacillus subtilis* ATCC 128263[11].

Emblica officinalis leaves were washed with distilled water and dried in sunlight. Then it is powered with the help of a mixer. The resulting fine powder was stored in a sample bottle. Eight different concentrations (0.2, 0.4, 0.8, 1.6, 3.2, 6.0, 8.0 and 10.0 g/dm3) of the extract were prepared with 1N hydrochloric acid and 1 N sulphuric acid solutions and was used for all measurement. Mild steel metal (the percentage elemental composition was found to be, C(0.048%), Mn (0.335%), Si (0.029%), P(0.041%) ,S (0.025%), Cr (0.050%), Mo (0.016%), Ni (0.019%) and Fe (99.437%) having a surface area of 5x1cm^2 were cut from a large sheet. The specimens were polished successively with emery sheets, degreased and dried. Distilled water and AR grade H_2SO_4 and HCl were used for preparing solutions[4]. The specimens in triplicate were immersed in 1 N acids solution containing various concentrations of the inhibitor for six hours at 30 ^{0}C. The specimens were removed washed with water and dried. The mass of the specimens before and after immersion was determined using an electronic digital balance.

The metal surface was dipped in 1N acids solution, stirred without and with various concentrations of the inhibitor with various concentrations (0.2g/l to 10 g/l) for desired interval of time (6 hrs) at 30 ^{0}C. The dissolution rates (mpy) were calculated by estimating the amount of mild steel surface dissolved in corrosive medium. The average mass loss of the three replicate measurements was calculated. Inhibitor efficiency (I.E.), corrosion rate and surface coverage (θ) were calculated from the weight losses of the specimens in the absence and presence of the inhibitor using the equations[5,6].

The corrosion rate for room temperature with various concentrations of inhibitor and various concentrations of anions was obtained from the following formula,

$$\text{C.R (mpy)} = \frac{436.095 \text{ x } 1000 \text{ x } W}{A \text{ x } T}$$

Where, W = Weight loss in grams, A = Area of specimen in cm^2 , T = Exposure time in hours. The unit of the corrosion rate is in mills per year (mpy).

$$IE\% = \frac{[\text{Weight loss without inhibitor - weight loss with inhibitor}]}{\text{Weight loss without inhibitor}} x100$$

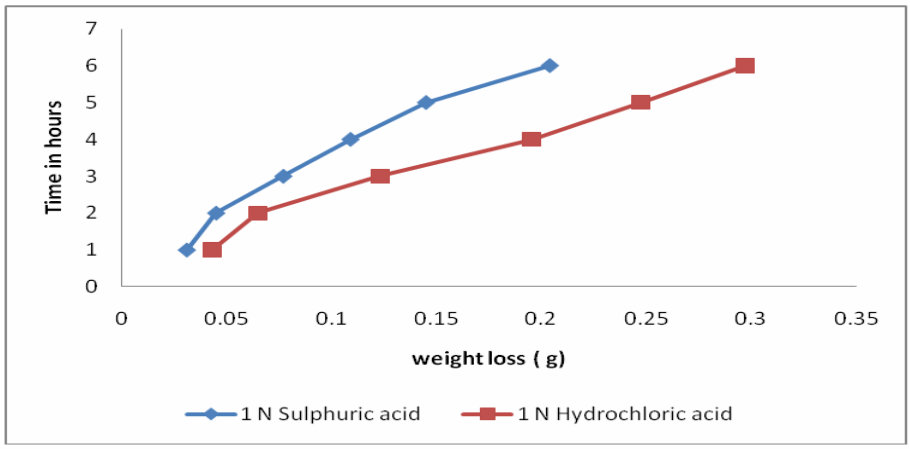
The corrosion rate was calculated by measuring the amount of mild steel dissolved in the solution analytically.

$$\text{Surfacecoverage } (\theta) = \frac{\text{Weightloss without inhibitor } - \text{ weight loss withinhibitor}}{\text{weight loss without inhibitor}}$$

Result & Discussion:

The results of weight loss experiments of corrosion of mild steel in 1N HCl and 1 N H_2SO_4 in different intervals of time and at 30 ^{0}C temperature are shown in figure-1. Corrosion rate (IE) increases at the given temperature for all concentrations.

Figure-1 : weight loss measurement for mild steel in the given acids of 1 N concentration for the given period of immersion



The results of weight loss experiments of corrosion of mild steel in 1N HCl and 1 N Sulphuric acid in the presence of Emblica officinalis leaves extract at 30 ^{0}C temperature are shown in table-1 and table-2. The I.E increases at the given temperature for all concentrations. The inhibition of corrosion may be due to the formation and maintenance of a protective film on the metal surface.

Table-1: Corrosion Rate for mild steel in the given concentration of inhibitor with 1N H_2SO_4 solution for the period of 6 hours immersion

Inhibitor concentration (g/l)	weight loss (g) H_2SO_4	CR(mpy)	Surface coverage (θ)	Inhibition efficiency (%)	C/(θ)
Blank	0.204	2965.45	-	-	-
0.2	0.191	2776.47	0.06	6.37	3.138
0.4	0.186	2703.79	0.09	8.82	4.533
0.8	0.177	2572.96	0.13	13.24	6.044
1.6	0.162	2354.91	0.21	20.59	7.771
3.2	0.135	1962.43	0.34	33.82	9.461
6.0	0.121	1758.92	0.41	40.69	14.747
8.0	0.098	1424.58	0.52	51.96	15.397
10.0	0.098	1424.58	0.52	51.96	19.245

Table-2: Corrosion Rate for mild steel in the given concentration of inhibitor with 1N HCl solution for the period of 6 hours immersion

Inhibitor concentration	weight loss (g) HCl	CR(mpy)	Surface coverage (θ)	Inhibition efficiency (%)	C/(θ)
Blank	0.297	4317.34	-	-	-
0.2	0.254	3692.27	0.14	14.48	1.381
0.4	0.201	2921.84	0.32	32.32	1.238
0.8	0.165	2398.52	0.44	44.44	1.800
1.6	0.121	1758.92	0.59	59.26	2.700
3.2	0.112	1628.09	0.62	62.29	5.137
6.0	0.098	1424.58	0.67	67.00	8.955
8.0	0.065	944.87	0.78	78.11	10.241
10.0	0.039	566.92	0.87	86.87	11.512

The surface coverage values for different concentrations of the inhibitors in both medium have been evaluated from the weight loss data. The data were tested graphically to find a suitable adsorption isotherm[7]. It is found that the data fitted the Langmuir adsorption, Temkin and Freundlich adsorption isotherms with correlation coefficients of > 0.9. The sigmoidal shape shows that the adsorption of the inhibitor on mild steel surface follows Frumkin isotherm.

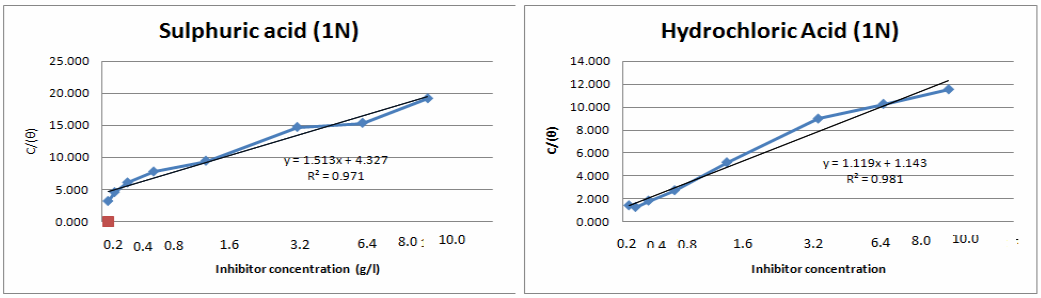


Figure-2 Langmuir adsorption of Emblica officinalis leaves extract in 1 N H_2SO_4 & 1N HCl

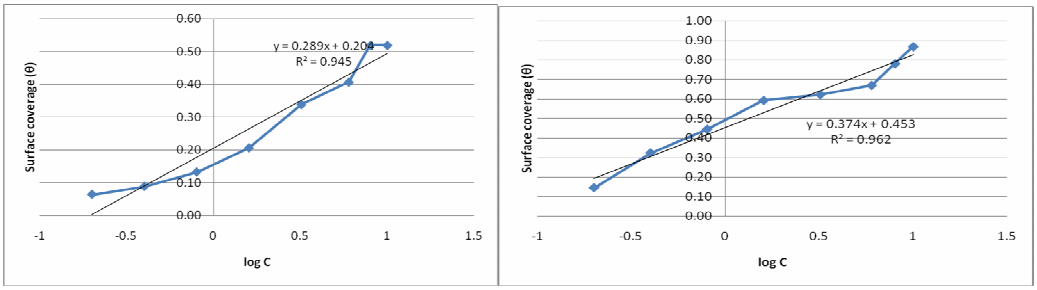


Figure-2 Tempkin adsorption of Emblica officinalis leaves extract in 1 N H_2SO_4 & 1N HCl

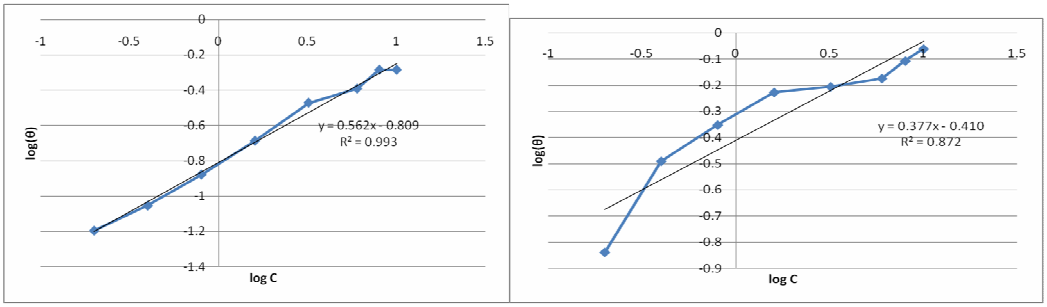


Figure-3 Freundlich adsorption Emblica officinalis leaves extract in 1 N H_2SO_4 & 1N HCl

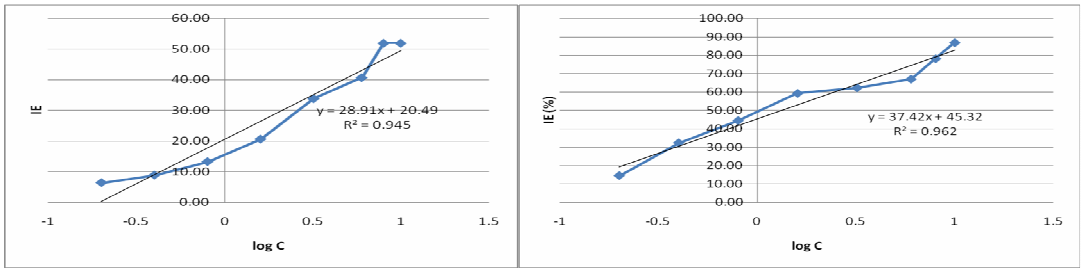


Figure-4 Frumkin's adsorption Emblica officinalis leaves extract in 1 N H_2SO_4 & 1N HCl

Calculated values of activation energy Ea ($kJmol^{-1}$), Rate constant k (s^{-1}) and Half life (s) for mild steel at 30 ^{0}C are recorded in table-3. These values indicate that the adsorption of Emblica officinalis leaves extract on the surface of mild steel is spontaneous and favoured the mechanism of physical adsorption[8].

Table 3. Calculated values of activation energy Ea ($kJmol^{-1}$) ,Rate constant ,k (s^{-1}) and Half life (s) for mild steel at 30 ^{0}C.

Inhibitor with corrosive media	slope	R^2	Ea	Rate constant	Half life $t_{1/2}$
H_2SO_4	0.642	0.972	9.001	0.00419	218.00
HCl	0.877	0.982	9.787	0.00196	633.23

Table-4 Antibacterial Potential of Embilica officinalis leaves aqueous decoction by Agar diffusion method

Sl. No	Bacterial strains	Zone of inhibition(mm)*			
		Trial-1	Trial-2	Trial-3	Average †
1	*Escherichia. Coli* ATCC 632	*8.2*	8.7	7.0	*7.97 ±0.71
2	*Salmonella typhi* ATCC 13311	*9.7*	9.6	9.8	9.70±0.08
3	*Pseudomonas aeruginosa* ATCC 13525	*6.9*	6.5	6.9	6.77±0.19
4	*Bacillus cereus* ATCC 128263	*8.7*	8.2	9.2	8.70±0.41
5	*Bacillus subtilis* ATCC 128263	*9.9*	9.2	10.2	9.87±0.42

* Values, including diameter of the well (0.85 cm), are means of three replicates,
† ± Standard deviation.

Emblica officinalis is being were traditionally used for the treatment of several diseases. Its antimicrobial potential was tested against a variety of bacteria and was shown to exert variable activities. The results of antimicrobial activity of the extract was done by agar well diffusion method have been shown in Table 4. From the data presented in the table 4, it is evident that the extract of Emblica officinalis leaves in aqueous solution showed antimicrobial inhibitory activity against all the five tested microorganism. In all bacterial strains *Escherichia. Coli* ATCC 632, *Salmonella typhi* ATCC 13311, *Pseudomonas aeruginosa* ATCC 13525, *Bacillus cereus* ATCC 128263 and *Bacillus subtilis* ATCC 128263 the zone of inhibition of test microorganisms was recorded 7.97 ±0.71, 9.70±0.08, 6.77±0.19, 8.70±0.41and 9.87±0.42 mm at 20 mg/ml concentration.

Conclusion:

Aqueous extract of Emblica officinalis leaves acts as good corrosion inhibitor for mild steel in 1N HCl medium. Inhibition efficiency increases with inhibitor concentration and maximum inhibition efficiency was 87% at the inhibitor concentration 10g/l. Corrosion inhibition may be due to the spontaneous physical adsorption of the biomass on the mild steel surface. Adsorption models-Langmuir, Temkin, Freundlich,and Frumkin isotherm fit well as evident from the correlation coefficient values. This proves the applicability of all the models to the process. The present study has also revealed the importance of biomass to control antibiotic resistant bacteria which are a threat to human health and can serve as an important platform for the development of inexpensive, non hazardous and effective medicine.

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