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AQUEOUS EXTRACT OF *CYCLEA PELTATA* LEAVES AS CORROSION INHIBITOR FOR MILD STEEL IN 1.0N H_2SO_4 BY EMPLOYING ISOTHERMS

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ABSTRACT
Inhibition efficiency of corrosion of mild steel in acid medium by using aqueous extract of Cyclea peltata plant leaves has been examined by applying weight loss method. The conclusion of this study exposed that various concentrations of the leaves extract of Cyclea peltata plant inhibited the corrosion of mild steel in 1.0N H2SO4 acid solution. The inhibition suitability of the leaves extract is consigned to the presence of the phytochemical constituents in that. The weight loss study reports exhibited that inhibition efficiency of corrosion on mild steel is increased with increasing the concentration of inhibitor. Adsorption study also exposed that adsorption of the aqueous extract of Cyclea peltata leaves on mild steel surface occurred by agreeing to Langmuir,Tempkin, Florry-Huggins and El-awady adsorption isotherm.

KEYWORDS: Cyclea peltata, Weight Loss, Langmuir, Tempkin, Florry-Huggins, El-awady.

1. INTRODUCTION
According to the chemical properties, when the environment reacts on the surface of mild steel, it creates an unattractive effect This kind of corrosion problem occur in the industries which is preparing boilers, tanks etc. In day today life the cost of preventing steel corrosion is very expensive and it is impossible to quit steel corrosion entirely. The purpose of inhibitors is greatly used to reduce corrosion level. Corrosion inhibitors are chemical compounds that works on the metal surface by the formation of film due to adsorption. Plant extracts constitute several phytochemical components which have substantial inhibiting capabilities. The inhibition properties vary mostly depending on the part of the plant kingdom. The study of the present work is aimed at exposing the inhibition efficiency of aqueous extract of *Cyclea peltata* leaves in acid medium.[1]

2. MATERIALS AND METHODS
2.1. Preparation of specimens
Mild steel specimen (0.026%-S, 0.06%-P, 0.4%-Mn, 0.11%-C and the remaining iron) of the dimensions 1x5x0.2 cm were polished to mirror finish they are degreased with acetone by using cotton and used for the weight loss method.

2.2. Details of *Cyclea peltata* leaves
Botanical name: *Cyclea peltata;* Family: Menispermaceace; Kingdome: Plantae; Class: Magnoliosida; Order: Ranunculales; Genus: Cyclea; Division: Tracheo Phyta; Tamil name: Malaitanki.

2.2.1 Phyto-chemical constituents present in aqueous extract of *Cyclea peltata* leaves: Alkaloids, flavonoids, steroids, terpenoids.[2]

2.2.2 Pharmacological action: Blood purifier, heart disorders, blood disorders, inflammation, cough, skin disorders anti-inflammatory, diuretic, anti-diabetic.

2.2.3 Collection of the plant material: The leaves were collected from the area of vayanadu, kerala, India.
The given below fig.1 shows the leaves of *Cyclea peltata.*

Fig. 1: *Cyclea peltata.*

2.3. Preparation of Extract and Corrosive Medium
Fresh leaves of *Cyclea peltata* were washed under running water, dried in shade and grinded into powder.

The powder obtained from the leaves was soaked in double distilled water for 72 hours and the extract is filtered. The filtrate is used as a stock solution. The stock solution of extract so obtained were used in preparing different concentrations of the extract by adding 1.0N H_2SO_4.[3]

2.4. Weight Loss evaluate

Previously degreased, polished and weighed mild steel plates of size 1x5x0.2 cm were immersed in 100ml of 1.0N H_2SO_4 solutions with and without the addition of different concentrations of inhibitors at room temperature for 2 hours exposure time. The mild steel strip plates were weighed and suspended in the beaker with the help of tripod stand and thread. After 2 hours interval, each sample was withdrawn from the test solution, washed twice in distilled water, dried with acetone and reweighed using B. Bran Electronic Balance. The differences in the weights of the mild steel plates before and after immersion in different test solutions were taken as the weight loss of the plates.[4,5] The corrosion rate (C.R) in the presence and absence of inhibitors, the inhibition efficiency (I.E) of the inhibitors, and the degree of surface coverage were calculated and applied for the different types of isotherms.

2.5. Adsorption

The corrosion rate (C.R) in the presence and absence of inhibitors, the inhibition efficiency (I.E) of the inhibitors, and the degree of surface coverage were calculated and applied for the different types of isotherms such as Langmuir, Tempkin, Florry-Huggins, El-awady isotherms by finding correlation coefficient (R^2) value from straight line graphical plot.[6,7]

3. RESULTS AND DISCUSSION

3.1. Weight - loss analysis

Weight loss analysis was conducted out to get the information regarding corrosion of mild steel in acid medium. The weight loss results for steel in 1.0N H_2SO_4 solution in the absence and presence of different concentrations of the extracts of *Cyclea peltata* inhibitor is shown in table-1.

Table 1: Inhibition effect of corrosion of mild steel in 1.0N H_2SO_4 medium by *Cyclea peltata* leaves extract.

[Inhibitor], ppm	Rate of corrosion, g cm^{-2} hr^{-1}	Inhibition Efficiency (%)
Blank	-	-
100	0.00020	10.81
200	0.00016	17.11
300	0.00015	36.03
400	0.00010	45.04
500	0.00008	54.95
600	0.00007	60.36
700	0.00004	73.87
800	0.00002	86.48
900	0.00001	91.89

The above **table-1** showed that the weight loss values decreased with increase in concentration of the extracts of *Cyclea peltata* leaves.[8,9,10]

3.2. Adsorption isotherms

Adsorption isotherms are practically used to explain the adsorption process. The most commonly used isotherms includes Langmuir, Flory-Huggins, Tempkin and the currently developed isotherm model of El-awady et al. The endowment of adsorption isotherms explains the adsorption of inhibitor can produce major idea to the nature of the inhibitor-metal interaction. Adsorption of phyto-components occurs as the energy of interaction between molecules and surface of metal is greater than the interaction energy between the water molecules and the surface of metal.[11,12,13]

3.2.1. Langmuir adsorption isotherm

Adsorption isotherms are very important to determine the mechanism of phyto-electrochemical reaction.

Table- 2 shows the values for this isotherm.

Langmuir adsorption isotherm is

$\Theta = K_{ads}.C/1+K_{ads}.C$

$\Theta\ (1+K_{ads}.C) = K_{ads}.C$

$\Theta = K_{ads}.C - K_{ads}.C\Theta$

$\Theta = (1-\Theta)\ K_{ads}.C$

$\Theta/1-\Theta = K_{ads}.C$

The plot of 3+ log (Θ/1-Θ) against 3+logC is a straight line in fig.2. Thus the Langmuir isotherm is valid for the inhibitor.

Table 2: Langmuir adsorption isotherm for the inhibition of corrosion of mild steel in 1.0N H_2SO_4 medium by *Cyclea peltata*l eaves extract.

[Inhibitor], ppm	Θ/(1-Θ)	3+logΘ/(1-Θ)	3+log C
Blank	-	-	-
100	0.1212	2.0836	5.0000
200	0.2064	2.3148	5.3010
300	0.5632	2.7507	5.4771
400	0.8195	2.9136	5.6020
500	1.2197	3.0862	5.6989
600	1.5227	3.1826	5.7781
700	2.8270	3.4513	5.8450
800	6.3964	3.8059	5.9030
900	11.330	4.0542	5.9542

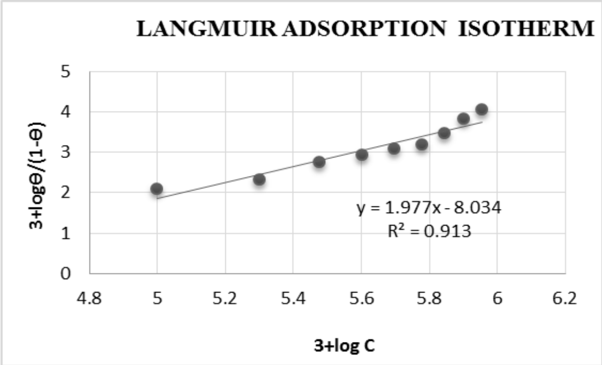

Fig. 2: Langmuir adsorption isotherm for the inhibition of corrosion of mild steel in 1.0N H_2SO_4 medium by *Cyclea peltata* leaves extract.

Calculation

Intercept= -8.304; K_{ads}= -0.1204; ΔG_{ads} = -4803.2; Slope = 1.977; R^2= 0.913; 1/y= 0.5058

3.2.2 Tempkin adsorption isotherm

It is given by the expression;

Θ = -2.303 log K/2a.-2.303 log C/2a

Where "K" is the adsorption equilibrium constant, "a" is the lateral interaction parameter. The values and plot of Θ against log C is shown in **table 3** and **fig 3**.The linear plot indicates that Tempkin adsorption isotherm was obeyed and negative, value of "a" indicated repulsion exist in the adsorption layer.

Table 3: Tempkin adsorption isotherm for the inhibition of corrosion of mild steel in1.0N H_2SO_4 medium by *Cyclea peltata* leaves extract.

[Inhibitor], ppm	Θ	2+log C
Blank	-	-
100	0.1081	4.0000
200	0.1711	4.3010
300	0.3603	4.4771
400	0.4504	4.6020
500	0.5495	4.6989
600	0.6036	4.7781
700	0.7387	4.8450
800	0.8648	4.9030
900	0.9189	4.9542

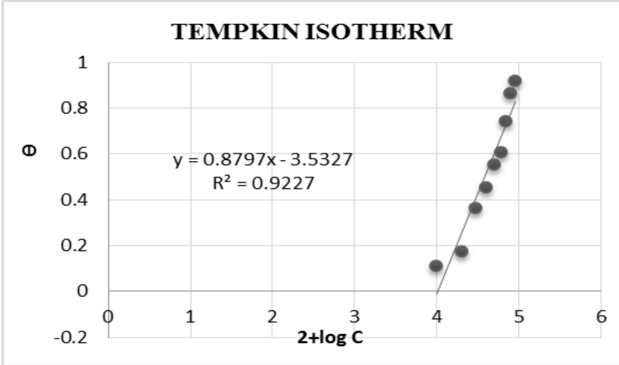

Fig. 3: Tempkin adsorption isotherm for the inhibition of corrosion of mild steel in 1.0N H_2 SO_4 medium by *Cyclea peltata* leaves extract.

Calculation

Intercept = -3.532; K_{ads} = -0.283; ΔG_{ads}= -6963.92; Slope = 0.879; R^2 = 0.922;
1/y =1.1376; a = -1.012

3.2.3 Florry-huggins adsorption isotherm

It is given by the expression
log Θ/C=log K+ x log (1-Θ)

The values are tabulated in **table 4.**

Where 'x' is the size parameter, and it is a measure of the number of adsorbed water molecules substitute by an inhibitor molecule. The plot of log Θ/C against log (1-Θ) is linear **fig 4.** showing that Florry-Huggins isotherm was obeyed. The adsorption parameter is shown in **table 4**.

Table 4: Florry-Huggins adsorption isotherm for the inhibition of corrosion of mild steel in 1.0N H_2SO_4 medium by *Cyclea peltata* leaves extract.

Θ	C	Θ/C	4+log Θ/C	1-Θ	4+log(1-Θ)
0.1081	100	0.0010	1.0339	0.8919	3.9503
0.1711	200	0.0085	0.9323	0.8289	3.9186
0.3603	300	0.0012	1.0800	0.6397	3.8060
0.4504	400	0.0011	1.0516	0.5496	3.7401
0.5495	500	0.0010	1.0410	0.4505	3.6537
0.6036	600	0.0010	1.0026	0.3964	3.5982
0.7387	700	0.0010	1.0233	0.2613	3.4172
0.8648	800	0.0010	1.0339	0.1352	3.1310
0.9189	900	0.0010	1.0091	0.0811	3.9091

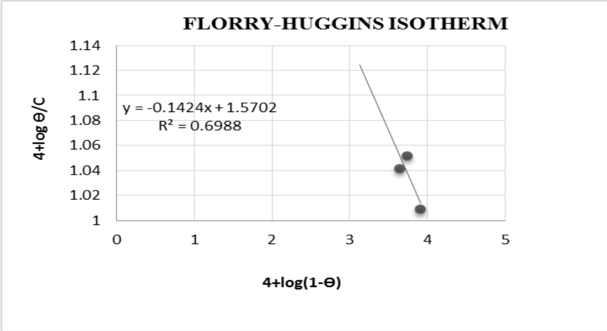

Fig. 4: Florry-Huggins adsorption isotherm for the inhibition of corrosion of mild steel in 1.0N H_2SO_4 medium by *Cyclea peltata* leaves extract.

Calculation

Intercept = 1.570; K_{ads} = 0.6369; ΔG_{ads} = 9014.88; Slope= -0.142; R^2 = 0.698;
1/y = -7.0422

3.2.4 El–awady isotherm

It is given by the expression:
log (Θ/1-Θ) = logK + y logC

K_{ads} the equilibrium constant of adsorption process is calculated by the relationship, K_{ads} = 1/k. A plot of 2+ log (1-Θ) Vs. 2+ logC is linear **fig 5**. The calculated K_{ads} and 1/y values are given. **Table 5** shows the values of this isotherm.

Table 5: El–awady adsorption isotherm for the inhibition of corrosion of mild steel 1.0N H_2SO_4 medium by *Cyclea peltata* leaves extract.

C	2+logC	Θ	1-Θ	Θ/1-Θ	2+logΘ/1-Θ
100	4.000	0.1081	0.8919	0.1212	1.0835
200	4.301	0.1711	0.8289	0.2064	1.3147
300	4.447	0.3603	0.6397	0.5632	1.7506
400	4.602	0.4504	0.5496	0.8195	1.9135
500	4.692	0.5495	0.4505	1.2197	2.0862
600	4.778	0.6036	0.3964	1.5227	2.1826
700	4.845	0.7387	0.2613	2.8270	2.4513
800	4.903	0.8648	0.1352	6.3964	2.8059
900	4.954	0.9189	0.0811	11.3304	3.0542

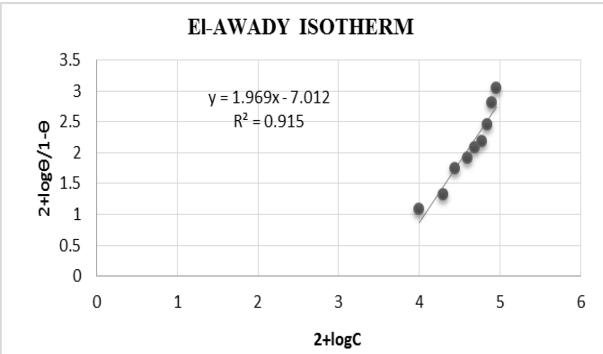

Fig. 5: El-awady adsorption isotherm for the inhibition of corrosion of mild steel in 1.0N H_2SO_4 by *Cyclea peltata* leaves extract.

The above **Figures** and **tables** showed the adsorption isotherm of *Cyclea peltata* leaves extract, where the values of surface coverage were tested graphically by employing different adsorption isotherms. The plots producing a linear graph that proved the application adsorption isotherms. The value of R^2 (correlation coefficient) tending to unity also indicated strong coherence to the assumptions of adsorption isotherms. But the highest value of R^2 shows that Langmuir, Tempkin and El-awady adsorption mechanism are the best fit and suitable isotherms in all.[14,15,16,17]

Calculation

Intercept= -7.012; K_{ads}= -0.1426; ΔG_{ads} = -5231.67; Slope= 1.969; R^2= 0.915; 1/y = 0.5078

3.2.5 Correlation coefficient

Table 6: Adsorption isotherm parameters for the inhibition of corrosion of mild steel in 1.0N H_2SO_4 by *Cyclea peltata* leaves extract.

Isotherm	ΔG^o_{ads}	Slope	R^2	a	1/y
Langmuir Isotherm	-4803.26	1.977	0.913	-	0.5058
Temkin Isotherm	-6963.92	0.879	0.922	-1.012	1.1376
Florry-Huggins Isotherm	9014.88	-0.142	0.698	-	-7.0422
El-awady Isotherm	-5231.67	1.969	0.915	-	0.5078

The above table shows the values of corrosion rate, Inhibition efficiency, and surface coverage estimated from the experiment. The results showed that as the concentration of the inhibitor increases, the inhibition efficiency increases and corrosion rate decreases. The surface coverage increases with the inhibitor concentration. By using the principle of adsorption , the molecules of the extracted inhibitor adsorb constantly on the steel surface and as such arrest the available reaction sites by formation of inhibitor film on the steel surface which reduces the active surface area available for the attack of the corrosive medium[18,19,20].

4. CONCLUSION

The investigation of corrosion inhibition properties of *Cyclea peltata* leaves extract by weight loss technique showed that the extract from *Cyclea peltata* leaves acts as a good corrosion inhibitor for mild steel in acid medium. The plots of adsorption isotherms also reveal that the value of R^2 for Langumir,Tempkin and El-awady isotherms are fitting best for the inhibition of mild steel. The negative values of free energy for the adsorption process indicates that the physical adsorption of the inhibitor on the mild steel surface occurs spontaneously. Thus, the biodegradable extract from *Cyclea peltata* leaves could serve a good replacement for most organic inhibitors which are toxic to living being and environment.

5. ACKNOWLEDGEMENT

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