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A Comperative Study of Inhibition Efficiency of Extract of Leaves and Stem of Solanum Xanthocarpum on Aluminium in 2N HCl Solution

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***Abstract*— Corrosion inhibition efficiency of alcoholic extract of leaves and stem of naturally occurring *Solanum xanthocarpum* on aluminium in 2N HCl solution was studied by weight loss and gasometric method. Inhibition efficiency was found to be increase with increasing concentration of leaves and stem extract. Maximum inhibition efficiency was found 94.53% in 2N HCl solution with 0.8% leaves extract, whereas it was 83.85% in stem. The results obtained by two methods have been found in good agreement with each other. The importance of the study lies in the fact that this naturally occurring plant which is found widely and ecofriendly can be used as corrosion inhibitor in severe acidic media in place of chemical inhibitors which are destructive and harmful for environment.**

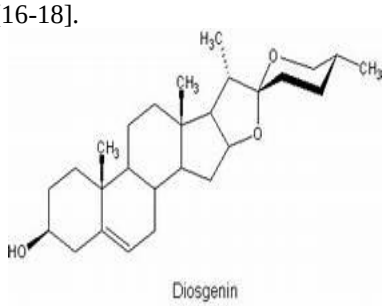
Keywords*— *Solanum xanthocarpum* , *corrosion rate* , *weight loss, corrosion inhibition efficiency, surface coverage, volume change.

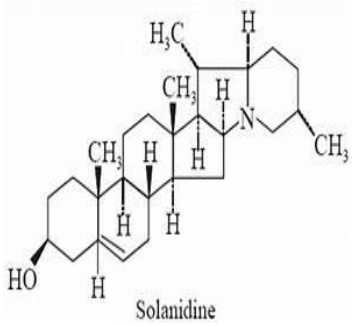
I. INTRODUCTION

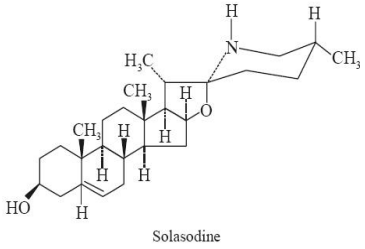
Aluminium is a very reactive metal with a high affinity for oxygen. The metal is highly resistant to most environments and to a great variety of chemical agents. This resistance is due to the inert and protective character of the aluminium oxide film, which forms on metal surface. The physical-chemical stability of the oxide film is dependent upon the pH value of the environment, since the oxide film is stable within the pH range of about 4 to 8. Below and above these values, acid dissolution yields Al^{3+} ions and the alkaline dissolution leads to the formation of $Al(OH)_4^-$ ions [1].

In addition to the heterogeneous organic compounds synthesized in laboratory some of naturally occurring substances have been evaluated as effective corrosion inhibitor[2-8]. Different plants extracts can be used as corrosion inhibitors. Green corrosion inhibitors are biodegradable, environmentally acceptable, cost effective [9,10].Desirable extracts of plant materials contain a wide variety of organic compounds most of them contain heteroatoms such as P, N, S, O. These atoms coordinate with the corroding metal atom (their ions) through their electron. Hence protective films are formed on the metal surface which help in the prevention of corrosion [11-14].

In present case, inhibition efficiencies of *Solanum xanthocarpum* leaves and stem have been studied in 2N HCl solution. *Solanum xanthocarpum* commonly known as the Indian night shade or yellow berried night shadeor kantkari. It is prickly diffuse, bright green perennial herb, woody at the base2-3 meter height, found throughout India, mostly in dry places as a weed along roadside and waste lands [15]. Various medicinal properties are attributed to it, particularly in treatment of asthma, chronic cough and catarnal fever. It contains several steroidal alkaloids like solanocarpine, solamargine, saponin, solasodine, diosenin, solasonine [16-18].







II. EXPERIMENTAL PART

A. Inhibitor Solution

Solanum xanthocarpum leaves and stem were collected, washed with water and dried in shade. The extract of stem and leaves of *Solanum xanthocarpum* obtained by refluxing the dried leaves and stem in soxhlet in ethanol. Solution of different concentration of extract were prepared in ethanol.

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B. Metal Specimen

Specimens of dimension 2.5 x 2.5 x 0.04 cm were cut out from an aluminium sheet and were cleaned by an emery paper and dried by acetone to get a clean surface without any spot. A hole was done at the upper edge of specimens to suspend it in the HCl solution.

C. Medium

2N HCl has been used for inhibitor studies. All chemical used were of AR grade

III. METHODOLGY

Weight loss and gasometric method were used to study inhibiton efficiency.

A. Weight Loss Measurements

The most common and widely used method to measure corrosion rate is weight loss analysis. Weighed specimens of aluminium metal were suspended with V-shaped glass capillary in beaker containing 50 mL 2N HCl solution. Weight loss of specimens after dipping in test solution with and without inhibitor extract in different concentration was calculated with a weighing balance of accuracy upto 4 decimal places. The percent inhibition efficiency (η%) of inhibitors were calculated by the following formula [19].

$$\eta\% = \frac{100\ X(\Delta W_o - \Delta W_i)}{\Delta W_o}$$

ΔW_o = weight loss in absence of inhibitor
ΔW_i = weight loss in presence of inhibitor

The weight loss is converted to an average corrosion rate in mmpy (millimeter per year) as follows [20]

$$C.R. = \frac{87.6\ X\ \Delta W}{ATD}$$

ΔW = weight loss of specimen in mg
A =area of exposure of specimen in square cm
T = time of exposure in hours
D =density of specimen in g/cm^3

The degree of surface coverage (θ) can be calculated as [21]

$$\theta = \frac{(\Delta W_o - \Delta W_i)}{\Delta W_o}$$

The Value of inhibitor efficiency and corrosion rate obtained from weight loss method at different concentration of *Solanum xanthocarpum* leaves and stem extract in 2N HCl solution are summarized in Table 1

TABLE I.
HIBITION EFFICIENCY AND CORROSION RATE(C.R) FOR ALUMINIUM IN 2N HCL SOLUTION WITH *SOLANUM XANTHOCARPUM* EXTRACT

Concentration of inhibitor	Weight loss in mg (ΔW)	Inhibition efficiency (η%)	Surface coverage (θ)	Corrosion rate (mmpy)*(C.R)*	Log $\left(\frac{\theta}{1-\theta}\right)$
Leaves					
Uninhibited	208.5			4329.38	
0.2%	51.3	75.39	0.7539	1065.21	0.4862
0.4%	15.7	92.47	0.8661	579.32	0.8107
0.6%	11.4	94.53	0.9247	326.00	1.0892
0.8%			0.9453	236.71	1.2330
Stem					
Uninhibited	219.2			4551.56	
0.2%	55.5	74.68	0.7468	1152.42	0.4697
0.4%	53.5	75.59	0.7559	1110.89	0.4908
0.6%	42.4	80.65	0.8065	880.41	0.6199
0.8%	35.4	83.85	0.8385	735.06	0.7153

B. Gasometric Method

Gasometric assembly is an apparatus that measures the volume of gas evolved from a corrosion reaction. 50 mL of 2N HCl was poured into the two- necked flask and the initial volume of paraffin oil in the burette was noted. Sample was dropped into the HCl and the flask was quickly closed. The volume of hydrogen gas evolved from the corrosion reaction was calculated by volume changes in the level of paraffin oil in burette.

In second experiment a fresh sheet of aluminium was immersed in flask containing 2N HCl along with different concentrations of *Solanum xanthocarpum* leaves and stem extract.

The hydrogen evolution rates and inhibition efficiencies were calculated from equation [20]

$$\%\eta = \left(\frac{CR_{blank} - CR_{inh}}{CR_{blank}}\right) x\ 100$$

$$CR_h = \frac{V_t - V_i}{t_t - t_i}$$

V_t = volume of hydrogen evolved at time t_t
V_i = volume of hydrogen evolved at time t_i

The change in volume (ΔV) and corrosion inhibition efficiency by leaves and stem extract of Solanum *xanthocarpum* in 2N HCl for aluminium are summarized in Table 2.

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TABLE II. INHIBITION EFFICIENCY AND HYDROGEN EVOLUTION RATE FOR ALUMINIUM IN 2N HCL SOLUTION BY LEAVESAND STEM EXTRACT OF *SOLANUM XANTHOCARPUM*

Concentration of inhibitor	Volume change(ΔV) in mL	Inhibition efficiency (η%)	Hydrogen evolution rate ($C.R_h$)
Leaves			
Uninhibited	21.0		1.400
0.2%	5.2	75.71	0.340
0.4%	4.3	80.00	0.280
0.6%	2.4	88.57	0.160
0.8%	1.9	91.00	0.126
Stem			
Uninhibited	31.2		2.080
0.2%	12.6	59.61	0.840
0.4%	11.0	64.90	0.733
0.6%	10.0	68.26	0.666
0.8%	6.0	80.76	0.400

IV. RESULT AND DISCUSSION

Corrosion inhibition efficiency of leaves and stem extract of *Solanum xanthocarpum* have been studied for aluminium metal in 2N HCl in blank and with different concentrations of inhibitor. Weight loss method and gasometric method have been used for the study. Table 1 shows the variation of inhibition efficiency, surface coverage and corrosion rate in uninhibited and inhibited solutions with different concentrations of inhibitor, for leaves and stem extract. This is obvious from the table that inhibition efficiency increases with increase in the concentration of inhibitor and corrosion rate decreases with increasing concentration of inhibitor, for both leaves and stem extract. Maximum corrosion inhibition efficiency for leaves was found 94.53% and 83.85% for stem extract in 0.8% solution of inhibitor.

Table 2 shows the volume change, inhibition efficiency and hydrogen evolution rate for uninhibited and inhibited solution by leaves and stem extract. The same results are observed in this method also. Here the maximum efficiency is 91.00% for leaves extract and 80.76% for stem extract. It means both methods are in good agreement with each other. The variation in inhibition efficiency with concentration of inhibitor are shown in figure 1 and in figure 2.

The natural plants like *solanum xanthocarpum* have alkaloids containing N, S, O etc. heteroatoms. These alkaloids are chemisorbed on the surface of metal due to high electron density on these heteroatoms, thus block the active site of surface for corrosion reaction and thus retard the corrosion rate. The surface coverage (θ) by inhibitor has been depicted in table 1, thus chemisorption is most probably the potential reason for protecting the metal from the corrosion.

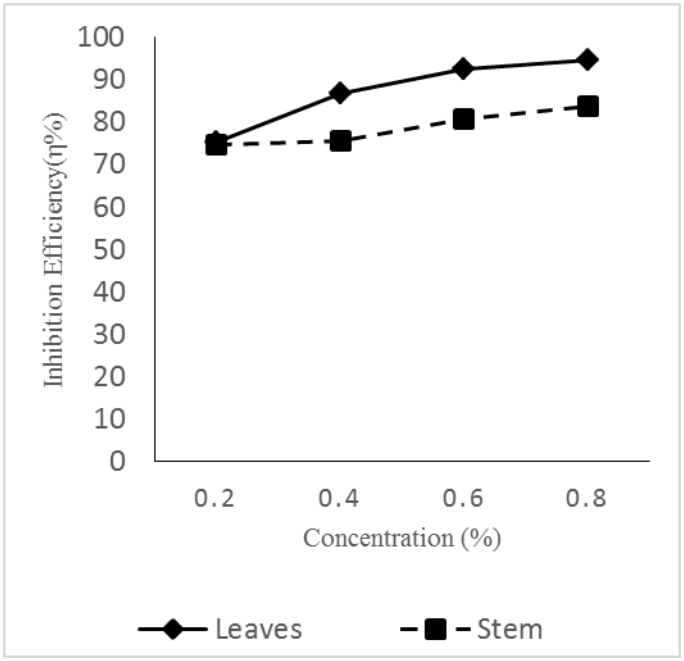

Fig 1 - Variation of Inhibition efficiency as a function of concentration in the presence of different concentrations of *Solanum xanthocarpum* in 2N HCl Solution on Aluminium by weight loss method

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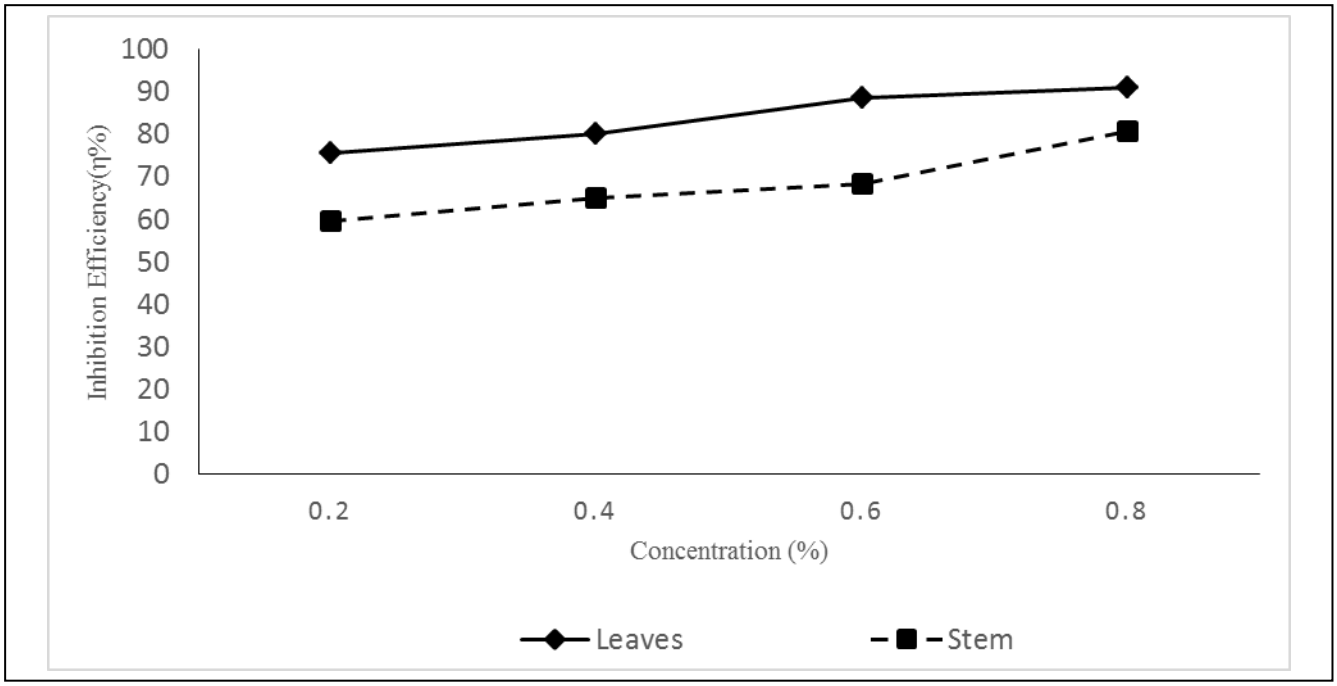

Fig 2 - Variation of Inhibition efficiency as a function of concentration in the presence of different concentrations of *Solanum xanthocarpum* in 2N HCl Solution on Aluminium by Gasometric method

V. CONCLUSION

The present studies show that both leaves and stem extract of *Solanum xanthocarpum* are good inhibitor for aluminium in 2N HCl. The present study reveals that leaves extract is better corrosion inhibitor than stem for aluminium in 2N HCl in same conditions. Both methods used in the present studies are in good agreement with each other.

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