INHIBITIVE PROPERTIES OF *Commelina Benghalensis* LEAVES ON THE COROSION OF MILD STEEL IN 1M HCL

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ABSTRACT

Corrosion is the degradation of materials and chemical reaction with the environment which the materials reside as a result of metal oxidation. Considerable efforts have been developed to find suitable corrosion inhibitors of organic origin in various corrosive media. In this study the corrosion inhibition of mild steel using methanol leaf extract of commelina benghalensis was studied using weight loss method. The study is to investigate the inhibition of mild steel in acidic media. The result of the study reveals that different concentration of extract of commelina benghalensis inhibits mild steel corrosion in acidic media. The inhibition efficiency of the extracts increases as the concentration of the extract increases. This study also reveals that inhibition efficiency decreases as temperature increases, the adsorption of methanol extract of commelina benghalensis on mild steel surface conforms with the mechanism of physical adsorption and the adsorption of methanol extract of comelina benghalensis on mild steel surface is exothermic. From the study, the methanol extract of commelina benghalensis is a good efficient inhibitor for corrosion of mild steel in IM HCL solution.

Keywords*: Corrosion inhibition, mild Steel, acid medium , phytochemicals, corrosion rate.*

INTRODUCTION

The behavior of metals and alloys in aggressive media depends on many factors such as the chemical composition, the stability of the oxide film, metallurgical and processing parameters, and the effectiveness of any applied protection (Al-Abdallah *et al*., 2009).
Corrosion is a prevailing destructive phenomenon in science and technology. In industries such as pulp and paper industry, power generation, underground structures, chemical and oil industries, metals are used in over 90% of construction process. Iron and steel are the most commonly used materials in the fabrication and manufacturing of oil field operating platforms because of their availability, low cost, ease of fabrication, and high strength (Osarolube *et al.*, 2008). An inhibitor is a substance (or a combination of substances) added in a very low concentration to treat the surface of a metal that is exposed to a corrosive environment that terminates or diminishes the corrosion of a metal. These are also known as site blocking elements, blocking species or adsorption site blockers, due to their adsorptive properties. The term “green inhibitor” or “eco friendly inhibitor” refers to the substances that have biocompatibility in nature. The inhibitors like plant extracts presumably possess biocompatibility due to their biological origin. Generally green inhibitors are excellent inhibitors under a variety of corrosive environments for most of the metals. The non-toxicity and biodegradability are the major advantages for these inhibitors (Devarayan *et al*., 2011).

Corrosion can be prevented or at least controlled using suitable preventive manures, and several techniques have been developed to control corrosion. Although there are numerous options for controlling the corrosion of metals, the use of inhibitors is one of the best methods of protecting metals against corrosion (Rajappa *et al., 2008*).

Comelina benghalensis, commonly known a perennial herb native to tropical Asia and African is widely distributed in tropical parts of Nigeria especially Birnin Kebbi as weed. The Hausa of northern Nigeria call it Baba Bulasa, while the Nupe of middle belt of Nigeria call it Lukonkuku. It’s preferred common name is Wandering Jew. The leave is about 3-7 cm long, and 1-2.5cm wide with base narrowed into a petiole. The plants in an ascending position are 15-40 cm long, branched and rooting at the nodes. It is used here in Nigeria as animal feeds not like in Pakistan where it is use as a vegetable and medicine (Schumann, 2010).

MATERIALS AND METHOD

SAMPLE PREPARATION

The leaves of *comelina benghalensis* were collected at different locations within Birnin Kebbi, Kebbi State. The leaves were dried under room temperature. They were then grinded to fine powder using a mortar and pestle. The fine powdered sample was then stored in a clean dry container.

EXTRACTION PROCEDURE

The extraction was done using methanol as solvent. 100g of powdered sample weighed into a container containing 700ml of methanol. The mixture was shook very well and allowed to be soaked for 2 hours. After which the mixture was filtered using a filter paper. The filtrate was further subjected to evaporation i.e it was exposed to air for 72 hours in order to leave the samples free of methanol. After extraction, the dried extract was subjected to phytochemical test and the extract was used as a corrosion inhibitor using the gravimetric method (Bouyanzer and Hammonti 2009).

PHYTOCHEMICAL TEST PROCEDURE

The phytochemical test was carried out using the method described by Harbone, 1973.

MATERIALS PREPARATION

Mild Steels of composition chemical of Fe = 99.11, C = 0.149, Si = 0.059, Mn = 0.359, S = 0.039, Ni = 0.048, Cu = 0.039, Cr = 0.038 and others = 0.075 were used for the study. The steels were cut to form different coupons of dimension of 1.0cm x 1.5cm using electronic venial caliper. Coupon was polished mechanically using Sic emery papers, washed thoroughly with distilled water and degreased with ethanol and acetone, air dried in a desiccators. Accurate weight of the sample was taken using electronic balance. All reagents used for the study were analytical grade and double distilled water was used during the experiment.

GRAVIMETRIC METHOD

After the initial weighing, the specimen were immersed in 200ml 1M HCL solution in the absence and presence of concentration of plant extracts, the steels were tied with the aid of a thread and immersed into the solution for 2hours at a temperature of 30^{o}C and 60^{o}C respectively. After which the specimens were removed, washed and weight noted, from the initial and final weights of the mild steel, the weight loss, the corrosion rate (gh^{-1} Cm^{-2}), inhibition efficiency (% I.E), and surface coverage (θ) was calculated at different concentration of the inhibitors in 1M HCl as used by Okafor *et al*. (2010).

$$CR\ (gh^{-1}\ cm^{-2}) = \frac{\Delta W}{AT}$$

ΔW = Weight loss in g
A = Area in cm^2
T = Time in hours

$$\%\ I.E = I - \frac{\Delta W_1}{\Delta W_2} \times 100$$

$$\Theta = 1 - \frac{\Delta W_1}{\Delta W_2}$$

Where Δw_1 and Δw_2 are weight loss in presence and absence of inhibitor.

RESULTS AND DISCUSSION

Effects of inhibitor concentration on corrosion rate and inhibition efficiency

The corrosion rates of mild steel in the absence and presence of *Commelina benghalensis* extract and inhibition efficiencies of various concentrations of *Commelina benghalenis* extract were shown in Tables 1 and 2 and Fig. 1 to 3. The results obtained showed that the rate of corrosion of mild steel decreased with increase in concentration of methanol extract of *Commelina benghalensis.* While the inhibition efficiency of the extract of *Commelina* *benghalensis* increased with increasing concentration of the extract, indicating that the adsorption of extract of *Commelina benghalensis* on mild steel surface is consistent with report of Eddy *et al*. (2009). It is obvious from table 2 that inhibition efficiency increases with increasing acid strength and it also increases with increasing concentration of leaves extract. The maximum efficiency (i.e. 80.20%) has been observed in 1M HCl at concentration of inhibitor (i.e. 0.6g/L) for leaves extract at 303K. Observations of inhibition efficiency corresponding to same concentrations of acid and inhibitor at 313K show that efficiency of the inhibitor is less at 313K than that at 303K, although the trends are the same.

Table 1: Showing the corrosion rate of mild steel in methanolic extract of *Commelina benghalensis* in 1M HCl at 303k and 333k

Conc. (g/L)	**(C.R ($gh^{-1}cm^{-2}$) at 303k**	**(C.R ($gh^{-1}cm^{-2}$) at 333k**
Blank	2.05×10^{-2}	1.09×10^{-1}
0.1	1.29×10^{-2}	1.01×10^{-1}
0.2	5.4×10^{-3}	9.4×10^{-2}
0.3	5.3×10^{-3}	8.7×10^{-2}
0.4	5.1×10^{-3}	8.1×10^{-2}
0.5	4.8×10^{-3}	7.2×10^{-2}
0.6	4.0×10^{-3}	6.4×10^{-2}
0.7	4.0×10^{-3}	6.4×10^{-2}
0.8	4.0×10^{-3}	6.4×10^{-2}

Table 2: Showing the inhibition efficiency and surface coverage of methanolic extract of *Commelina benghalensis*in1M HCl at 30^0c (303k) and 60^0c (333k)

Conc. (g/L)	ϴ(333k)	% I.E(333k)	% I.E (303k)	ϴ(303k)
Blank	-	-	-	-
0.1	0.0686	6.86	36.8	0.368
0.2	0.1372	13.72	73.2	0.732
0.3	0.1949	19.49	74.0	0.740
0.4	0.2526	25.26	74.8	0.748
0.5	0.3307	33.07	76.3	0.762
0.6	0.4095	40.95	80.2	0.802
0.7	0.4109	41.09	80.2	0.802
0.8	0.4131	41.31	80.2	0.802

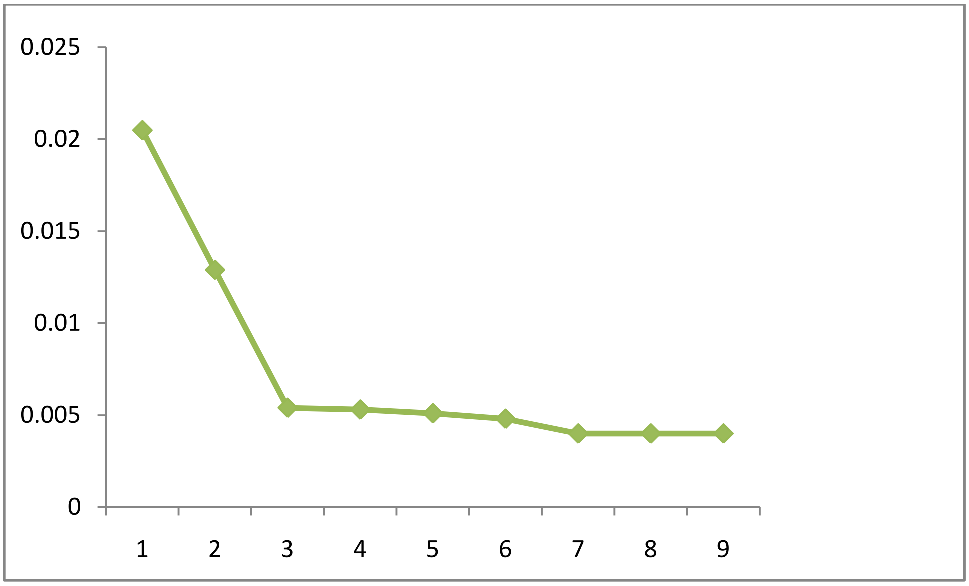

Fig. 1: Showing the corrosion rate of mild steel on methanolic extract of *Commelina benghalensis* in 1M HCl at 303k

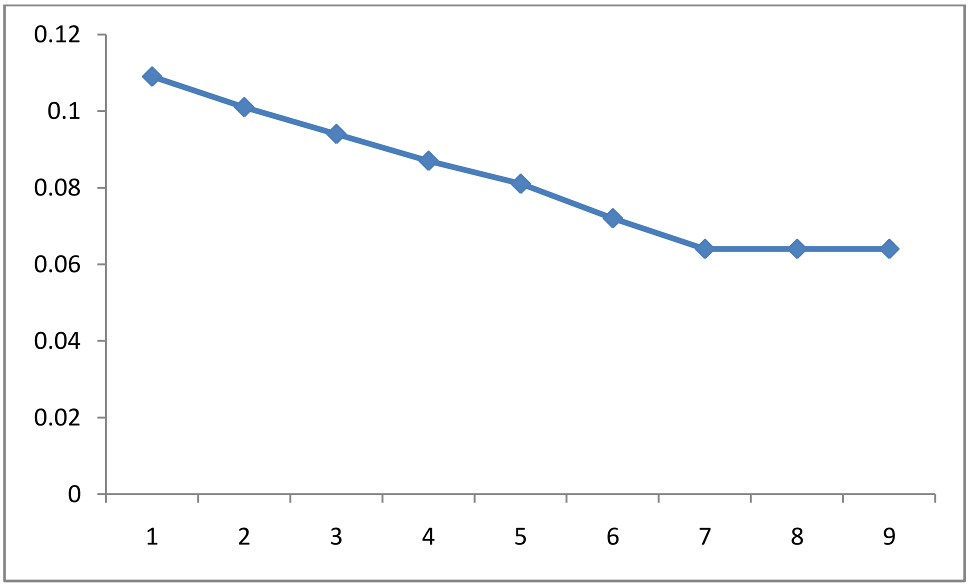

Fig.2: Showing the corrosion rate of mild steel on methanolic extract of *Commelina benghalensis* in 1M HCl at 333k

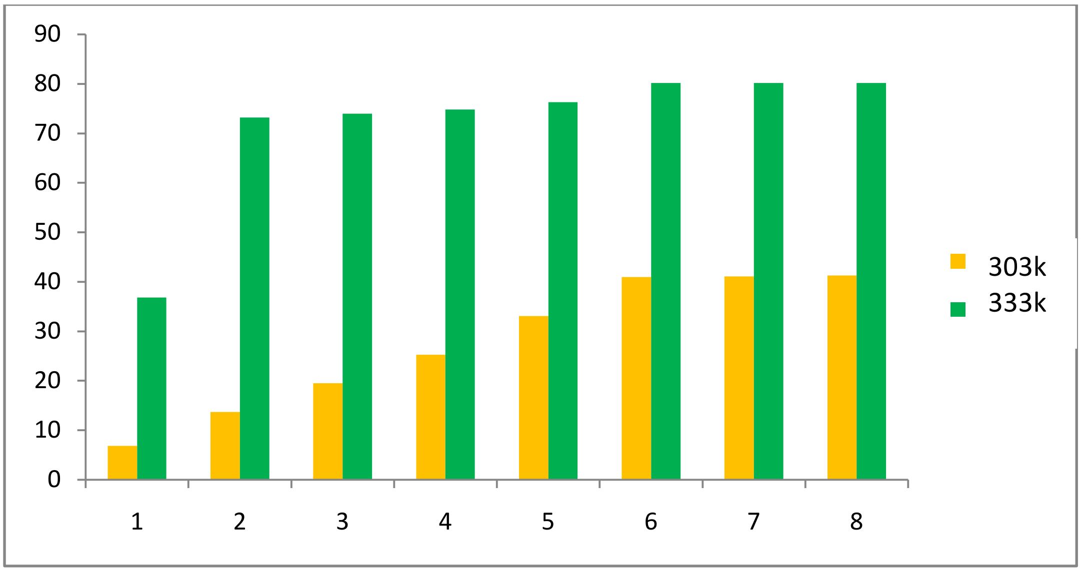

Fig. 3: Showing the inhibition efficiency of the methanolic extract of *Commelina benghalensis*

Effect of temperature

The Arrhenius equation was employed to study the effect of temperature of the rate of corrosion of mild steel in HCl at 303k and 333k containing various extract of *Commelina benghalensis* as expressed by equation (i) (Eddy *et al*., 2009).

$$\log\frac{CR_2}{CR_1} = \frac{E_A}{2.303R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right) \quad - \quad - \quad - \quad - \quad -(1)$$

Where CR is the corrosion rate of mild steel, Ea is the activation energy. R is the gas constant and T is the temperature. The corrosion rates of mild steel at 303k (T_1) and 333k (T_2) is CR_1 and CR_2, E_a values calculated from Equation (i) are presented in table (4), these values ranged from 46.76 to 79.88kjmol^{-1} and are lower than threshold value of 80kjmol^{-1}required for chemical adsorption, indicating that the adsorption of methanol extract of *Commelina benghalensis* on mild steel surface conforms with the mechanism of physical adsorption (Eddy *et al*., 2009).

Thermodynamic/adsorption considerations (Q_{ads})

The heat of adsorption Q_{ads} was calculated using Equation (ii) (Eddy *et al*., 2009).

$$Qads = 2.303R \log\left(\frac{\theta 2}{1-\theta_2}\right) - \log\left(\frac{\theta 1}{1-\theta_1}\right) \text{ x } \left(\frac{T_1 \, x \, T_2}{T_{2-}T_1}\right) \text{kjmol}^{-1} \ldots\ldots\ldots\ldots\ldots\ldots \text{(ii)}$$

Where R is the gas constant, $\theta_1 \, and \, \theta_2$ are the degree of surface coverage at temperature, T_1 and T_2 respectively. As shown in table 3 calculated heat of adsorption values range from -48.94 to -79.53kjmol^{-1} indicating that the adsorption of methanol extract of *Comelina benghalensis* on mild steel surface is exothermic (Ebenso et al., 2003).

Table 3: Showing the calculated activation energy and heat of adsorption methanolic extract of *Commelina benghalensis*in 1M HCl media at 303k and 333k

Conc. (g/L)	Ea $Kjmol^{-1}$	Q_{ads}
0.1	46.76	-57.83
0.2	57.54	-79.53
0.3	79.88	-68.92
0.4	78.16	-60.76
0.5	77.30	-52.42
0.6	75.72	-49.36
0.7	77.52	-49.19
0.8	77.08	-48.94

PHYTOCHEMICAL ANALYSIS

The phytochemical constituents of methanolic extract of *Commelina benghalensis* is shown in table 4. The result obtained indicates that saponin, Tannin, alkaloids, glycoside, flavonoid, are present in the methanolic extract of *Commelina benghalensis*. This indicates that the inhibition efficiency of the extract is due to the presence of these phytochemical components in it.

Table 4: showing the phytochemical analysis (qualitative) of methanolic extract of *Commelina benghalensis*

PARAMETERS	**METHANOLIC EXTRACT OF *Commelina benghalensis***
Alkaloids	+
Flavoniods	+
Tannins	+
Saponins	+
Glycosides	+

CONCLUSION

The present study shows that methanol extract of *commelina benghalensis* is a good inhibitor of the corrosion of mild steel on HCl at 30^0c (303k). The inhibition potential of extract is attributed to the presence of saponin, tannin, cardiac glycoside, flavonoid, alkaloid in the extract.

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