Available online at www.worldnewsnaturalsciences.com

World News of Natural Sciences

WNOFNS 10 (2017) 95-100 EISSN 2543-5426

Photochemical screening and corrosion inhibition of *Poupartia birrea* back extracts as a potential green inhibitor for mild steel in 0.5 M H_2SO_4 medium

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ABSTRACT

Corrosion of metals is a serious environmental problem and has been given much attention in the oil and gas industries. In several industrial processes (acid cleaning and etching, removal of rust and scale), metal surfaces are often made to come in contact with acids. In the present study, an attempt was made to examine *Poupartia birrea (P. birres)* back extract as a potential green corrosion inhibitor for mild steel in a 0.5 M H_2SO_4 medium, using the weight loss determination method. The results of our work indicate that highest inhibition efficiency exhibited by *Poupartia birrea* is 70%. The inhibiting effect of the studied extract could be attributed to the presence of phytochemical constituents present in the extract that are adsorbed on the surface of the mild steel. The plant extract can, hence, be considered as being eco-friendly and an effective green corrosion inhibitor for mild steel exposed to an acid medium.

***Keywords*: *Poupartia birrea*, inhibitor, corrosion, mild steel**

1. INTRODUCTION

Steel and steel-based alloys are widely employed in majority of engineering and structural applications such as acid pickling, cleaning and oil-well acidizing processes. In these service conditions, degradation of the material and the use of alkyd-based polymer coating has been reported (Louis *et al.,* 2015). Accordingly, methods for improving/or controlling such occurrence sbecomes a research focus among. Over the years, development and identification of potential inhibitors for corrosion control in majority of environments have been subject of interest with a promising result output (Lebrini *et al.*, 2011 and Louis *et al.*, 2016). In that direction, the use of organic and inorganic substances as corrosion inhibitor to reduce the corrosion rate of metals and alloys have been widely reported (Znini et al., 2011).

Most of the corrosion inhibitors are synthetic chemicals which are expensive and very hazardous to environments. Due to the toxicity of some corrosion inhibitors, there has been increasing search for green corrosion inhibitors. Green corrosion inhibitors are biodegradable and do not contain heavy metals or other toxic compounds (Smitha *et al*., 2009). The use of plant extracts as corrosion inhibitor has become important because they are environmentally acceptable, readily available and renewable source for a wide range of green inhibitors. The use of natural products such as leaves and seeds as corrosion inhibitors have been widely reported by many researchers (Mathina and Rajalakshmi, 2016). Various plant extracts, containing mixture of compounds having oxygen, sulphur, and nitrogen elements, are employed as green corrosion inhibitors from acidic solution (Verma and Khan, 2016).). In the present study, an attempt was made to examine *Poupartia birrea (P. birres)* back extract as a potential green corrosion inhibitor for mild steel in 0.5 M H_2SO_4 medium using gravimetric method. So far no studies were reported using P. birrea bark as corrosion inhibition studies using on mild steel in acidic medium using weight loss determination method. Poupartia birrea is an evergreen woody perennial and drought tolerant shrub, indigenous and wide spread throughout the tropics belonging to family Sapindaceae (Sandiya, *et al*., 2009).

2. EXPERIMENTAL

Sample Collection

Poupartia birrea bark was collected from the farm near Bagalci in Girei Local Government Area of Adamawa and was identified in the department of plant science, Modibbo Adama University of Technology Yola.

Sample Preparation

The bark of *Poupartia birrea* was dried for 7 days until devoid of moisture. The dried plant parts were ground into fine powder and transferred into airtight containers with proper labeling. The extract was prepared by reflux method. 50g of the powdered sample in 400ml methanol. The extracts were filtered and heated to evaporate the solvent. Rectangular size specimens of Mild Steel (MS) with dimension 1×5 cm^2 strips and 2 mm thickness, containing a small hole near the upper edge were employed for mass loss study. The strips were mechanically polished, degreased, washed in double distilled water, dried, and stored in a dessicator and were used for the entire immersion studies. A cylindrical mild steel rod of the same composition embedded in a Teflon rod with an exposed area of 1×1 cm^2 was used for electrochemical polarization studies and AC impedance measurements. Analar grade H_2SO_4 and double distilled water were used to prepare the 0.5M H_2SO_4.

Weight loss measurement

The weight loss measurements were carried out according to the method reported by Louis *et al*.,. Five specimens used were labeled as: S1, S2, S3, S4 and S5 in which four were immersed in four different beakers containing 20 ml 0.5 H_2SO_4 solutions with different volume of P. birrea stem extract using glass hooks and rods for a predetermined time period at room temperature. In order to get good reproducibility, experiments were cleaned according to ASTM G-81 and the weight recorded. The average mass losses of five parallel mild steel specimens were obtained at 24 hours interval for 120 hours. The test specimens were removed and then washed with de-ionized water, dried and reweighed.

The weight loss corrosion rate (CR) and inhibitor efficiency were calculated from the formula given below.

$$\text{Corrosion rate, } \mathrm{CR} = \frac{\text{weight loss x 534}}{\text{Density x Area x time}}$$

where:

Weight loss in mg
Density of the mild steel/coupon = 7.85 g/cm^3
Area is that of the coupon in square inches, (in 2)
Time is the exposure time in hrs.
The efficiency of the inhibitor was computed using the following equation:

$$\text{Inhibitor Efficiency: } \mathrm{IE}\ (\%) = \frac{w_o - w_1}{w_o} \text{ x } 100$$

where:

W_0 = weight loss without inhibitor
W_1 = weight loss with inhibitor

Phytochemical analysis

Standard procedures were employed to test for the presence of phytochemicals such as tannins, saponins, alkaloids, terpenoids, phenols, flavonoids and steroids in the brown leaves of *poupartia birrea* (Louis *et al*., 2017).

3. RESULT AND DISCUSSION

The Table below shows phytochemical analysis of bark extract of *Poupartia birriea*. The presence of alkaloids, saponims, tannins, phenols, and terpenoids were detected but flavonoid steroids, alkaloids and were absents. Phytochemical chemical screening test did not show the presence of any common phytotoxic compound in the extract.

Table 1. Phytochemical analysis of *Poupatia birrea*

Phytochemicals	Results
Tanins	+
Saponins	+
Flavanoid	-
steroids	-
Alkanoids	-
Terpenoids	+
Phenol	+

Key: Present +, Absent –

Effect of amount of extract on corrosion rate and inhibitor efficiency

This study has shown that *Poupatia birrea* extract can be used as corrosion inhibitor. The highest inhibition efficiency exhibited by *Poupartia birrea* is 70%. It is speculated that inhibition efficiency could be a function of chemical bond formation between the inhibitor and the mild steel surface. Furthermore, the low result in the inhibition efficiency can also be attributed to the absence of some important phytochemicals (alkaloids and flavonoids) in the plant bark extracts. Generally the first stage in the corrosion inhibition mechanism is the adsorption of inhibitor molecules on the mild steel surface. The process of adsorption is influenced by the type of the aggressive electrolyte, the chemical structure of the inhibitor molecules, and the nature and charge of the metal ((Mathina and Rajalakshmi, 2016).

Effect of corrodent concentration on mild steel corrosion

The influence of the corrodent concentrations on mild steel corrosion is shown in Figures 2. It is observed that the mild steel corrodes in different concentrations of inhibitor solutions. This is because of the decrease in the original weight of the coupons. The corrosion is attributed to the presence of water, air and hydrogen ion, which accelerates the corrosion process (Louis *et al*., 2016).

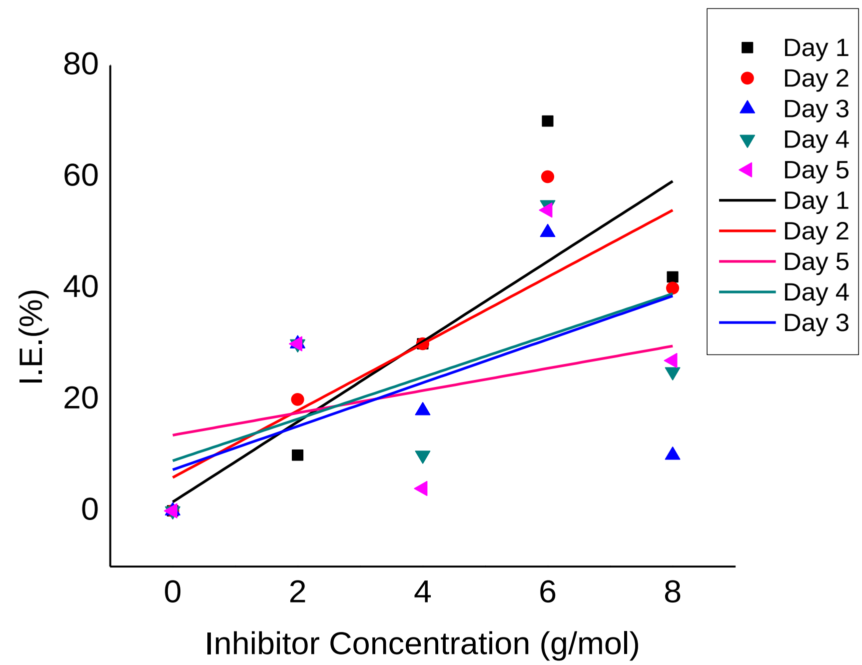

Figure 1. Effect of amount of extract on corrosion rate and inhibitor efficiency

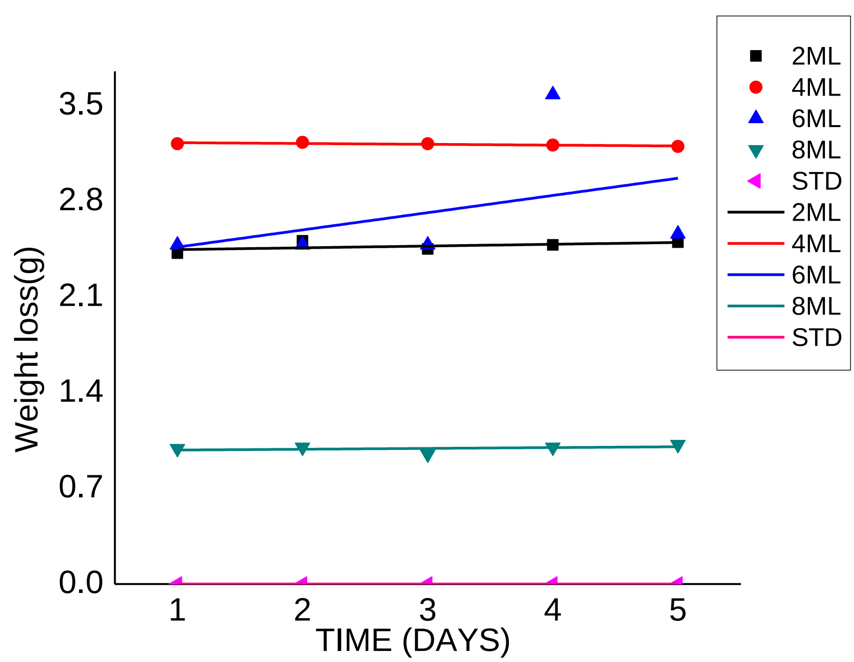

Figure 2. Effect of corrodent concentration on mild steel corrosion

4. CONCLUSION

The present study shows *Poupartia birrea* bark extract acts as inhibitor for mild steel corrosion in 0.5 M H_2SO_4. The inhibition efficiency increased with increase in inhibitor concentration at constant temperature. The inhibiting effect of the studied extract could be attributed to the presence of phytochemical constituents present in the extract which is adsorbed on the surface of the mild steel. The plant extract can be considered as an eco-friendly and effective green corrosion inhibitor for mild steel in acid medium.

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(Received 22 April 2017; accepted 06 May 2017)