ETHANOL EXTRACT OF *LAUNEA TARAXACIFOLIA* LEAVE AS CORROSION INHIBITOR OF MILD STEEL IN 1M HCL

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Abstract

Using gravimetric analysis, potentio-dynamic, and adsorption isotherm techniques we researched how mild steel corrodes in 1M hydrochloric acid, in the presence of varying amounts of ethanol extract of Launaea taraxacifolia (wild lettuce). Effect of inhibitor concentrations (0.1, 0.3, 0.5 and 0.7g/l), temperatures (303K, 323K) at various immersion times were evaluated on the inhibition efficiency (%IE) of the extract on mild steel submerged in IM HCl solution. The weight loss increased with increasing temperature and exposure time, according to the findings. According to the gravimetric measurements, the weight loss was lowest on mild steel at 303 K and 0.7 g/l. The inhibitor's effectiveness improved as the inhibitor concentration grew. The results show that Launaea taraxacifolia worked well as a corrosion inhibitor. According to the electrochemical data, the examined molecule functions as a mixed-type inhibitor. The inhibitory efficiency values derived using these techniques accord rather well. The inhibitory compound's adsorption was discovered to follow Langmuir isotherms. Launaea taraxacifolia leaf extract exhibited outstanding inhibitory properties due to the presence of phytochemicals. Launaea taraxacifolia leaves extract demonstrated its ability to inhibit corrosion in green environments.

***Keyword**: Adsorption isotherm; corrosion; inhibitors; gravimetric; potentiodynamic*

Introduction

Mild steel is an alloy containing 0.05–0.30% carbon, it is malleable and flexible, a bit stable but not readily tempered. It has a less tensile strength, modest and straightforward to frame; and the surface hardness can be expanded through carburizing (Steeloncall, 2022). Pig iron is utilized as a raw material for the manufacture of mild steel. It is ductile and very tough and also has a good weldability enabling its usage in engineering applications. In Engineering it is applied as a major part of production such as in automobiles, building structures, mega plants and other engineering components (Callister, 1997). Because of its superior mechanical characteristics and inexpensive cost, it finds application in chemical production, petroleum production, refining, pipelines, mining, and construction (Pavitra et al., 2013).

The exposure of materials and the effect of the impact of the environment causes corrosion. The lifespan of equipment can be shortened as a result of corrosion which might lead to its redundancy (Ibert, 1970). This could lead to economic loss in the form of repairing or replacement of damaged metal. The corrosion rate of metals is highly affected by natural and environmental factors (Amadi, 2000). The acid medium is also a common source of corrosion, and it has a direct impact on the physical form of the steel (Shukla et al., 2012).

Corrosion inhibitors are naturally occurring chemicals., organic or inorganic based use in the prevention or reduction of the rate of corrosion of metals. Alloys such as mild steel are affected by corrosion thus, there is the need for its prevention (Goyal et al., 2018). Natural inhibitors like plant extracts contain heteroatoms with multiple bonds like nitrogen, phosphorus, carbon and oxygen which prevent corrosion of steel (Ogunleye et al., 2020; Haldhar et al., 2021; Shahini et al., 2021). The corrosion inhibition ability of the extracts from these plants is due to the fact that they contain functional groups, N=N, C=O, C=H, (flavonoids, tannins, polyphenols, amino acids etc.) (Van Hien et al., 2019; Ben Harb et al., 2020; Trung et al., 2021).

Plants like ginkgo biloba, citrus plant, tea, sunflower, have been used by researchers as organic corrosion inhibitor (Li X, et al., 2012; Verma et al., 2017; Herrero et al., 2018; Cvjetko Bubalo et al., 2018; He S, et al., 2018;), according to Hamad et al., (2014) *Launaea* specie can serve as a plant-based corrosion agent.

Launaea taraxacifolia is West African plant from the tropics popularly categorised as wild lettuce. It is a very valuable plant that is utilised as a food source, livestock feed, and to cause numerous births in livestock. It is also used to make vegetable salt, which is then burned into ash. Nigerians have utilised the herb for years to treat a variety of ailments, including eye disorders (conjunctivitis), yaws, and measles. A leaf extract mixed with nursing mother's breast milk is used to heal partial blindness caused by a snake bite (Adebisi 2004; Gbadamosi et al., 2020). This study however focused on using this abundant plant as a corrosion inhibition agent in mild steel.

Materials and methods

Plant collection

The foliage of the plant *Launaea taraxacifolia* (wild lettuce) was harvested around Ilaro metropolis, Ogun State. Authentication of the plant was done at the Forestry Research Institute of Nigeria, Ibadan.

Sample preparation

Before being pulverized to powder and steeped in ethanol for 24 hours, the leaves were thoroughly cleaned with distilled water and dried at room temperature for a few days.

Preparation of the inhibitor's solution

Following ethanol evaporation, the inhibitor solution was prepared by measuring 6.0g of inhibitor with an analytical balance, dissolved in about 2-3ml of ethanol, transferred to a 500cm^3 volumetric flask, and made up to the mark with 1M HCl solution (Abiola, et al., 2007).

Preparation of Mild Steel Coupons

The study used mild steel specimens containing C = 0.01%, Mn = 0.34%, P = 0.08%, and Fe = 99.51%. The mild steel coupons measured 15 mm× 15 mm × 2 mm. We cleaned and dried the coupons in acetone and ethanol before storing them in a desiccator until needed.

Extraction Process

The leaves of *Launaea taraxacifolia* (wild lettuce) were removed, washed thoroughly with distilled water and dried at room temperature to constant weight for seven days and pulverised. 102.4g of the powder were soak with ethanol for 24hours after which it was filtered, and the ethanol evaporated with a minimal heat (so as not to decompose the active ingredient) with hot plate. After complete evaporation of ethanol, the inhibitor solution was prepared by measuring 3.0g of inhibitor with the aid of analytical balance, dissolved in about 2-3ml of ethanol and transferred into 500cm^3 volumetric flasks and made up the mark with 1M HCl solution (Abiola, Oforka, Ebenso and Nwinuka, 2007).

Gravimetric method

The metal coupons were all weighed before and after immersion using an analytical weighing scale A metal coupon that had previously been weighed was dipped in 40 ml of each of the test solutions. of 0.1 g/l, 0.3 g/l, 0.5 g/l, and 0.7 g/l produced in 100 ml beakers with 1 M HCl. The beakers were immersed in 303 K and 323 K water baths for 1-5 hours. Before reweighing, the corrosion product was removed (taken from the test solution), rinsed with distilled water, dried in acetone, and air dried. The corrosion rate was determined using a formula based on the weight loss estimates.

$$V = \frac{\Delta W}{At}$$

Corrosion rate V is determined by the change in weight loss ΔW, sectional area A and exposure time t measure corrosion rate.

$$\Delta W = W_1 - W_0$$

W_1 is the final weight and W_0 is the initial weight. The inhibition efficiency (%) of the *Launaea taraxacifolia* extracts was evaluated from the following equation.

$$\% \, I.E = \frac{V_{blank} - V_{inh}}{V_{blank}} \times 100$$

Electrochemical method

Three electrodes were used in the electrochemical studies, including a potassium chloride reference electrode and a platinum electrode. Before use, the metal surface was thoroughly polished with silicon carbide paper. At 303 K and 323 K, the acidic solution was utilised as an electrolyte with varying inhibitor concentrations. A potentiodynamic polarisation research was carried out, and the inhibitors' inhibition efficacy was assessed.   An open circuit potential (Eocp) was established on the working electrode for polarisation curves by submerging it in a test solution for around 30 minutes. Recording the polarisation curve required a scanning rate of 100 mVs-1(8).

Results and discussion

At 303 K and 323 K, *Launaea taraxacifolia* leaves extract at concentrations of 0.1 g/l, 0.3 g/l, 0.5 g/l, and 0.7 g/l of HCl showed the highest weight loss over time when corrosion was induced by 0.1 g/l, 0.3 g/l, 0.5 g/l, and 0.7 g/l of leaves extract.at different temperature. The data demonstrate that as the temperature and exposure time increased, so did the weight loss. The graphs show that the weight loss was lowest on mild steel at 303 K at 0.7 g/l (the highest inhibitor concentration evaluated).. There is a correlation between mild steel corrosion and the leave extract from *Launaea taraxacifolia leaves*. The investigation revealed that the weight loss of mild steel increased with accelerating temperature but decreases with inhibitor extract concentration. It was noted that inhibition efficiency was achieved at the highest concentration (0.7 g/l) at 303 K. (Onen et al., 2011).

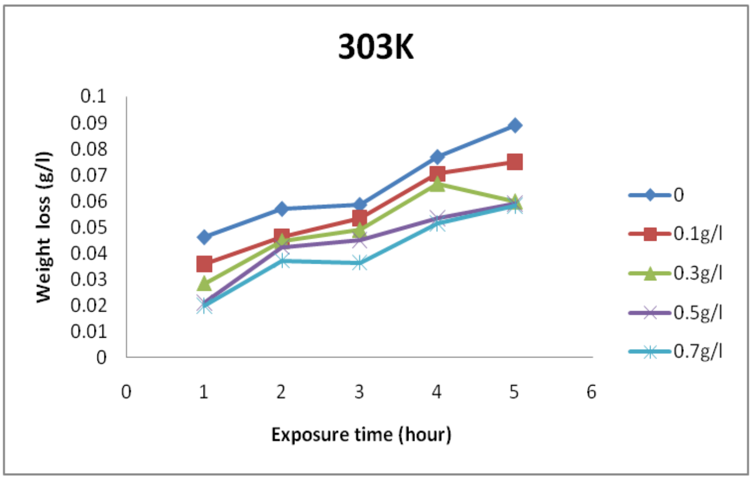

Figure1: Weight loss as a function of exposure time for different concentration at 303K

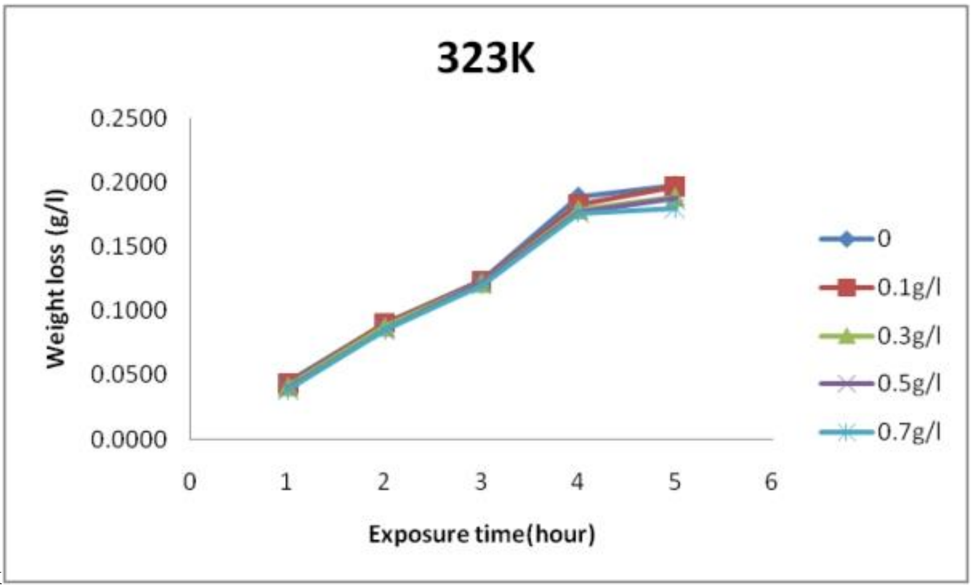

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Figure 2: Weight loss as a function of exposure time for different concentration at 323K.

Potentiodynamic polarisation curves for mild steel in 1M HCl solution of varying extract concentrations at 303 K and 323 K. As indicated by the deviation of the corrosion current density from the blank following the addition of leaf extracts to the corrosive medium (1 M HCl), the extracts inhibited the corrosion rate of mild steel. Furthermore, anodic and cathodic current densities are lowered, indicating that *Launaea taraxacifolia* leaf extract functions as a mixed type of corrosion inhibitor. The results shown in Figures 3 and 4 reveal that the corrosion rate reduced with increasing concentrations at 303 K and 323 K (Hussin & Kassim, 2011).

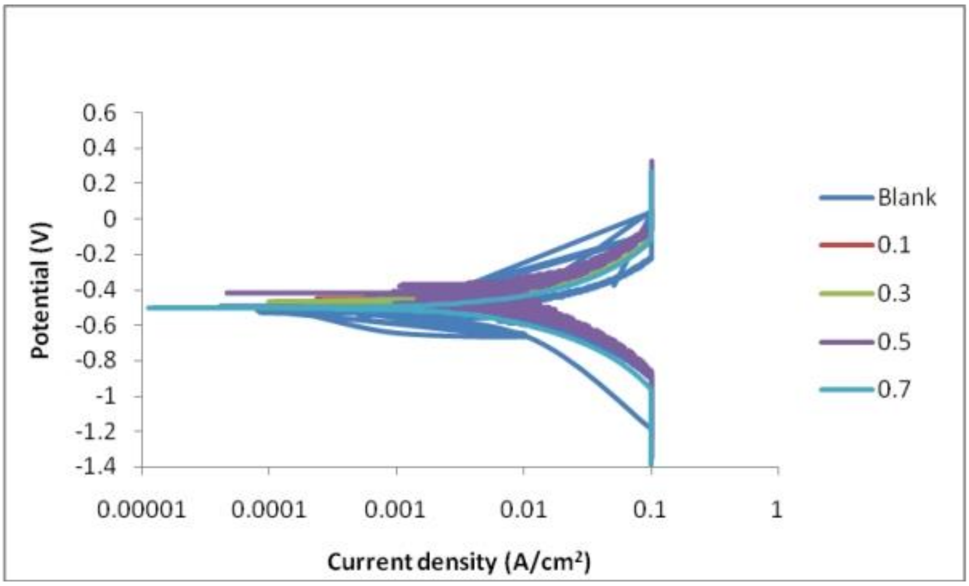

Figure 3: Potentiodynamic polarization plot of aqueous leaves extract at different inhibitor concentration at temperature of 303K.

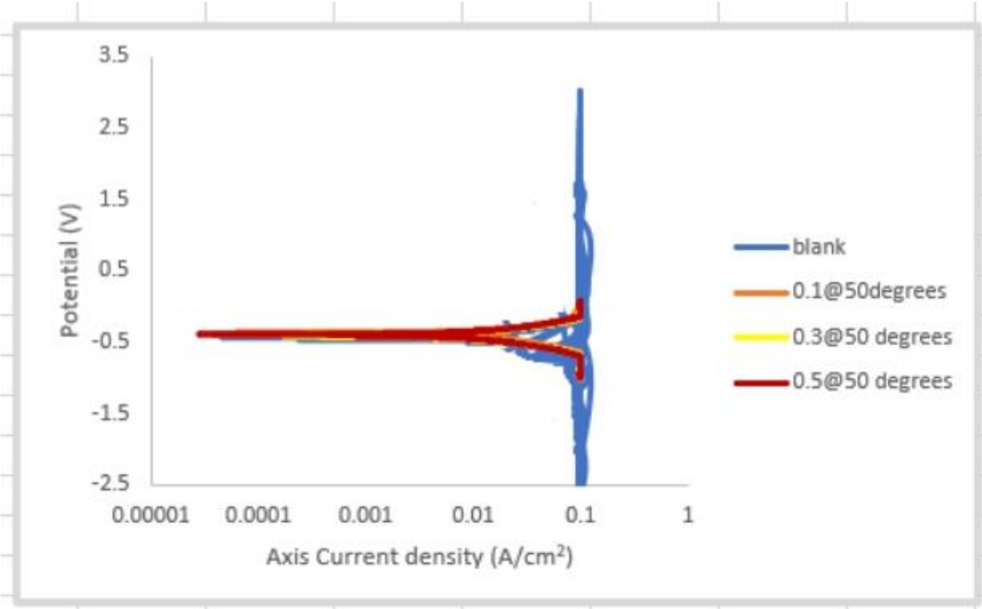

Figure 4: Potentiodynamic polarization plot of leaves extract at different inhibitor concentrations at temperature of 323K

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Figure 5 and 6 displayed inhibition efficiency, the results revealed an increase with increasing extract concentration and a reduction with accelerating temperature. The corrosion-inhibiting properties of *Launaea taraxacifolia* leaf extracts can be linked to phytochemical elements such as saponins, flavanoids, tannis, alkaloids, organic acid, and anthraquinones. (Onen et al., 2011).

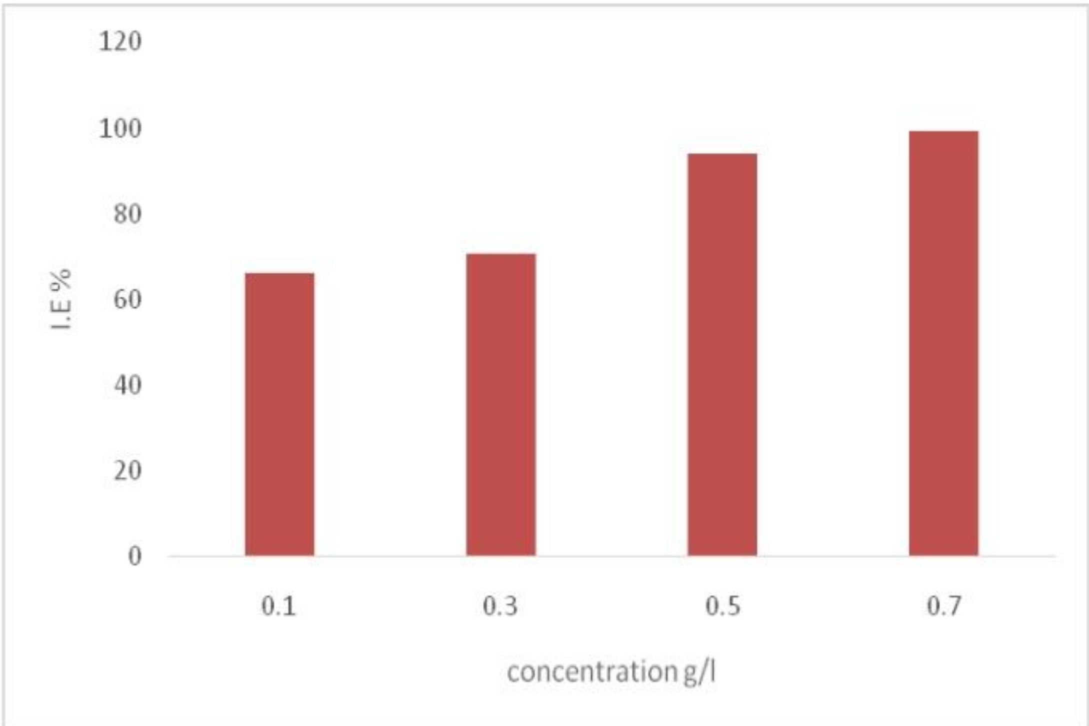

Figure 5: Plot of % I.E versus inhibitor concentration for mild steel corrosion at 303K and 323K

Figure 6: Plot of % I.E versus inhibitor concentration at 303 K

Figures 7 and 8 depict a plot of corrosion rate (mm/year) versus inhibitor concentration at various temperatures. The inclusion of leaf extract to the corrosive solution (1 M HCl) decreases the corrosion rate of the mild steel specimen, suggesting that the corrosion rate reduced with accelerating concentrations at 303 K and 323 K (Hussin & Kassim, 2011).

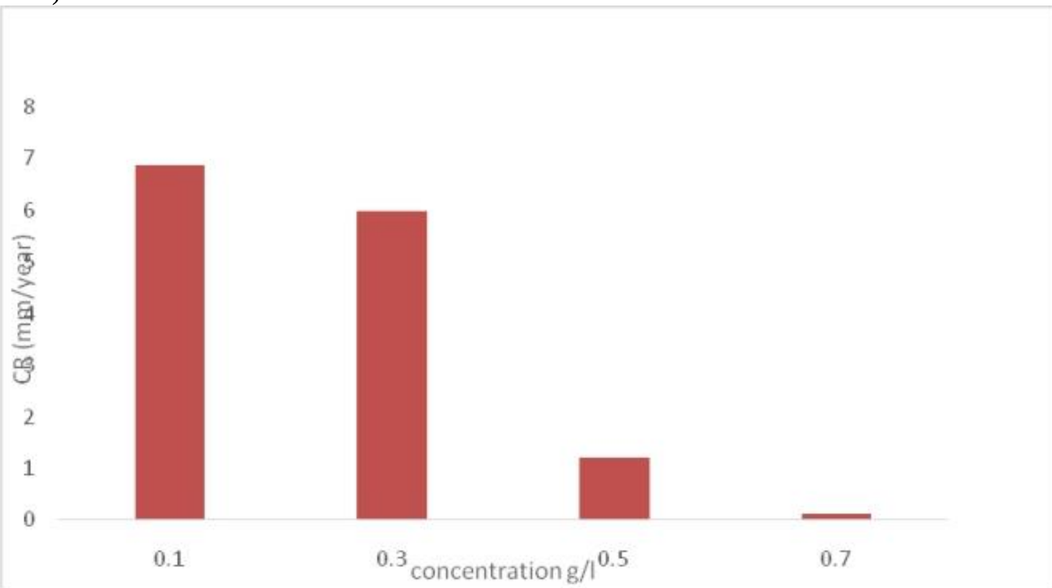

Figure 7: Plot of corrosion rate (mm/year) versus inhibitor concentration at 303 K

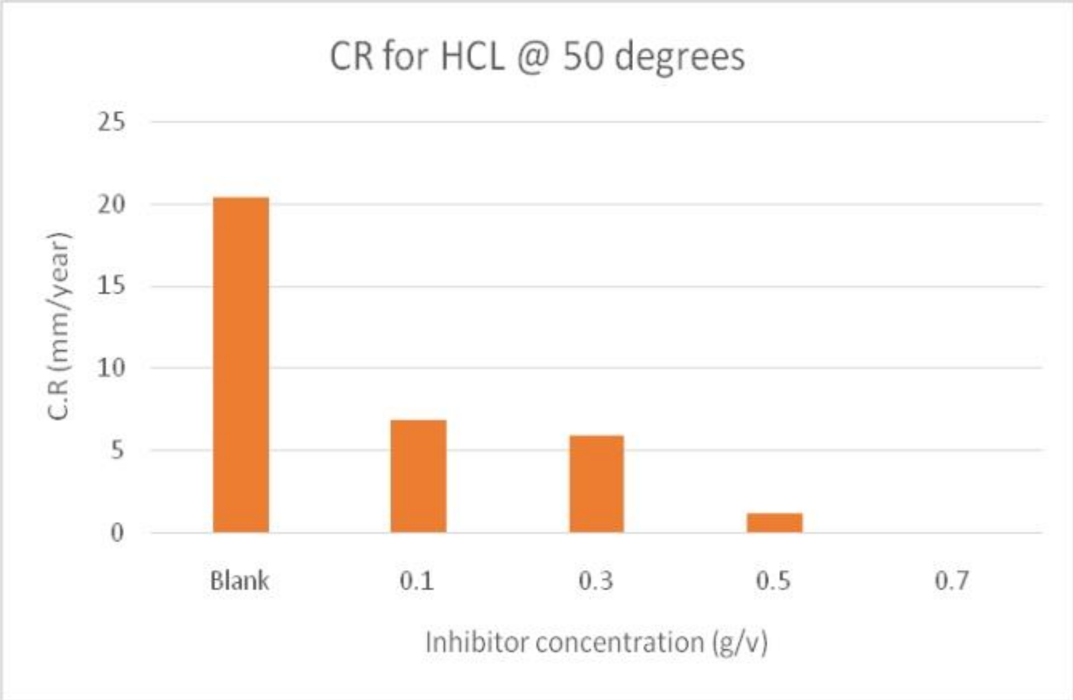

Figure 8. Plot of corrosion rate (mm/year) versus inhibitor concentration at 323K.

To understand the nature of the adsorption of *Launaea taraxacifolia* leaf extracts on a mild steel surface in contact with data points were fitted using a variety of adsorption isotherm models for 1 M HCl solution at multiple temperatures.

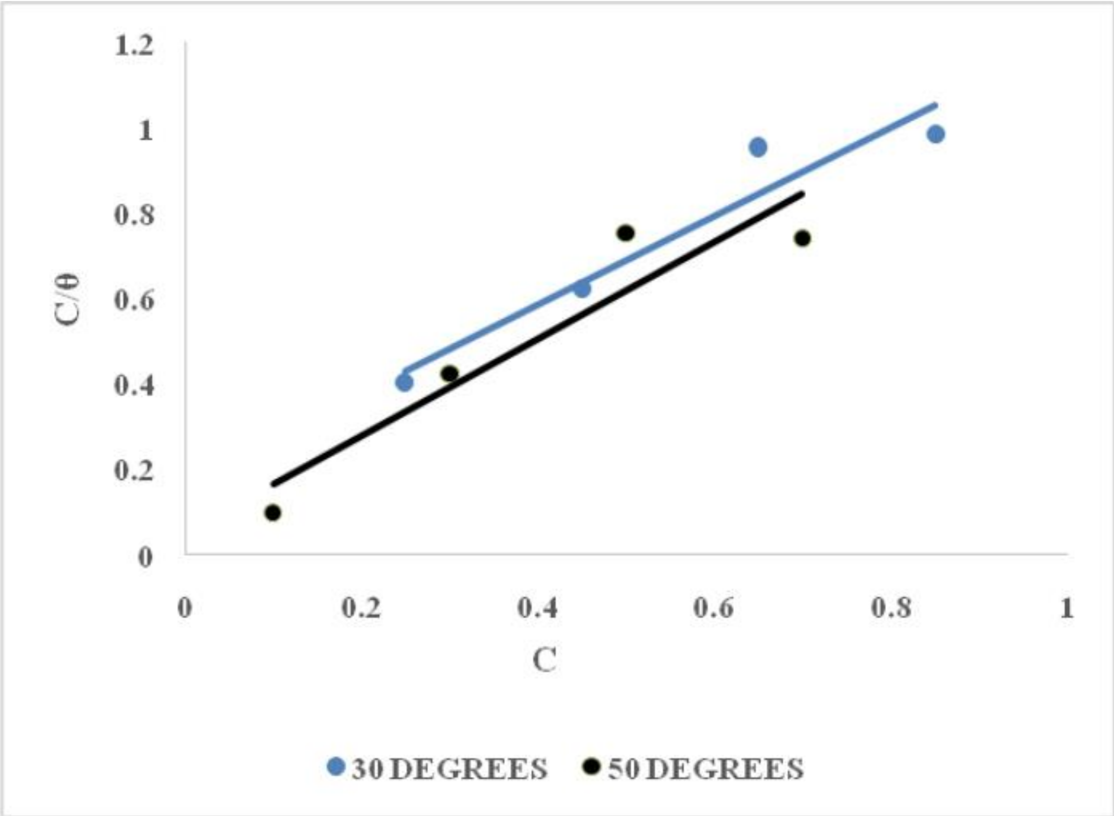

Figure 9: Langmuir isotherm

The obtained results show that the adsorption of extract components follows the Langmuir isotherm (Figure 9). It appears that there exists a linear correlation $\frac{C_{inh}}{\theta}$ a between against C_{inh} and correlation coefficients ((R^2) within the order of 0.92, indicating that Langmuir adsorption isotherm models are applicable. This indicates that the extract components are chemically adsorbing onto the steel surface. (Refaey, *et al*., 2004).

Conclusion

To investigate the green corrosion inhibitor potential of Launaea taraxacifolia leaves extract, gravimetric and electrochemical techniques were utilized. The presence of phytochemicals in *Launaea taraxacifolia* leaf extract resulted in a remarkable mild steel inhibiting property in 1M HCl solution. Methods for weight loss and potentiodynamic measurement give consistent results. Maximum concentrations of the extract were shown to be effective inhibitors.

Recommendation

The inhibitor is inexpensive, widely available, environmentally friendly, and causes no risk to the environment. They are biodegradable and a renewable resource. In the metal, alloy, and surface coating sectors, the inhibitor may find use. Most organic inhibitors that are detrimental to living beings and the environment could be replaced with a biodegradable extract from Launaea taraxacifolia.

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