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Corrosion Inhibition by Various Plant Products at Mild Steel Surfaces in Acidic and Basic Media

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ABSTRACT

Extract of various plants (*Wrightiatinctoria, Clerodendrumphlomidis, Ipomoeatriloba*) leaves was investigated as corrosion inhibitor of mild steel in acidic and basic media using conventional weight loss, electrochemical polarization, electrochemical impedance spectroscopy and scanning electron microscopic studies. The weight loss results showed that all the plant extracts are excellent corrosion inhibitors, electrochemical polarization data revealed the mixed mode of inhibition and the results of electrochemical impedance spectroscopy have shown that the change in the impedance parameters, charge transfer resistance and double layer capacitance, with the change in concentration of the extract is due to the adsorption of active molecules leading to the formation of a protective layer on the surface of mild steel. Scanning electron microscopic studies provided the confirmatory evidence of improved surface condition, due to the adsorption, for the corrosion protection. There is a growing trend to utilize plant extracts and pharmaceutical compounds as corrosion inhibitors. The inhibitive performance of extract of *Adhatoda Vasika* (AV) on the corrosion of mild steel in acidic and basic media were studied using mass loss and electro chemical measurements. Results confirmed that the extract of AV acts as an effective corrosion inhibitor in the acid environment. Potentiodynamic polarization and electrochemical impedance studies confirmed that the system follows mixed mode of inhibition. Surface characterization techniques (FT-IR, SEM and EDAX) are also used to ascertain the nature of the protective film. Many plants are investigated to inhibit corrosion of steel in both acidic and basic media.

KEYWORD: *plant products, acidic and basic media, mild steel, surfaces, corrosion, inhibition, SEM*

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INTRODUCTION

The alcoholic extracts of eight plants namely *Lycium shawii*, *Teucrium oliverianum*, *Ochradenus baccatus*, *Anvillea garcinii*, *Cassia italica*, *Artemisia sieberi*, *Carthamus tinctorius*, and *Tripleurospermum auriculatum* grown were studied for their corrosion inhibitive effect on mild steel in HCl media and NaOH using the open circuit potential (OCP), Tafel plots and A.C. impedance methods. [1,2]

Cassia italica

All the plant extracts inhibited the corrosion of mild steel in acidic and basic media through adsorption and act as mixed-type inhibitors. The use of corrosion inhibitors is the most economical and practical method in reducing corrosive attack on metals. Corrosion inhibitors are chemicals either synthetic or natural which, when added in small amounts to an environment, decrease the rate of attack by the environment on metals. Nevertheless, the popularity and use of synthetic compounds as a corrosion inhibitor is diminishing due to the strict environmental regulations and toxic effects of synthetic compounds on human and animal life. Consequently, there exists the need to develop a new class of corrosion inhibitors with low toxicity, eco-friendliness and good efficiency. [3,4]

Carthamus tinctorius

Although, a number of plants and their phytochemical leads have been reported as anticorrosive agents, vast majority of plants have not yet been properly studied for their anti-corrosive activity. For example, of the nearly 300,000 plant species that exist on the earth, only a few (less than 1%) of these plants have been completely studied relative to their anticorrosive activity. Thus, enormous opportunities exist to find out novel, economical and eco-friendly corrosion inhibitors from this outstanding source of natural products.[5,6] Corrosion inhibitive effect of eight plants namely *Lycium shawii* (L.S.), *Teucrium oliverianum* (T.O.), *Ochradenus baccatus* (O.B.), *Anvillea garcinii* (A.G.), *Cassia italica* (C.I.), *Artemisia sieberi* (A.S.), *Carthamus tinctorius* (C.T.) and *Tripleurospermum auriculatum* (T.A.) grown in greenhouse were used to carry out corrosion inhibition evaluation of these plants on mild steel in 0.5 M HCl solution and 0.5 M NaOH base using open circuit potential (OCP), Tafel plots and electrochemical impedance spectroscopy (EIS) methods.[7,8]

Lycium shawii

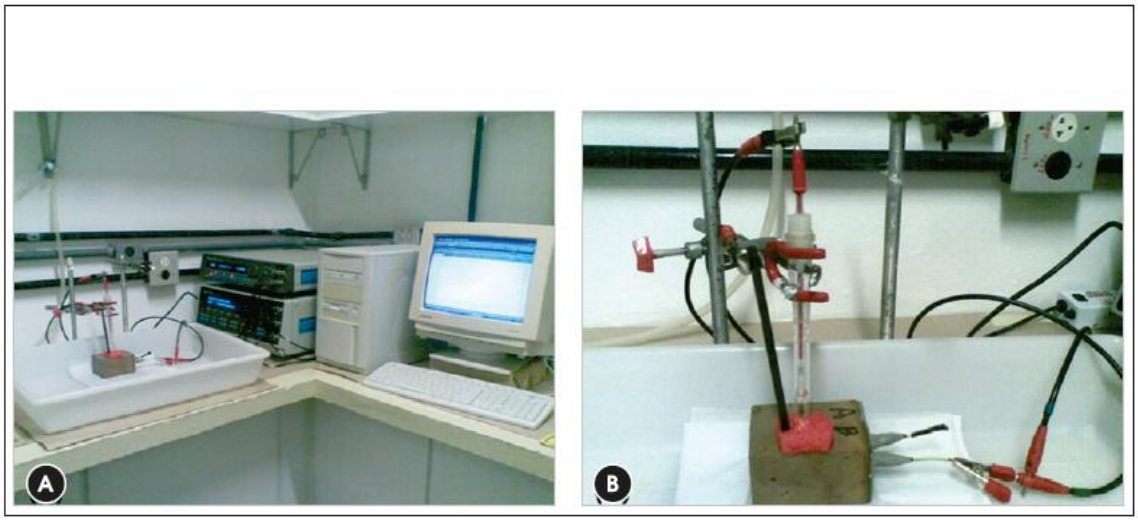
Discussion

The corrosion current density (I_{corr}) values decreased in the presence of plants' alcoholic extracts indicating that the corrosion process of mild steel was suppressed in the presence of plant extracts. The highest inhibition efficiency was obtained for alcoholic extract of plants A.S. and T.A. (90.9%) followed by C.T. (89.0%), L.S. (85.4%), and O.B. (84.7%) suggesting that these plant extracts could serve as effective green corrosion inhibitors.

Tripleurospermum auriculatum

The corrosion of mild steel in HCl solution and NaOH containing plant extracts can be inhibited due to the adsorption of phytochemicals present in plant extracts through their lone pair of electrons and π-electrons with the *d*-orbitals on the mild steel surface. Hence, the corrosion inhibition of mild steel through these studied plants may be attributed to the adsorption of the phytochemicals containing O, N or π-electrons in their molecules as these atoms are regarded as centers of adsorption onto the metal surface.[9,10] However, the highly complex chemical compositions of the plant extracts make it rather difficult to assign the inhibitive effect to a particular compound present in plants extracts. Having confirmed the corrosion inhibition effectiveness of

these plants extracts, further detailed investigation for each plant extract through inhibitive assay guided isolation using surface analytical techniques will enable the characterization of the active compounds in the adsorbed layer and assist in identifying the most active phytochemicals.[11,12]



Electrochemical impedance spectroscopy (EIS) apparatus

Results and Conclusions

Table 1: Major phytochemicals of the studied plants.

Plants	Phytochemicals
Lycium shawii	No reports concerning the phytochemical isolation are available.
Teucrium olivrianum	Neo-clerodane diterpenoids and their derivatives (Al-Yahya et al., 2002).
Ochradenus baccatus	Flavanoids and their glycosides (Barakat et al., 1991).
Anvillea garcinii	Germacranolides (Abdel-Sattar and McPhail, 2000).
Cassia italica	Coumarins, carotenoids, flavonoids, anthraquinones, sterols and triterpenes (Kazmi et al., 1994).
Artemisia sieberi	Flavanoids, terpenoids and their glycosides (Marco et al., 1993).
Carthemus tinctorius	Unsaturated fatty acids, flavanoids and their glycosides, adenosine, adenine, uridine, thymine, uracil, roseoside, acetylenic and aromatic glycosides (Jiang et al., 2008, Zhou et al., 2008).
Tripleurospermum auriculatum	Unsaturated fatty acids and sterols (Al-Wahaibi, 2003).

The alcoholic extracts of the eight studied plants, in particular, *A. sieberi*, *T. auriculatum*, *C. tinctorius*, *L. shawii*, and *O. baccatus* have showed promising corrosion inhibition properties for mild steel in 0.5 M HCl and NaOH media.[13,14] On comparing the percentage inhibition efficiencies of these five plant extracts with those of previously reported percentage inhibition efficiencies of different plant extracts in various acidic and basic media, it was found that these five plants of the present study could serve as effective green corrosion inhibitors for mild steel in acidic HCl and basic NAOH media. From the polarization studies it is evident that all the plant extracts act as mixed-type corrosion inhibitors. Further investigations to assess the corrosion morphology and to isolate and confirm the active phytochemicals responsible for the inhibition of mild steel corrosion in acidic media and basic media are required.[15]

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