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Effect of Albino Tamarind Seeds Extract on Corrosion Inhibition of Mild Steel in Acidic Medium

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Abstract: *Due to negative effect of synthetic inhibitors regarding safety and public health, their use in several applications has raised many questions to be answered. This led to the use of organic inhibitors such as plant extract, which is considered as a cheap, eco-friendly and can suitably substitute inorganic inhibitors. An extract Albino Tamarind seeds was investigated for corrosion inhibitive properties using mild steel in the presence of HCl. Weight loss method was used to determine the corrosion rate and inhibition efficiency at four different concentrations (250 ppm, 500 ppm, 750 ppm and 1000 ppm). It was found that increasing the concentration of the plant extract resulted in improvement of the inhibition efficiency and a decrease in corrosion rate.*

Keywords: *Albino Tamarind, Concentration, Inhibition and efficiency*

Background of Study

Of all metallurgical problems that face civilization, only a few can be economically more important than the prevention of metallic corrosion. Environmental attack on metal produces a destructive effect on their physical and mechanical properties which consequently, contributes to economic loses, impairs the safety of operating equipment and invariably depletes our metal reserves(Njoku, 2002).Due to the problems arising from corrosion, several methods of corrosion control and preventions have been innovated: use of protective coatings, proper selection of material, alloying, proper design, cathodic protection, the use of inhibitors, etc. The method used for any specific application is based on economic considerations, nature of the corrosive environment, efficiency and cost consideration (Rozenfeld, 1981). According to Gosta, 1982 and Schmitt, 1984, inhibitors are used in a wide range of applications such as in oil pipe lines, domestic central heating systems, industrial central cooling systems, corrosion protection of machines, in power generating plant, metal extraction, oil extraction, chemical processing and protection of metals operating under corrosive environment. Inhibitors are also used in the chemical removal of surface oxides from metal surface by immersion in acid solution; a process referred to as pickling. Ferrous oxides dissolve readily in acid solutions during pickling in such a way that the oxides are attacked first making it easier for scale removal (Rozenfeld, 1981).Development in pickling techniques (ultrasonic pickling)does not eliminate the use of inhibitors but rather proffers solution to the problems of environmental pollution and improvement of pickling yield (Goode *et al*, 1996).

Over the years, many researches were carried out to find suitable corrosion inhibitors of organic origin in various corrosive media (Adzor *et al.*, 2014). Currently, a large amount of research has focused on natural extracts that can replace synthetic compounds. The following are some of works on by-product and farm waste extracts used as corrosion inhibitors for low carbon steel in acidic media. Anafi and Obi, (2004) investigated the corrosion inhibition of mild steel in simulated media by a Methanolic Extract of Bitter leaf. The solvent extract of bitter leaf was compared with sodium benzoate with mild steel immersed in sea water, 0.3 M H_2SO_4 and HCl media at ambient temperature using weight loss method. They found out that the inhibition ability of bitter leaf against corrosion was best in sea water where it exhibited an inhibitive efficiency of 61.19%. Sodium benzoate however surpassed bitter leaf in its corrosion inhibition ability in all test media used in the investigation.

El-Etre (2007) investigated the inhibitive action of the aqueous extract of olive (*OleaeuropaeaL.*) leaves toward the corrosion of C-steel in 2 M HCl solution using weight loss measurements, Tafel polarization, and cyclic voltammetry. They found out that the extract acts as a good corrosion inhibitor for the tested system. The inhibition efficiency increases with increase in extract concentration. The result showed the 32adsorption of extract components onto the steel surface by spontaneous process and it follows the Langmuir adsorption isotherm. The inhibition efficiency is greatly reduced as temperature increased.

Also,Singh, *et al* (2010) studied the inhibition of the corrosion of mild steel in 1M HCl hydrochloric acid solution by the extract of Kalmegh (*Andrographispaniculata*) leaves using weight loss, electrochemical impedance spectroscopy, linear polarization, and potentiodynamic polarization techniques. The result showed that the Inhibition corrosion of mild steel increases with increase in concentration of the extract. They also investigated the effect of temperature and immersion time on the corrosion behavior of mild steel with addition of extract. The result showed the adsorption of the molecules of the extract on the mild steel surface obeyed the Langmuir adsorption isotherm. They concluded that the extract could serve as an effective inhibitor of the corrosion of mild steel in hydrochloric acid media. Similarly, Quraishi *et al.,* (2010) studied the inhibition of the corrosion of mild steel in 1 M HCl and 0.5 M H_2SO_4 acid solutions by the extract of *Murrayakoenigii* leaves using weight loss, electrochemical impedance spectroscopy (EIS), and linear polarization and potentiodynamic polarization techniques. They found that the inhibition of corrosion of mild steel increases with increase in concentration of the leaves extract and the adsorption of the extract on the mild steel surface obeys the Langmuir adsorption isotherm. They concluded by saying that the extract could serve as an effective inhibitor of the corrosion of mild steel in hydrochloric and sulphuric acid media. Similarly, Obot and Obi-Ebedi (2010) investigated the inhibitive and adsorption properties of extract of therminiliacatappa on corrosion of mild steel in 0.5M and 1M H_2SO_4 solution using weight loss method. Their result shows an increase in inhibition potential of extract of the catappa which according them is attributable to the presence of Saponin, tannin, phlobatin, antraquinone, cardiac, glycoside, flavonoids, terpene and alkaloid in the extract. The inhibitive performance of gum exudates from Acacia Drepanolobium and Acacia Senegal from Tanzania, towards the corrosion of mild steel in fresh water was investigated by Buchweishaija (2009), using potentiodynamic polarization and electrochemical impedance spectroscop) (HIS) studies. The polarization studies reveal that both extract exhibit reduction of current densities and anodic shift of potential thus characterized as inhibitors of the mixed type with a predominant anodic effect. However, the impedance method reveals the transfer of charge speculating the inhibition mechanism of adsorption for inhibiting the corrosion process without interfering with the electrochemical process. Their investigation shows that an inhibition efficiency of up to 90.7% and 99.7% respectively was attained at 30°C and maintained above 90% efficiency irrespective of temperature rise.

Methodology

Sample Collection

Fresh seeds of Albino Tamarind were collected at Ramat Polytechnic and were taken for identification by a Plant Taxonomist, in the Department of Biological Science Faculty of Science, University of Maiduguri.

Sample Preparation

The seeds were first air-dried in the laboratory at room temperature and were ground to fine powder using wooden mortar and pestle. The sample was the stored in the research laboratory of Science Laboratory Technology Department of Ramat Polytechnic Maiduguri Borno state for further analysis.

Preparation and Elemental Content Analysis

Sample Extraction

The extraction of the from the ground seeds of the Albino Tamarind was performed using 2000g of ground seed and 85% ethanol by Soxhlet technique. The crude extract was concentrated at reduced temperature and then stored in a desiccator. The chaff was socked in distilled water for three hours and the mixture was filtered, concentrated and stored under pressure and reduced temperature.

Phytochemical Screening of Albino Tamarind

Phytochemical screening was carried out on the ethanol crude extract and the partition portions of the plant Albino Tamarindare as follows:

Test for Tannins

To extract (0.5g) 10ml of distilled water was added and stirred. The mixture was filtered. To 2 ml of the filtrate, 1% ferric chloride solution was added. The occurrence of a blue-black, green or blue-green precipitate indicates the presence of tannins. A mixture of equal volume of 10% lead ethanoate was added to 2 ml of the filtrate. The formation of white precipitate indicates the presence of tannins. The filtrate of the extract was boiled with drops of 10% HCl, and a drop of methanol. A red precipitate was taken as indication for the presence of tannins (Sofowora, 1993; Trease and Evans, 2002).

Test for Phlobatannins

The (0.5g) of the extract was boiled with 5ml of distilled water and then filtered. The filtrate was further boiled with 1% aqueous HCl. The appearance of red precipitate indicates the presence of phlobatannins (Trease and Evans, 2002).

Test of glycosides

Lieberman Burchard's test

To the extract (0.5g), 2ml of acetic anhydride was added. The mixture was cooled in ice and then 3ml of concentrated tetraoxosulphate(VI) acid was added carefully. Color development from violet to bluish-green indicates the presence of a steroidal ring (Silver *et al*., 1998).

Salkowski's Test (test for steroidal nucleus)

To the extract (0.5g), 2mlof chloroform was added. Then, 3ml of tetraoxosulphate(VI) acid was carefully added by the side of the test tube to form a lower layer. Appearance of a reddish-brown colour or yellow at the interphase indicates the presence of steroidal ring. (Silver, 1998).

Test for Flavonoids

Ferric Chloride Test

The extract (0.5g) was boiled with 5ml of distilled water and then filtered. To a 2 ml of the filtrate, few drops of ferric chloride solution were added. A green-blue or violet coloration indicates the presence of phenolic hydroxyl group (Trease and Evans, 2002).

Test for Saponins Glycosides

The extract (0.5g) was boiled with 5ml of distilled water and filtered. The filtrate was divided into 2 portions to the first portion about 3ml of distilled water was added and shaken for about 5 minutes. Frothing which persist on warming is an evidence for the presence of saponins (Sofowora, 1993). To the second portion, 2.5ml of a mixture of equal volume of Fehling's solution A and B was added. The appearance of brick-red precipitate is indication for saponins glycosides (Vishnoi, 1979).

Test for Alkaloids

Preliminary Test for Alkaloids

The extract (0.5 g) was stirred with 5 ml of 1% aqueous HCl on water bath then filtered. Three milligram (3ml) of the filtrate was taken and divided equally into 3 portions in a test tube. To the first portion, few drops of Dragendoff's reagent were added. The occurrence of orange red precipitate was taken as the indication for the presence of alkaloids. To the second; 1 ml of Mayer's reagent was added and the appearance of buff-coloured precipitate is an indication of presence of alkaloids; to the third portion, 1 ml or a few drops of Wagner's reagent was added and a dark-brown precipitate indicate the presence of alkaloids (Brain and Tuner, 1975).

Corrosion Efficiency

Weight loss method was used for the evaluation of corrosion inhibition efficiency of the extracts.

Weight Loss Method

Cylindrical coupons of 10mm diameter and 10mm in length were used in this research. Five test media were prepared by dissolving 250 ppm 500 ppm, 750 ppm and 1000 ppm of the extract of the Albino Tamarind in each 100ml of 1M HCl acid kept in different beakers. In addition, one beaker containing 100ml of 1M HCl was used as control, making a total of five test media. The corrosion inhibition and immersion test was carried out in accordance with ASTM G3 1 -72.

Six coupons were weighed and suspended in each test medium kept at room temperature with the aid of a thread. An exposure period of 432hr (18 days) was observed, at every72hr (3days) interval unit specimen was removed from each beaker, cleaned off corrosion products, dried and then reweighed. The change in weight was recorded was used to calculate the rate of corrosion measured in millimeter per year (mmpy) as described by Yawas, (2005):

Corrosion rate (CR) = $\frac{87.6\, x\, W}{P\, x\ \ A\, x\, T}\ (mmpy)$ ... 3.4

Where:

W = The weight loss in mg, P = The metal density in g/cm^3.

A = The exposed area of the test coupon in cm^2.

T = The exposure time in hrs.

However, the inhibition performance can also be calculated as follows (Ibrahim et al., 2011):

Inhibition Efficiency (IE) = $\frac{CR_0 - CR}{CR_0}$ x 100% ... 3.5

The surface degree of coverage (Ø) at each inhibitor concentration, defined as the degree of surface of material coverage by the inhibitor will be calculated as;

Degree of Surface Coverage (Ø) = $\frac{CR_0 - CR}{CR_0}$ 3.6

Where;

CR_0 = The corrosion rates without inhibitor

CR = The corrosion rates with inhibitor.

Results and discussion

Table 1: The results of phytochemical analysis of the Albino Tamarind

S/No	Chemical Constituent	Results
1	Alkaloids	++
2	Phenols	+
3	Tannins	+
4	Flavanoids	++
5	Saponins	+
6	Quinines	+
7	Steroids	+
8	Terpenoids	++
9	Glycosides	-
10	Proteins	+
11	Aminoacids	-
12	Lipids	+
13	Carbohydrates	-

Table 1 shows the results of the phytochemical analysis of the Albino Tamarind seed extract. The results revealed that the extract contains phytochemical compounds (alkaloids, tannins, Lipids and steroids) essential in corrosion inhibition (Ihebrodike *et al.,* 2010). The phytochemical components contain heteroatoms that form complex chemical bonds between the mild steel and the extract. The heteroatoms are usually found in organic compounds used as corrosion inhibitors because of N, O, P, and S and polar functional groups such as CHO, COOH, and OH in these aromatic and heterocyclic compounds. The lone pair of electrons on the metal surfaces of these hetero-atoms helps in providing protective shields, which lower the corrosion rate. Results from some earlier researches indicated that tannins and some antioxidant compounds in plant extracts are responsible for inhibition of steel corrosion in some acidic medium (Martinez, 2002; Eddy and Ebenso, 2008; Oguzie, 2008). Plant extracts which have proven corrosion inhibiting properties in corrosive media are known to contain one or more of the following organic compounds; tannins, triterpenoids, flavonoids, amino acids, alkaloids, saponins, phenols, glycosides, essential oils, carotenoids, crude proteins among others (Oguzie *et al.,* 2007, 2008). It is therefore, obvious from the phytochemical analysis results and works reviewed that Albino Tamarind extract can be used as corrosion inhibitor.

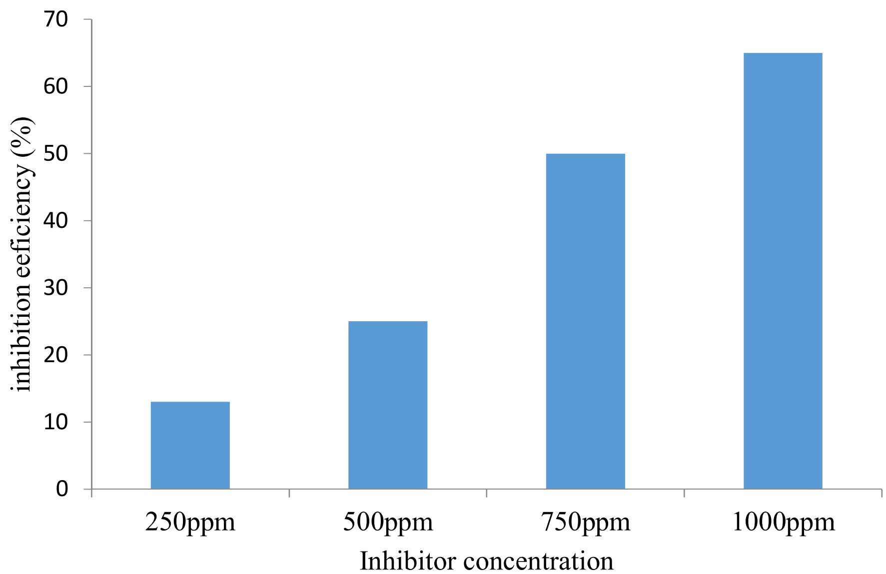

Figure 1: Effect of extract concentration on the inhibition efficiency

Figure 1 shows effect of concentration of extract of Albino tamarind on the inhibition efficiency. It is clear from the above result that the extract has some inhibitive properties and these properties increase with increase in the extract concentration. It can be seen that at 250ppm of the extract concentration the inhibition efficiency was 13 % but as the concentration increased to 500ppm the efficiency increased further to 25 % and reached 65 % at 1000 ppm. Similar trend was reported by (Zubairu, *et al.*2021).

Analysis of variance results

Table 2: Analysis of variance

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	688551.1	1	688551.1	13.15004	0.011014	5.987378
Within Groups	314166.8	6	52361.13			
Total	1002718	7				

Table 2 shows the analysis of variance on the effect of concentration of Albino Tamarind extract on the efficiency which shows that the concentration has significant influence on the efficiency of the extract. This is evident from the p-value which is less than 0.05.

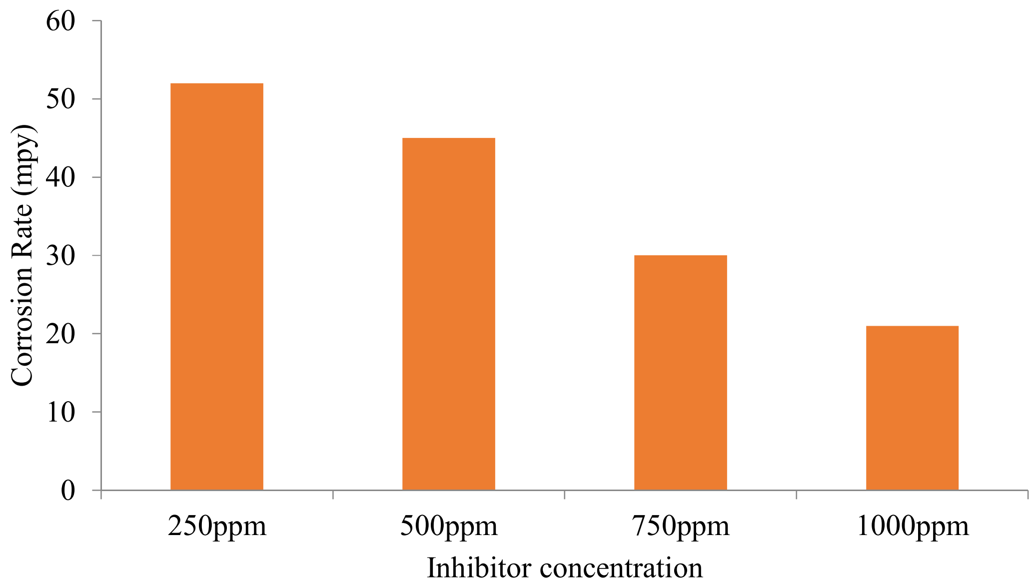

Figure 2: Effect of concentration of the extract on rate of corrosion of Mild steel

The addition of 250ppm extract to the solution the corrosion rate reduced the corrosion rate significantly. It can be seen that the corrosion rate decreased as the concentration of the extract was increased. This reduction in the corrosion rates is attributable to tendency of adsorption of bioactive inhibitor molecules on the metal surface forming a thin coating film that reduces corrosive attack on the metal thereby reducing the rate corrosion of the mild steel. Similar trends were observed in previous findings (Yawas, 2005)

Conclusion

It is concluded that Albino tamarind contains most of the phyto-compounds that help prevent or reduce corrosion. It can there be used as corrosion inhibitor since it posses the inhibition properties. It is also concluded that both efficiency and the corrosion rate are concentration dependent.

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