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Evaluation of the Shelf-Life of some Locally Sourced Plants Extracts in use for the Prevention of Corrosion of Mild Steel

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Abstract: *Corrosion inhibition using some locally sourced plant extracts in use for the prevention of corrosion on mild steel. The Experimented was carried out in Maiduguri Borno State and was accomplished using some locally sourced plant extracts which were namely; Neem leaves, Neem seed, Lemon leave and Orange leave which was experimented on mild steel. The finding was analysed using Analysis of Variance (ANOVA) and Regression R^2. The finding was also accomplished using the weight loss technique. The extract acts as an inhibitor in the acidic environment. The finding revealed that both corrosion rate and inhibition efficiency increased with increase in inhibitor exposure time, but decreased with decreased in temperature. The inhibiting effect could be attributed to the presence of some phytochemical constituents in the selected extract which is adsorbed on the surface of the low carbon steel and the inhibition efficiency for leave and seed in both Neem and Lemon via media are greater 70%, Similarly, regression graph between the Seed and leave of the Neem experimented exhibited significant relationship of about 65%, likewise that of between Orange and Lemon gave R^2 of about 55%. therefore, the study revealed that the experimented extracts serves as good inhibitors in preventing mild steel which is very much affordable especially in this region.*

Key words: *Corrosion rate; Neem leaves; Neem seed; Orange leaves; Lemon leaves; Mild steel and Inhibition*

1.0 Introduction

Metal interaction with environment is a process that cannot be disregarded when the issue of corrosion and its effect comes to play. The use of steel is well pronounced in various aspects of human life such as in manufacturing, oil and gas, construction, medical, textile, transport and aviation industries to mention a few. The steel industry as profitable and important as it is, is plagued by one of the greatest engineering problems known to Man,

called Corrosion. Corrosion has been variously defined by many authors in recent time. According to (Mclean, 1986), corrosion is the degradation or destruction of a material that occurs when it reacts with its environment. The effect is seen when metal in the combined state tends to revert back to its most stable natural state on exposure to certain environmental conditions. The effect of corrosion process has drastically affected a number of industries resulting in loss and damages with huge deficit (Barbara *et al.*, 2006). Several efforts have been made using corrosion preventive practices, the use of green corrosion inhibitors is one of them (Anuradha *et al.*, 2007). Corrosion inhibitors are chemicals that react with metallic surface or the environment, the surface is exposed to, giving the surface a certain level of protection. Corrosion inhibitors often work by absorbing themselves on the metallic surface by forming a film which stands as barrier between the metal and the environment to prevent or reduce the corrosion rate of the metal. The effect of corrosion on the aqueous environment of sea water, salt water and rain, can be felt when pipes corrode with toxic metals are allowed to sip into the environment thereby causing health complications to the living system as contained in the aqueous environment. The effect can be hazardous, which may results in loss of capital, loss of equipment and isolation of workforce, fire and explosion etc (Holsen *et al.*, 1991).

The ability to shield metallic materials especially those used in engineering becomes important and a number of ways have been deployed in controlling corrosion such as electroplating and use of inhibitors. These are substances added in small concentrations in corrosive media to reduce or prevent the reaction of the metal in the media (Chauhan *et al.*, 2007). The inhibitors can be organic or inorganic, and most credible option is the use of natural inhibitors as an eco-friendly option. The synthetic inhibitors have heteroatom such as O, N, and S and multiple bonds in their molecules through which they become adsorbed on the metal preventing the metals from corroding, they are highly basic with high electron density which gives the characteristics of an inhibitor (James *et al.*, 2011; Rani *et al.*, 2012). However, investigation has shown that some of the synthetic or inorganic inhibitors are toxic causing kidney failure, liver failure, mutation of the enzymes etc (Singh *et al.*, 2012). Since synthetic inhibitors have been proven to have acute hazardous effect to human, therefore natural products have been scrupulously analyzed and found to be effective in prevention of corrosion. Plant extracts have been found to be eco-friendly, inexpensive and obtainable in large quantities (Olusegun *et al.*, 2013; Singh *et al.*, 2012; Singh *et al.*, 2010). The availability of organic compounds in the natural product such as tannin, Saponins, and alkaloids give it its inhibitive traits (Abdel-Gaber *et al.*, 2008; Ajanaku *et al.*, 2012). A number of researchers are now attracted to the trend of using natural products as inhibitors. These compounds are found in varying amount/quantities in most green plants. Several different methods can be employed to slow or prevent corrosion of metallic structures. The most commonly used methods are protective coatings on metals using organic molecules, plastics, polymers and cathodic and/or anodic protection using organic or inorganic inhibitors. The initial report of corrosion inhibition by organic inhibitors is attributed to Speller *et al.* (1927), who examined the corrosion inhibition of scaled water pipes in HCl. Since then, many organic and inorganic compounds that are added to the corrosive fluids have been investigated for this purpose. Therefore, the current work was

undertaken to ascertained the effect of some selected locally sourced plant extract on corrosion rate and inhibition efficiency on mild steel in Maiduguri.

1.2 Materials Methods

The following materials were used for this work.

i. Mild steel coupons
ii. Neem, Orange, Lemon leaves and Neem seed
iii. Acidified solution (3M HCl solution)

1.3 Preparation of mild steel coupon

The mild steel that was tested in the present study with a dimension of 5 x 5 cm. Distilled water was used for preparing all solutions. Polishing was effected using successively finer grade of emery papers (600-1200 grade). Each of the plant leaves that were extracted using soxhlet apparatus. The insoluble residues were removed and the ethanol evaporated.

1.4 Use of Soxhlet Extractor

Normally a solid material containing some of the desired compound was placed inside a thimble made from thick filter paper, which was loaded into the main chamber of the Soxhlet extractor. The Soxhlet extractor was placed onto a flask containing the extraction solvent. The Soxhlet was then equipped with a condenser. The solvent was heated to reflux, the vapour from solvent travels up a distillation arm and flows into the chamber housing the thimble of solid. The condenser ensures that the vapour from solvent cools and drips down into the chamber housing the solid material.

The chamber containing the solid material was slowly filled with warm solvent. Some of the desired compound were then dissolve in the warm solvent. When the chamber was almost full, the was emptied by a siphon side arm into distillation flask. This process was repeated for 6-8 cycles. After extraction the solvent was removed, typically by means of evaporation, yielding the extracted compound. The non-soluble portion of the extracted solid remains in the thimble, and is usually discarded (Selamat, 2010)

1.5 Experimental set-up

Weight Loss Experiment

The conventional weight loss method involves the weighing of the sample before immersion and then re-weighing after duration of pre-determined period. Afterwards same sample is re-immersed for the next duration. Mild steel coupons measuring 5 cm by 5 cm were weighed and subsequently immersed in the test media consisting of the organic green inhibitors and control solutions (3 M HCl). After the duration, the samples were removed from the test media and reweighed and subsequently returned into the media until the duration of the test was reached. The differences in weight was used to determine the corrosion rate and the inhibition efficiency.

1.6 Experimental Equation

Stock concentration $C_1 = \frac{\%\ \text{purity of acid} \times \text{density}}{\text{Malar mass of acid}} \times 10$ . . . . . (1)

The quantity (volume) of the stock needed was estimated by using the relation:

$C_1V_1 = C_2V_2$

Where:
C_1 = Concentration of the stock,
C_2= the required molarity of the acid
V_1= Volume of stock solution needed to prepare the acid and
V_2= Volume of acid required

Corrosion rate (CR) (mmpy) $= \frac{87.6W}{AxTxD}$ . . . . . (2)

Where T = immersion time in hours
W = weight loss
A = area of sample cm^2

Inhibition efficiency (IE) $= \frac{CR_{cont} - CR_{inh}}{CR_{cont}} x\ (100)$ . . . . . (3)

Where
CR_{cont} = Corrosion rate of sample in acid media
CR_{inh} = Corrosion rate of metal sample in the presence of the inhibitor and the acid

3.0 RESULTS AND DISCUSSION

The experimented result on neem leave, neem seed, orange leave and lemon leave on corrosion rate and inhibition efficiency on mild steel was presented in figure 1-4. As illustrated in figure 1. The rate of corrosion against time curve of different extracts solution has clearly shown that the corrosion rate increase with decrease in exposure time and increases with lemon leave at all exposure time, it was closely followed by orange leave extract and least corrosion rate was observed in neem seed. The difference in performance could be attributed to the high electronegativity in mild steel.

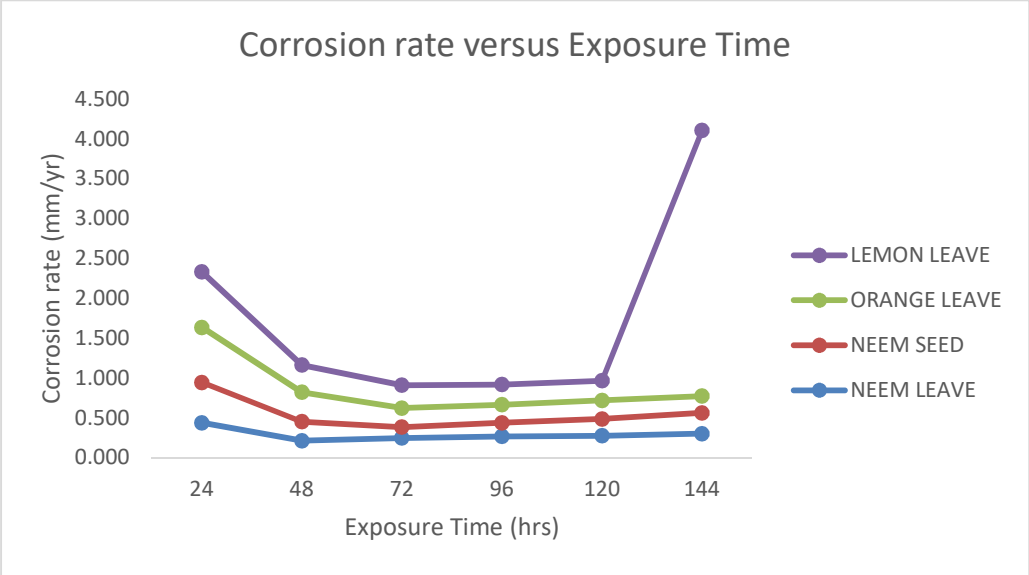

Figure 1: Variation of Corrosion Rate (mm/yr) against Exposure Time (hr) on Mild steel at different extracts

As presented in figure 2, The inhibition efficiency against time curve of different extracts solution experimented on mild steel has clearly shown that the inhibition efficiency decrease with increase in exposure time and the highest was observed at all exposure time with neem leave and neem seed it was then followed by orange leave and lemon leave extracts throughout the period of the experiment.

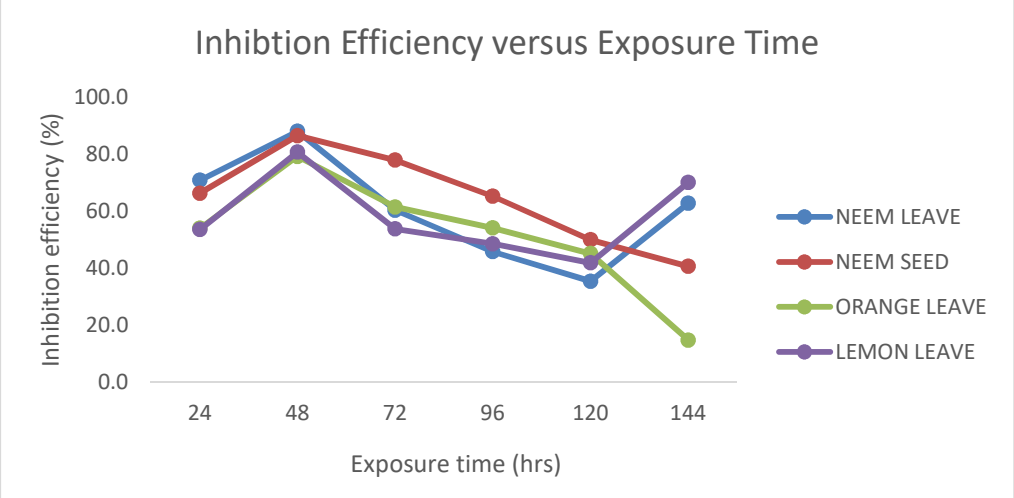

Figure 2: Variation of Inhibition efficiency (%) against Exposure Time (hrs.) on Mild steel at different extracts

As shown in the figure 4. The graph R^2 exhibited a significant relationship between neem seed and leave of about 77% and 61 %. Similarly, the relationship between lemon leave and orange were also significant with the corresponded R^2 of about 60% and 71% respectively.

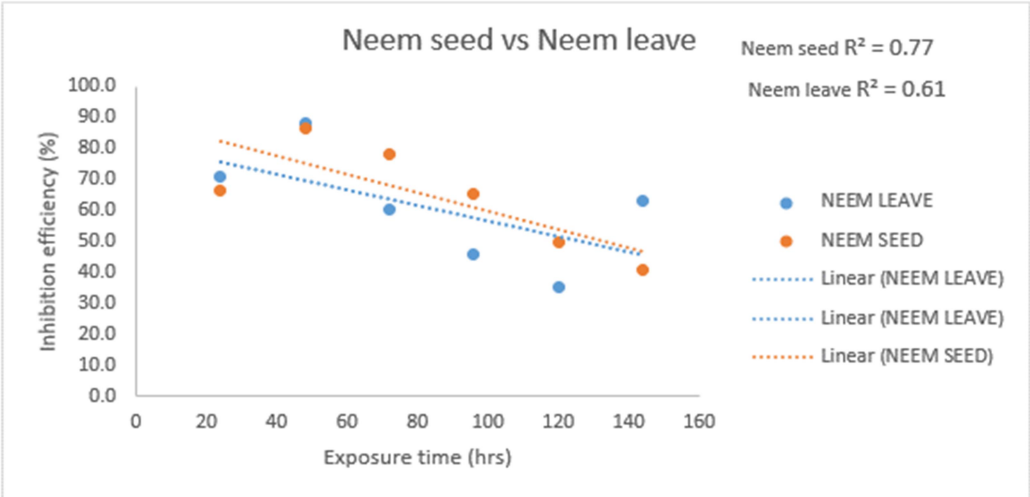

Figure 3: Regression relationship between Neem seed and Neem leave) against Exposure Time (hrs.) on Mild steel.

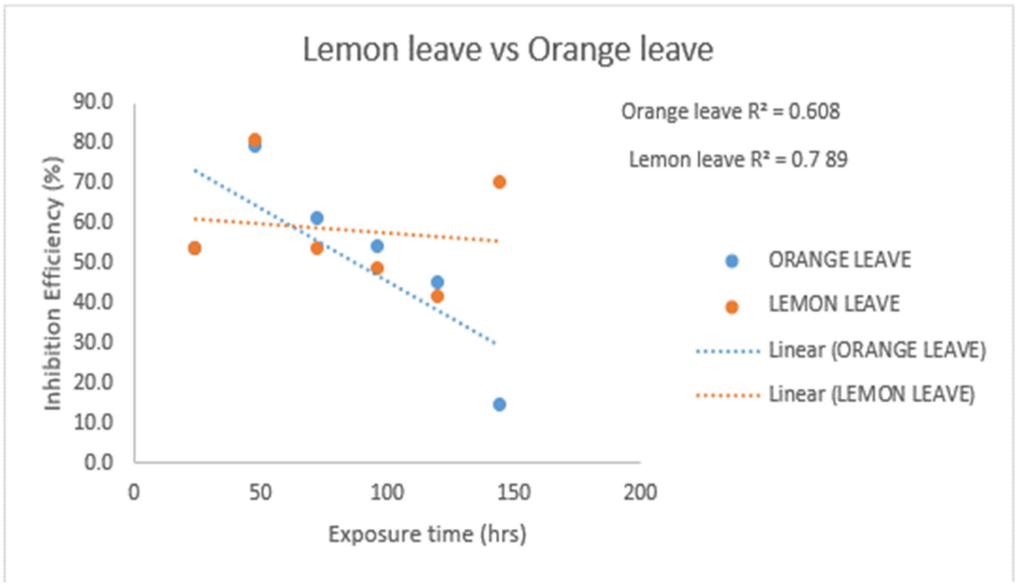

Figure 4: Regression relationship between lemon leave and Orange leave against Exposure Time (hrs.) on Mild steel.

3. CONCLUSION AND RECOMMENDATIONS

The experiment has shown the analysis of the inhibitory effects of some locally selected leaves extracts and corrosion behaviour of mild steel in acidic environments. From the results, the following conclusions were drowned

(i) The analysis revealed that rate of corrosion against time curve of different extracts solution has clearly shown that the corrosion rate increase with decrease in exposure time and increases with lemon leave at all exposure time experimented.

(ii) Inhibition efficiency of the extracts tested was found best with neem leave and neem seed and inhibition increases with increase in exposure time.

(iii) Significant regression relationship exists between the neem seed and neem leave

4.3 Recommendations

(i) Since this experiment was limited to mild steel, further studies should be conducted on different steel properties on same leaves extract.

(ii) Further research need to be carried out using different techniques and methods.

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