

# Comparison of Corrosion Inhibitory Effects of Neem Seed and Wire Croton Extracts for Mild Steel in Salt and Fresh Water Media

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**Abstract:** Green inhibition capability of aqueous plant extracts of Neem Seed and Wire Croton on mild steel corrosion in salt and fresh water environments were studied via plant inhibitors extraction and characterization, inhibition efficiency, weight loss analysis and corrosion rate. Corrosion rate is dependent of contact time and the performance of the plant extracts inhibitors was monitored for a period of 35 days as presented in the research. The variation in the mild steel weight loss could be attributed to the physiochemical properties of the salt and fresh water environments examined, which include  $P^H$  value of 8.56, Temperature of 26.4°C, Salinity of 14,000 ppm and Total Heterotrophic Bacteria Count of  $5.2 \times 10^3$  mg/l for salt water environment and  $P^H$  value of 6.32, Temperature of 26.9°C, Salinity of 126 ppm and Total Heterotrophic Bacteria Count of  $3.8 \times 10^4$  mg/l for Fresh water environment respectively. Also, inhibition efficiency increased progressively with increasing extract concentration, confirming concentration-dependent behaviour. The corrosion rate and inhibition efficiency behavioural trend shown by the mild steel in salt and fresh water environment emphasizes that the application of the plant extracts contributed immensely to the reduction of mild steel corrosion immersed in the salt and fresh water media.

**Keywords:** Azadirachta, Codiaeumvariegatum, Green Inhibitor, Aqueous Extraction, Inhibition Efficiency.

## 1. INTRODUCTION

Mild steel is an indispensable material in many industrial applications due to its mechanical strength, formability, and low cost. However, its high susceptibility to corrosion, especially in aggressive environments such as acidic, saline, and freshwater media, significantly limits its long-term utility (Sharma & Sharma, 2014). Corrosion not only reduces the structural integrity of mild steel but also leads to increased maintenance costs, frequent replacements, safety hazards, and environmental pollution due to the release of metal ions into ecosystems. To mitigate these effects, synthetic corrosion inhibitors have been widely adopted. These inhibitors, often composed of inorganic salts or complex organic compounds, have shown effectiveness in reducing corrosion rates. Nevertheless, they present several drawbacks: they are often toxic, non-biodegradable, expensive, and can contaminate the environment (Verma *et al.*, 2017). As global attention shifts toward environmental sustainability and green chemistry, the continued use of these inhibitors has come under scrutiny. Corrosion remains one of the most persistent and costly challenges facing the industrial and engineering sectors

globally. According to a study by the National Association of Corrosion Engineers (NACE), global expenditures on corrosion-related issues exceed \$2.5 trillion annually, accounting for more than 3% of the world's GDP (Koch *et al.*, 2016). Mitigating corrosion, especially on mild steel, a metal commonly used in pipelines, water tanks, bridges, and machinery is therefore of paramount importance for economic, structural, and environmental sustainability. The hazardous nature of some of these anti corrosive substances constitute reasons for search of source of inhibitors from products of natural plant. Extracts of natural plant are to be a good source of renewable and ecofriendly substances that are made naturally. Extracts of different parts of plant in earlier research have shown that they are good and inhibitors of corrosion in various acid or salty environment. (Abiola *et al.*, 2009). Extracts of plant are known as good natural compounds, with a simple extraction procedure (El-Nabeyeta, 2012). Them a in inhibitive components in the plant extracts includes alkaloids, nitrogen bases, carbohydrates and proteins (Loto & Muhammed, 2005). Alrefae *et al.* (2021) investigated plant extracts as environmentally friendly corrosion inhibitors, establishing them as sustainable alternatives to toxic synthetic compounds. The study conducted an extensive literature review, analyzing inhibition mechanisms through electrochemical studies, surface characterization, and computational modeling. Key findings revealed that phytochemicals like alkaloids and flavonoids adsorb onto metal surfaces via both physisorption and chemisorption. Results demonstrated that these extracts primarily act as mixed-type inhibitors, with efficiency ranging from 62% to over 98%, and their adsorption typically follows the Langmuir isotherm model Madawa *et al.* (2025) investigated the corrosion inhibition of Ocimum gratissimum (Scent Leaf) and Azadirachta indica (Neem Leaf) extracts on mild steel (C-1026) in seawater. The study utilized weight loss methods, surface roughness analysis to evaluate the inhibitors' performance. Enekwe *et al.* (2024) investigated the impact of neem (Azadirachta indica) leaf extract as a green corrosion inhibitor for mild steel in HCl medium. Ekeke *et al.* (2019) studied the corrosion inhibition of mild steel and copper in  $H_2SO_4$  using Azadirachta indica (neem) seed extract. The experiments employed the gasometrical method, monitoring hydrogen gas evolution to model corrosion kinetics. Chukwueze and Aneke (2019) investigated the

corrosion inhibition of mild steel in 1M H<sub>2</sub>SO<sub>4</sub> using Carica papaya (pawpaw) and Azadirachta indica (neem) leaf extracts, comparing the performance of both inhibitors. Elachi *et al.* (2016) conducted a comparative study on the corrosion inhibition performance of Azadirachta indica (neem) and Vernonia amygdalina (bitter leaf) leaf extracts for stainless steel in cassava fluid, using the weight loss method over 35 days. Although several studies have investigated the inhibition efficiency of various plant extracts, the corrosion-inhibiting capabilities of neem seed and wire croton have not been comprehensively compared, particularly in fresh water and salt water corrosive environments. Therefore, this research is focused on examining, evaluating and comparing the performance of the plant extracts of Neem seed and Wire Croton on the corrosion of mild steel inhibition from fresh and salt water media. Thus, this aim will be achieved through characterization of plants extract, investigation of corrosion rate of mild steel in fresh and salt water environment, analysis of corrosion inhibition mechanism using weight loss technique and inhibition efficiency.

## II. MATERIALS AND METHOD

### 2.1 Materials

Locally sourced materials were applied in this research by purchasing neem seed at Rumuokoro market in Obio/Akpor while wire croton leaves were gotten within Rivers State University surrounding. Acetone were bought from a Chemical Shop in Port Harcourt while Mild Steel, salt and fresh water were gotten in Rivers State. Also, materials such as Sample Reactors, Metal cutting machine, Rubber thread, Toothbrush, A pair Scissors, Digital Weight Balance etc were applied in this research study.



Plate 1: 5.5 x 4 Mild Steel Couple Sample

TABLE 1: Chemical Composition of Mild Steel

| Element         | Composition (%) |
|-----------------|-----------------|
| (C)Carbon       | 0.017           |
| (Si) Silicon    | 0.007           |
| (Mn) Manganese  | 0.196           |
| (P) Phosphorous | 0.009           |
| (Ni)Nikel       | 0.013           |
| (Mo) Molybdenum | 0.015           |
| (Cr) Chromium   | 0.043           |
| (S)Sulphur      | 0.014           |
| (Fe)Iron        | 99.686          |

The density of the mild steel used is 7.86g/cm<sup>3</sup>

### 2.2 Extraction and Characterization of Neem Seed

Wire Croton leave of 1.5kg was weight into a reactor and later poured in a fine crushing mortal for size reduction. After crashing the wet wire croton leave, it was poured into a 75um sieve mesh. The wire croton wet leave was poured inside the

sieve mesh and was properly squeezed with hand to extract the natural lipid without contamination and adulteration. The recovered Wire Croton lipid was bottled and immediately kept in a fridge to prevent it from losing concentration before it could be used as an inhibitor.



Plate 2: Wire Croton Plant Extract

### 2.3. Extraction and Characterization of Wire Croton

1.5kg of the Neem Seeds was weight into a reactor and later poured in a fine crushing mortal for size reduction. After crashing, the wet Neem Seed was poured into a 75um sieve mesh. The neem seed cake was poured inside the sieve mesh and properly squeezed with hand to extract the natural lipid without contamination or adulteration. The recovered neem seed lipid was bottled and immediately kept in a fridge to prevent it from losing concentration before it could be used as an inhibitor



Plate 3: Natural Neem Seeds Plant, Harvested Neem Seeds and Neem Seeds Extract

### 2.4 Investigation of the Corrosion Rate of Mild Steel in Salt and Fresh Water, Environments without the Inhibitors

The corrosion rate of two mild steel coupon of dimension of (5.5x4) with respective weight 87.18g (Fresh water medium) and 83.74g (Salt water medium) respectively and the thickness were perforated at one end of the coupon. The initial weight of each the coupons were recorded. The coupons were wire brushed and sand papered and washed with detergent to removed coated rust on its body.

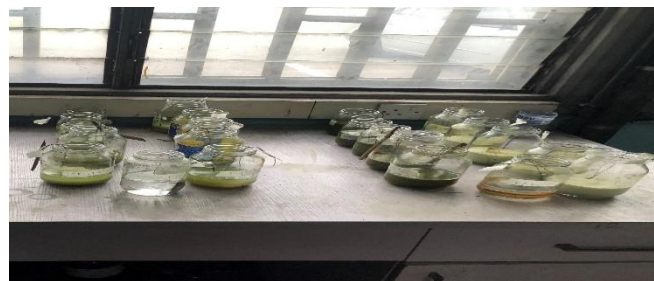


Plate 4: Laboratory Sample of Salt water and Fresh water Environments

After washing the coupon with distilled water and detergent, the coupons were immersed into 250ml of acetone to prevent immediate or instance corrosion attack. The acetone also aids fast drying of moisture on the coupons' surface. The coupons were immersed and harvested weekly to check the corrosion

rate of the metal coupon without the inhibitor in their respective medium for 6 weeks. Thus, the corrosion rate was determined on each metal coupon.

### 2.5. Determination of the Inhibition Efficiency of Neem Seed and Wire Croton Extracts in the Two Media

The corrosion rate of twenty (20) mild steel coupon of dimension (5.5x4) with their individual weight were grouped into two (2) media (salt and fresh water) of ten (10) sample each comprise of five for wire croton and five for neem seed in their respective medium. The initial weight of each of the coupons were measured and recorded. The coupons were wire brushed and sand papered and washed with detergent to removed coated rust on its body. After washing the coupon with distilled water and detergent, the coupons were immersed into 250ml of acetone to prevent immediate or instance corrosion attack. The acetone also aids the drying very fast the moisture on its surface. Difference concentration (dosages) of neem seed and wire croton extracts were prepared as inhibitor in a difference relative. The media Fresh water and Salt water of the same volume 250ml were also measured in difference reactors. The concentrations of the inhibitor were introduced to the media in the reactor according to the research layout as shown in Table 2.

TABLE 2: Measured Volume (ml) of Extracts

| Fresh water |           | Salt water  |           |
|-------------|-----------|-------------|-----------|
| Wire croton | Neem seed | Wire croton | Neem seed |
| 5:2.5       | 5:2.5     | 5           | 5         |
| 10:5        | 10:5      | 10          | 10        |
| 15:7.5      | 15:7.5    | 15          | 15        |
| 20:10       | 20:10     | 20          | 20        |
| 25:12.5     | 25:12.5   | 25          | 25        |

The coupons were harvested weekly to check the corrosion rate and the effectiveness of the two inhibitors in their respective medium for six (6) weeks, and the corrosion rate of each coupon was evaluated.

### 2.6 Mild Steel Corrosion Rate Investigation in Fresh and Salt Water

Standard methods were applied to study and investigate mild steel corrosion rate in fresh and salt water environments to determine the corrosion rate ( $C_r$ ), surface Coverage ( $\theta$ ) and Inhibition efficiency (IE%) in tandem and as reported by Izionworu *et al.* (2021).

#### 2.6.1 Determination of Weight Loss

Weight loss analysis was carried out using Equations 1, 2 and 3 respectively

$$\Delta W_{L(A)} = W_{i(A)} - W_{f(A)} \quad (1)$$

$$\Delta W_{L(B)} = W_{i(B)} - W_{f(B)} \quad (2)$$

$$\Delta W = \frac{(\Delta W_{L(A)} + \Delta W_{L(B)})}{2} \quad (3)$$

#### 2.6.2 Determination of Corrosion Rate

Corrosion rate of metal in mmpy can be evaluated using Equation 4 as shown thus.

$$C_r \left( \frac{\text{mm}}{\text{year}} \right) = \frac{87,600 \Delta W (g)}{\rho \left( \frac{g}{\text{cm}^3} \right) A (\text{cm}^2) t (\text{hr})} \quad (4)$$

#### 2.6.3 Determination of Surface Coverage and Inhibition Efficiency

The evaluation of surface coverage and inhibition efficiency are depicted in Equations 5 and 6 respectively

$$S_c, \theta = \left[ \left( 1 - \frac{C_r^{inh}}{C_r^{blk}} \right) \right] \quad (5)$$

$$IE\% = \left[ \left( 1 - \frac{C_r^{inh}}{C_r^{blk}} \right) \right] \times 100 \quad (6)$$

## III. RESULTS AND DISCUSSION

### 3.1 Corrosion Rate Investigation of Mild Steel in Fresh Water and Salt Water

The variations in corrosion rate of mild steel immersed in salt water environment over a 35-day period with and without the addition of wire croton extract as a corrosion inhibitor is depicted in Figure 1.

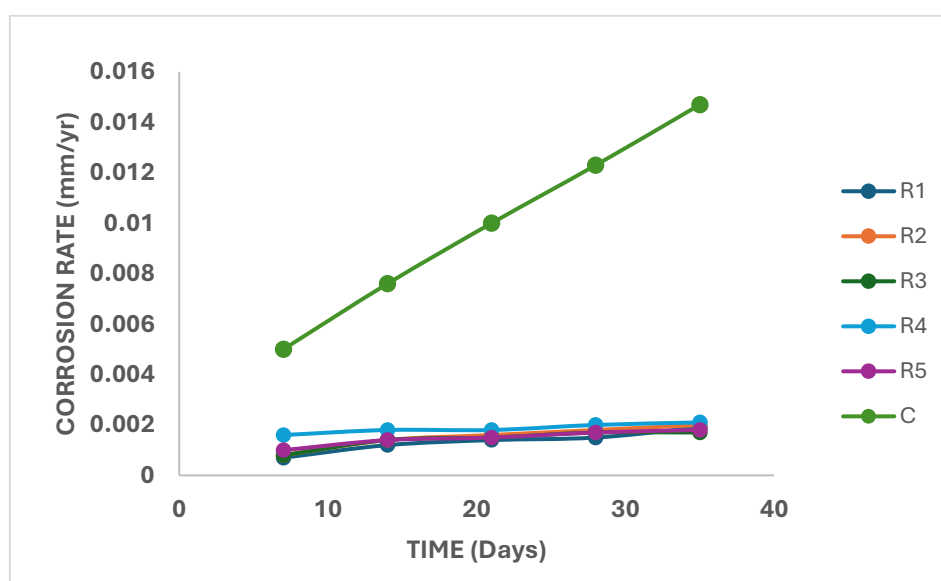


Figure 1: Comparative Effect of Mild Steel Corrosion Rate Against Time in Salt water in Absence and Presence of Wire Croton Extract

The control sample without the inhibitor exhibited the highest corrosion activity. Its rate started at 0.005mm/yr and gradually increased to 0.0147mm/yr by day 35, indicating accelerated surface deterioration due to continuous exposure to the salty environment. In contrast, plant extract-treated samples (R1–R5) recorded slight corrosion rates, thereby confirming the protective coating effects of the inhibitor. Thus, R4 (20 mL extract) and R5 (25 mL extract) showed the best performance by maintaining corrosion rates below 0.01 mm/yr throughout the test period.

The reduction in corrosion rate with increasing extract concentration indicated effective adsorption of phytochemical constituents on the steel surface, forming a barrier that hindered acid attack. This observation agreed with the findings of Rani and Basu (2012), who reported that plant-based inhibitors reduces metal dissolution through the adsorption of bioactive compounds. Also, Chigondo and Chigondo (2016) further stated that phenolic and amine groups in such extracts enhanced inhibition by donating electrons to the metal surface, leading to protective film formation, while Yadav *et al.* (2016) noted that higher inhibitor concentrations improved surface coverage, consistent with Langmuir adsorption behaviour. Therefore, the wire croton extract effectively inhibited corrosion and provided long-term protection in acidic conditions, validating its potential as an eco-friendly inhibitor for mild steel.

Figure 2 illustrated the variation in corrosion rate of mild steel immersed in fresh water environment over a 35-day period with and without the addition of wire croton extract as a corrosion inhibitor. The control sample without the inhibitor exhibited the highest corrosion rate values throughout the exposure period, starting at about 0.0153 mm/yr and slightly increasing to around 0.0259 mm/yr by the 35<sup>th</sup> day. This trend suggested mild but progressive corrosion typical in less aggressive environments like fresh water. In contrast, the wire croton plant extract-treated samples (R1–R5) displayed relatively lower corrosion rate values, indicating that the

inhibition effect was very active as corrosion inhibitor. Among the treated samples, R5 (25mL extract) and R4 (20mL extract) recorded slightly higher corrosion rates, while R1 (5mL extract) and R2 (10mL extract) showed moderate stability across the test duration. The observed trend suggested that the inhibitor's performance in fresh water depended on the extract's concentration and the nature of adsorption on the steel surface. The results implied that the phytochemicals from the wire croton extract were less strongly adsorbed under neutral pH, leading to weaker film formation.

Also, the variation in corrosion rate of mild steel immersed in salt water over a 35-day period both with and without the addition of neem seed extract as a corrosion inhibitor is shown in Figure 3. The control sample (C) that contained no inhibitor exhibited the highest corrosion activity. Its rate started at 0.0050mm/yr and progressively increased to approximately 0.0147 mm/yr by day 35, showing a steady acceleration in surface degradation due to continuous exposure to the acidic medium. In contrast, all inhibitor-treated samples (R1–R5) demonstrated substantially lower corrosion rates, confirming that the extract effectively reduced metal dissolution whereas inhibitor-treated sample (R4 and R5) showed a bit higher corrosion rate. The observed trend revealed that the corrosion rate decreased with decreased inhibitor concentration, signifying efficient adsorption of phytochemical constituents from the neem seed extract onto the steel surface. These adsorbed molecules formed a protective film that limited acid penetration and minimized electrochemical reactions.

In addition, the illustration of the variation in corrosion rate of mild steel immersed in fresh water over a 35-day period with and without the addition of Neem Seed extract as a corrosion inhibitor. The control sample (C) without the inhibitor exhibited the lowest corrosion rate values throughout the exposure period starting at about 0.0029mm/yr and slightly increasing to around 0.0100mm/yr by the 35<sup>th</sup> day.

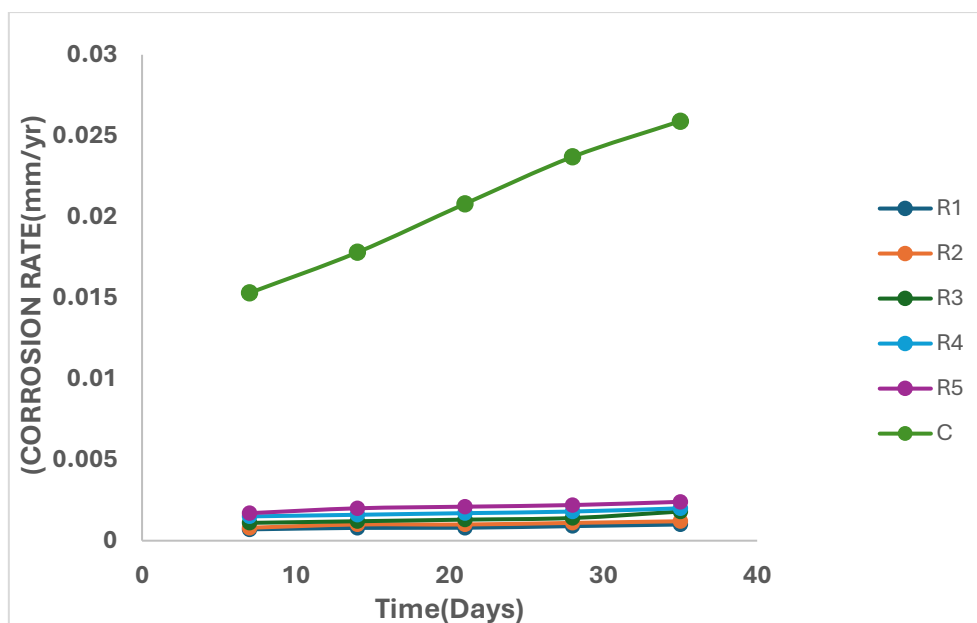


Figure 2: Comparative Effect of Mild Steel Corrosion Rate Against Time in Fresh water in Absence and Presence of Wire Croton

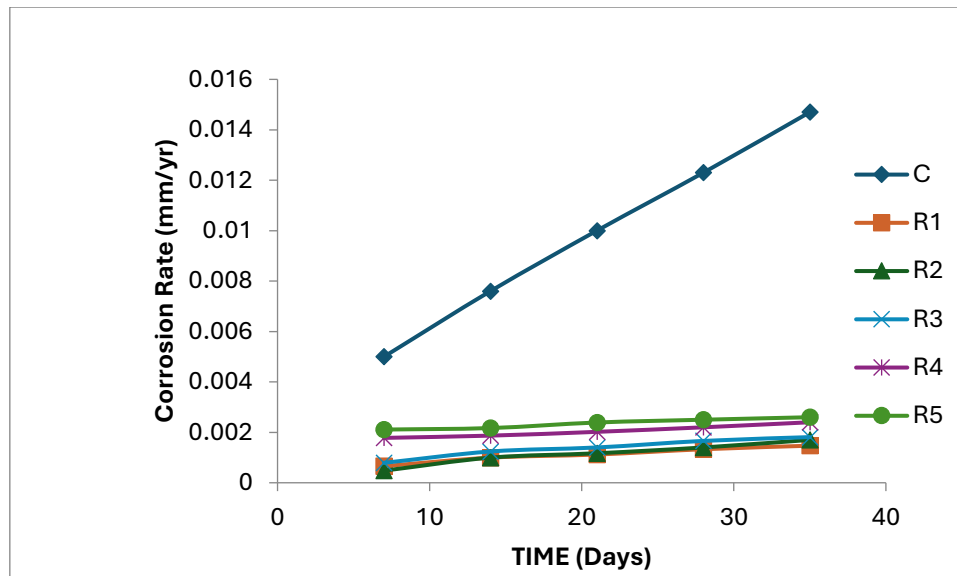


Figure 3: Comparative Effect of Mild Steel Corrosion Rate Against Time in Salt Water in Absence and Presence of Neem Seed Extract

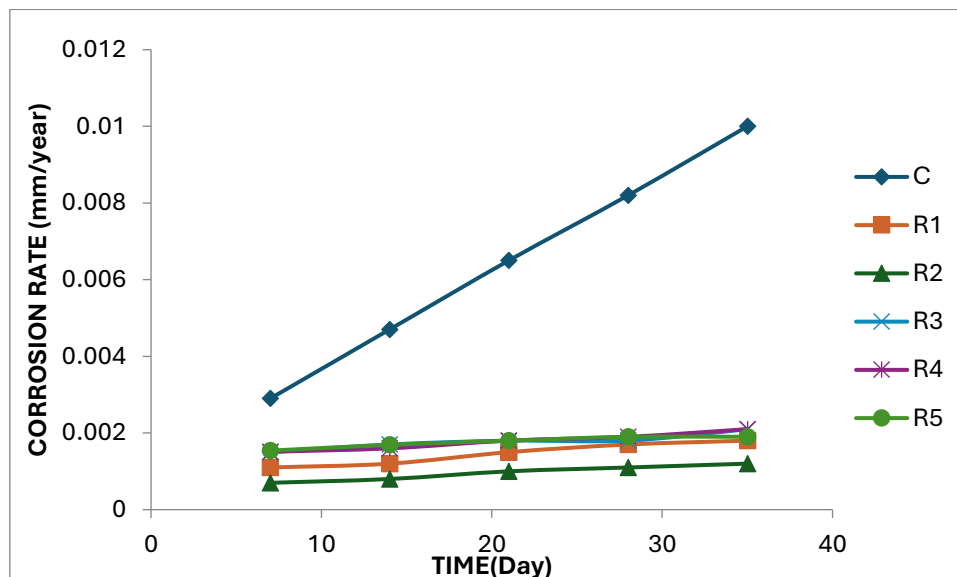


Figure 4: Comparative Effect of Mild Steel Corrosion Rate Against Time in Fresh Water in Absence and Presence of Neem Seed Extract

This slow increase suggested mild but progressive corrosion typical in less aggressive environments like fresh water. In contrast, the extract-treated samples (R1–R5) displayed relatively higher corrosion rate values indicating that the inhibition effect was less pronounced in neutral conditions compared to acidic media. Thus, among the treated samples, R5 (25mL extract), R4 (20 mL extract) and R3 (15mL extract) recorded slightly higher corrosion rates, while R1 (5mL extract) and R2 (10mL extract) showed moderate stability across the test duration. The observed trend suggested that the inhibitor's performance in fresh water depended on the extract's concentration and the nature of adsorption on the steel surface. The results implied that the phytochemicals from the wire croton extract were less strongly adsorbed under neutral pH, leading to weaker film formation.

### 3.3 Inhibition Efficiency of Neem Seed and Wire Croton Extracts in Salt and Fresh Water Media

The time dependent inhibition efficiency (IE%) of wire croton extract on mild steel in salt water is highlighted in Figure 5. All extract concentrations (5–25 mL) demonstrate a rapid increase in IE% within the first 10–35 days, followed by stabilization or slight decline during prolonged exposure. R1 (5mL extract) achieved the highest efficiency, exceeding 85% at 35 days, indicating prompt and effective surface interaction between phytochemicals and the steel substrate. The concentration-dependent trend further reinforces its effectiveness as a sustainable green corrosion inhibitor.

Furthermore, Figure 6 showed the time-dependent inhibition efficiency (IE%) of Wire Croton Extract on mild steel in Fresh Water. All extract concentrations (5-25 mL) demonstrate a rapid increase in IE% within the first 10-35 days,

followed by stabilization or slight decline during prolonged exposure. Sample R2 (10 mL extract) achieved the highest efficiency, exceeding 85% at 35 days, indicating prompt and

effective surface interaction between phytochemicals and the steel substrate.

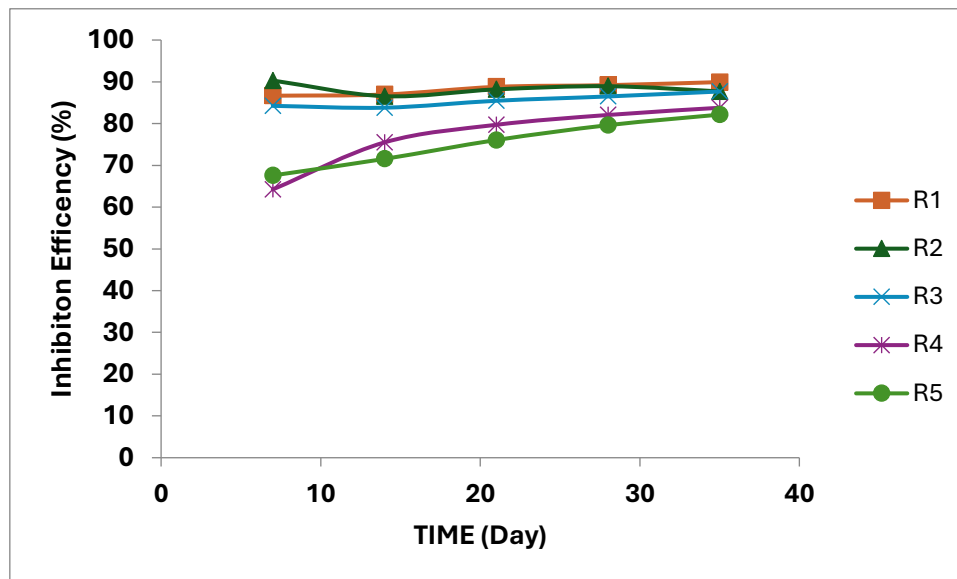


Figure 5: Comparative Effect of Wire Croton Extract Inhibition Efficiency on Mild Steel Corrosion in Salt Water Against Time

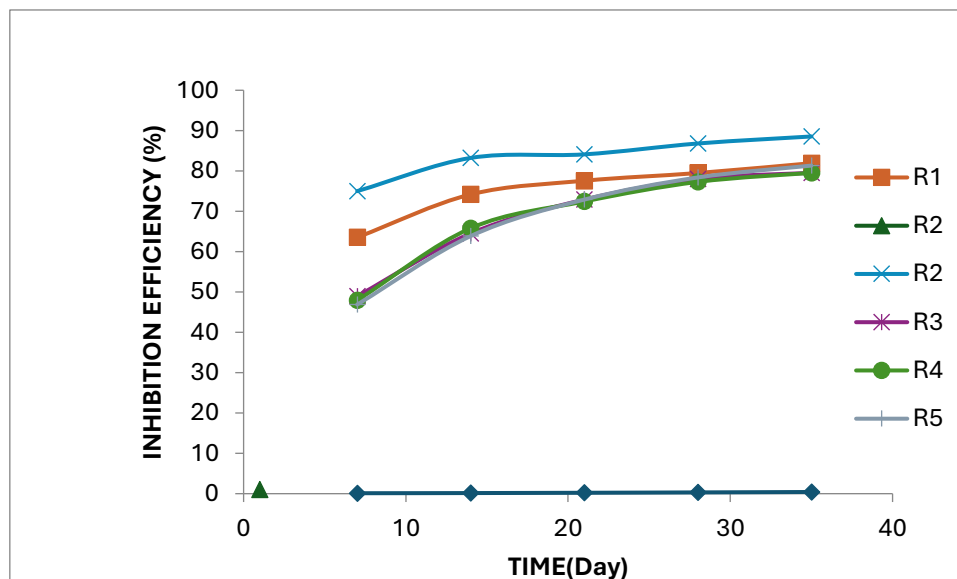


Figure 6: Comparative Effect of Wire Croton Extract Inhibition Efficiency on Mild Steel Corrosion in Fresh Water Against Time

These initial efficiency spike trends in both fresh and salt water environment as depicted in Figures 5 and 6 respectively aligns with findings by Rani and Basu (2012), who reported that adsorption of organic inhibitors on metal surfaces typically, occurs rapidly, forming a protective layer that resists aggressive ions. Over time, minor reductions in IE% as seen in this study can result from desorption or breakdown of the inhibitor layer under prolonged acid exposure, a behavior also observed by Odewunmi et al. (2015) in plant-based systems. Thus, Chigondo and Chigondo (2016) emphasized that stability of the adsorbed film depends on concentration, functional groups, and environmental persistence. Thus, despite slight temporal variation, inhibition efficiency remained significantly higher

than the control, thereby confirming that extract provides consistent and stable protection as posited by Ukpaka et al. (2023).

In addition, Figures 7 and 8 illustrated the time-dependent inhibition efficiency (IE%) of Neem Seed extract on mild steel in salt and fresh water environment. All extract concentrations (5–25 mL) demonstrate a rapid increase in IE% within the first 10–35 days, followed by stabilization or slight decline during prolonged exposure. R1 (5 mL extract) achieved the highest efficiency, exceeding 85% at 35 days, indicating prompt and effective surface interaction between phytochemicals and the steel substrate in salt water environment while R2 (10 mL

extract) achieved the highest efficiency in fresh water environment, exceeding 85% at 35 days, indicating prompt and

effective surface interaction between phytochemicals and the steel substrate.

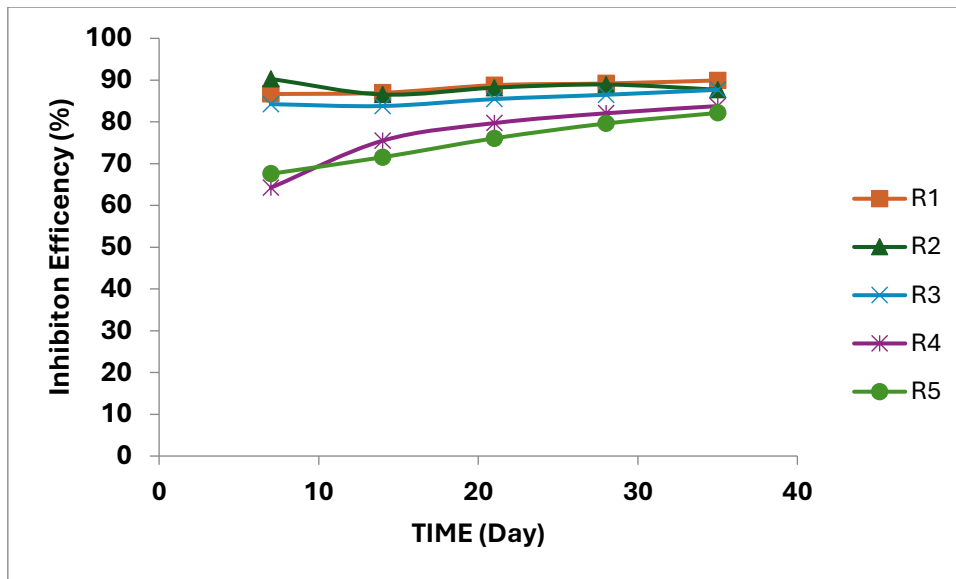


Figure 7: Comparative Effect of Neem Seed Extract Inhibition Efficiency on Mild Steel Corrosion in Salt water Against Time

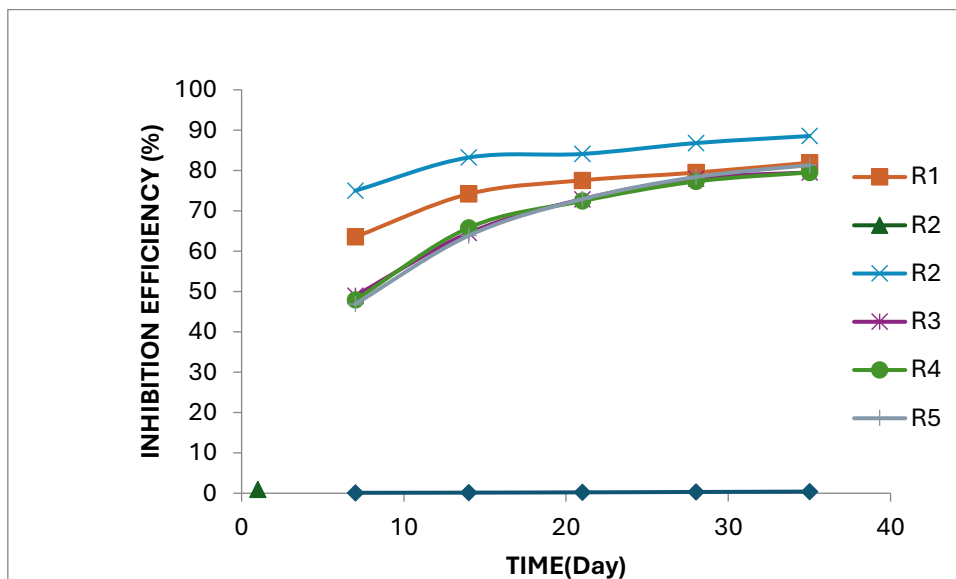


Figure 8: Comparative Effect of Neem Seed Extract Inhibition Efficiency on Mild Steel Corrosion in Fresh Water Against Time

These trends observed in Figures 7 and 8 are in tandem with Rani and Basu (2012), who reported that adsorption of organic inhibitors on metal surfaces occurred rapidly by forming a protective layer that resists aggressive ions. Therefore, the minor reductions in IE% observed over time can be attributed to desorption or breakdown of the inhibitor layer under prolonged acid exposure as observed by Odewunmi *et al.* (2015) in plant-based systems. Hence, Chigondo and Chigondo (2016) emphasized that stability of the adsorbed film depends on concentration, functional groups, and environmental persistence, and the inhibition efficiency remained significantly higher than the control irrespective of slight variation, thereby confirming that extract provides consistent and stable protection as posited by Ukpaka *et al.* (2023).

### 3.4 Determine the Weight Loss of Neem Seed and Wire Croton Extracts in the Two Media

The variation of weight loss analysis of mild steel corrosion in salt and fresh water environments with and without neem seed and wire croton inhibitors over a 35-day period are shown in Figures 9, 10, 11 and 12 respectively. The control sample (C) exhibited the highest weight loss throughout the exposure, indicating rapid corrosion in the absence of inhibitor protection, while inhibited samples (R1–R5) recorded lower weight losses, thereby demonstrating that the inhibitors (wire croton) effectively reduced metal dissolution as depicted in Figure 9. Among the inhibited systems, R1 displayed the least weight loss indicating the best

inhibition efficiency and most stable protective film formation on the metal surface.

Therefore, the steady increase in weight loss for all samples with time suggests that corrosion progressed gradually, although more slowly for inhibited specimens. The difference between the control and inhibited samples becomes more pronounced with prolonged immersion, confirming that the inhibitor suppressed corrosion by reducing the rate of salty attack and forming an adherent barrier on the steel surface. Also, in fresh water environment, the control sample (C) recorded the highest weight loss, indicating maximal corrosion activity in the absence of inhibitor, while the inhibited samples

(R1–R5) displayed progressively lower weight loss values due to increased inhibition performance or ineffective protective film formation. Among the inhibited samples, R1 and R2 exhibited comparatively smaller increases in weight loss suggesting moderate corrosion resistance, while R5 showed the highest weight loss, representing the least effective inhibition under the conditions tested. The general upward trend for all samples with time indicates that corrosion continued gradually throughout the exposure period. However, differences in weight loss among samples reflect the varying efficiency of inhibitor concentrations in mitigating metal degradation.

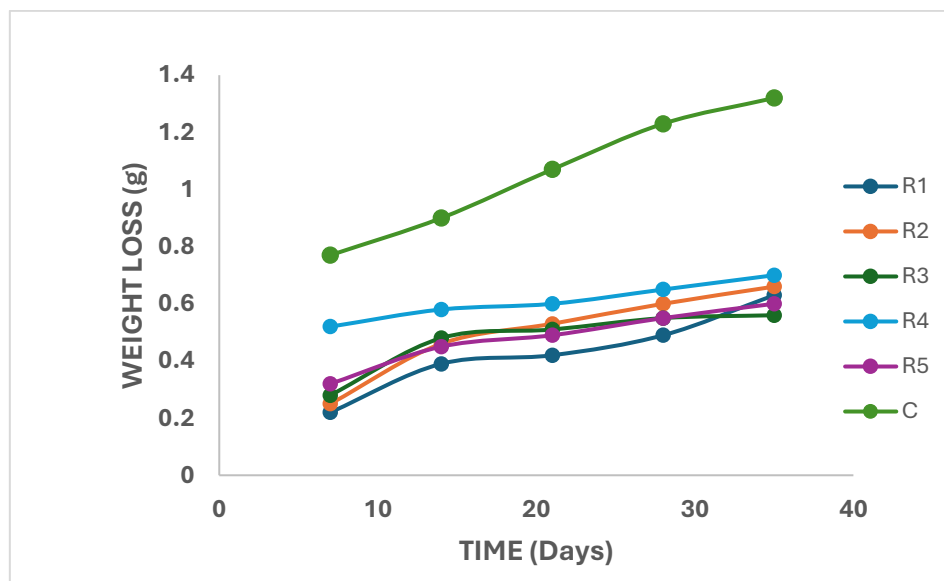


Figure 9: Comparative Effect of Mild Steel Weight Loss Against Time in Salt Water in Absence and Presence of Wire Croton Extract

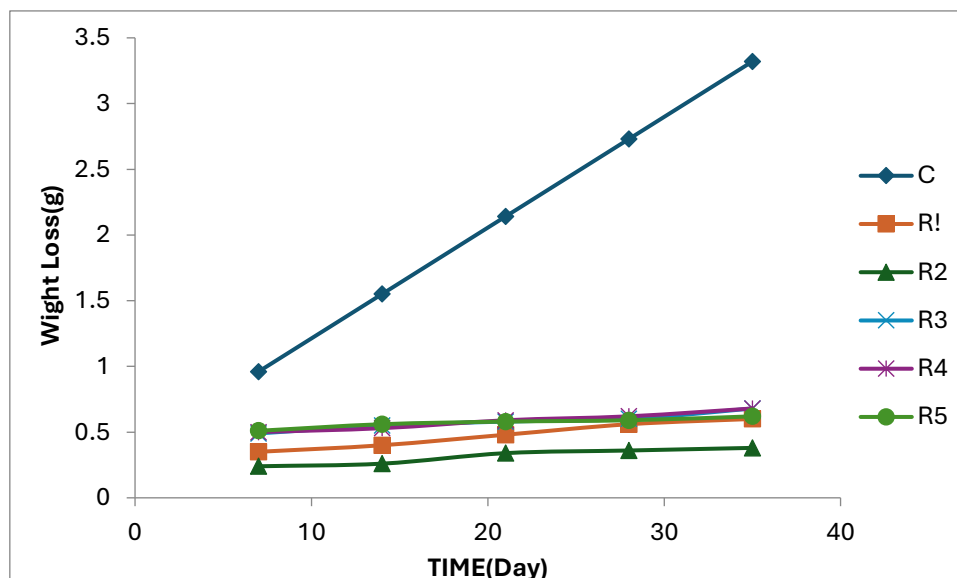


Figure 10: Comparative Effect of Mild Steel Weight Loss Against Time in Fresh Water in Absence and Presence of Wire Croton Extract

Besides, the variation of weight loss of mild steel specimens immersed in a salt water environment for 35 days with and

without inhibitors in salt and fresh water environment are shown in Figures 11 and 12 respectively.

The control sample recorded the highest weight loss indicating minimal corrosion activity in the absence of inhibitor, while the inhibited samples (R1–R5) displayed progressively increase in weight loss values indicating reduced inhibition performance or ineffective protective film formation. Thus, R1 and R2 exhibited comparatively smaller increases in weight loss suggesting moderate corrosion resistance, while R5

showed the highest weight loss, representing the least effective inhibited sample under the conditions tested. In addition, R1 and R2 exhibited comparatively smaller increases in weight loss suggesting moderate corrosion resistance, while R4 showed the highest weight loss representing the least effective inhibited sample as displayed by Figure 12.

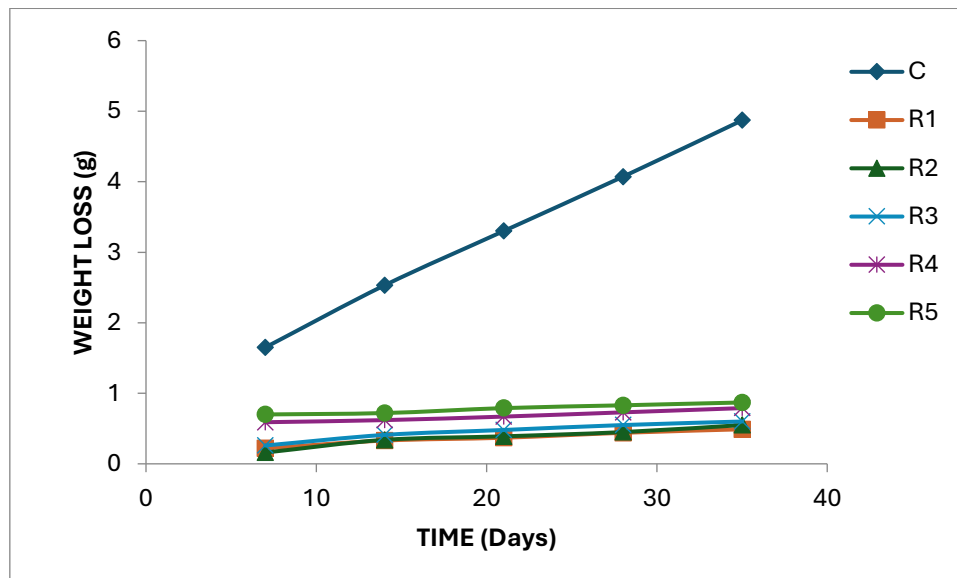


Figure 11: Comparative Effect of Mild Steel Weight Loss Against Time in Salt Water in Absence and Presence of Neem Seed Extract

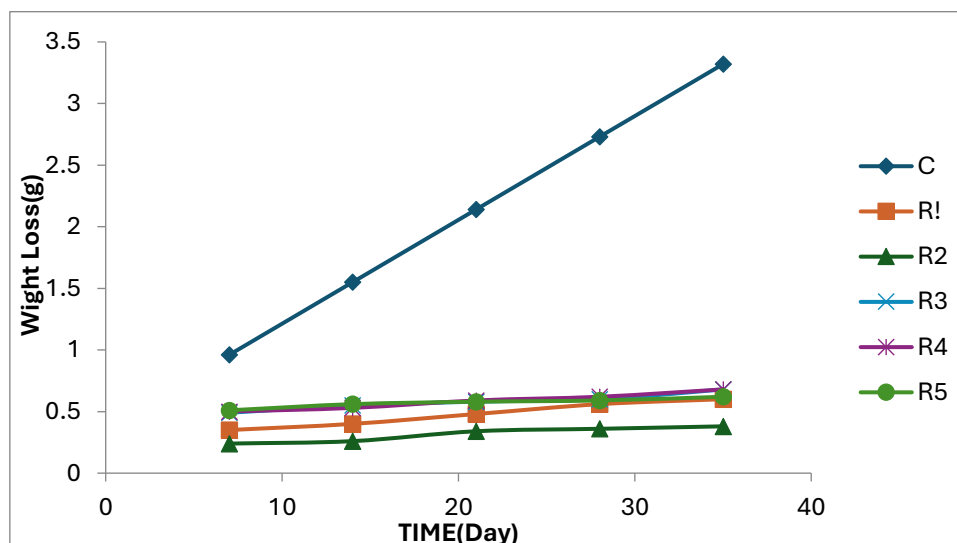


Figure 12: Comparative Effect of Mild Steel Weight Loss Against Time in Fresh Water in Absence and Presence of Neem Seed Extract

The general upward trend for all samples with time indicates that corrosion continued gradually throughout the exposure period. However, differences in weight loss among samples reflect the varying efficiency of inhibitor concentrations in mitigating metal degradation.

#### IV. CONCLUSION

The research focused on the evaluation and comparative effects of corrosion green inhibitors of neem seed and wire croton extracts on mild steel corrosion in salt and fresh water

environment via extraction and characterization of plant extracts, weight loss analysis, corrosion rate and inhibition efficiency. Experimental results showed that mild steel corrosion rate was highest in moderate in salt water and lowest in fresh water environments respectively. This trend confirmed the strong influence of chloride ions on metal dissolution and established salt as the most aggressive test environment. The green inhibitors (neem seed and wire croton) extracts significantly reduced corrosion rates in both media. Inhibition efficiency increased with extract concentration with neem seed

achieving higher maximum efficiencies in salt water environment, while wire croton showed effective inhibition in fresh water environment. Also, the weight loss deductions yielded substantial reductions in metal loss in the presence of inhibitors, thereby confirming adsorption-based inhibition. The results indicated that both extracts suppressed corrosion by forming protective films on the steel surface, thereby reducing metal dissolution over the exposure period. Comparative analysis demonstrated that neem seed extract consistently outperformed wire croton across both media, achieving higher inhibition efficiencies and lower corrosion rates. This higher performance was attributed to its richer phytochemical composition and stronger adsorption capability on the mild steel surface. Results confirmed that both extracts are eco-friendly, biodegradable, and non-toxic with low production costs due to simple extraction and its local availability. Thus, their high inhibition efficiencies at low concentrations demonstrated cost-effective corrosion control compared to conventional synthetic inhibitors.

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