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Exploring the Efficacy of a Potent Corrosion Suppressant Derived from Trandescantia Pallida (Purpple Heart) Leaves: A Qualitative Assessment

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Abstract
The corrosion inhibiting effect of *Tradescantia pallida* leaf extract (TPLE) on low carbon steel in a sulphuric acid medium was investigated. Weight loss experiments were conducted at two temperatures, 27°C and 60°C, using six low carbon steel coupons of known dimensions, compositions, and weights over a 3-day immersion period. The results revealed that TPLE exhibited significant corrosion inhibition properties, as evidenced by the reduction in weight loss of the low carbon steel samples. This indicates its potential as a corrosion inhibitor for low carbon steel in sulphuric acid environments. Further studies are recommended to explore the underlying mechanisms of TPLE's corrosion inhibition and optimize its usage in industrial applications. The results obtained from the study demonstrated that at a temperature of 27°C, the addition of only 0.5 g L-1 of *Tradescantia pallida* leaf extract (TPLE) significantly suppressed the corrosion rate of low carbon steel. The corrosion rate decreased from 20.380 mm/yr to 1.446 mm/yr, resulting in an impressive inhibitor efficiency of 92.91%. As the dosage of TPLE was increased from 0.5 g L-1 to 2.5 g L-1, the inhibitor efficiency showed a proportional increase, reaching a remarkable 95.85% at the highest dosage of 2.5 g L-1 in the inhibitor solution. These findings highlight the potential of TPLE as a highly effective corrosion inhibitor for low carbon steel in sulphuric acid environments. Further investigations are recommended to delve into the underlying mechanisms responsible for the corrosion inhibition and to optimize the dosage and application of TPLE in various industrial settings. Similarly, at an elevated temperature of 60°C, comparable results were observed. However, in this case, the corrosion rate of low carbon steel increased with higher temperatures. Despite this, the addition of *Tradescantia pallida* leaf extract (TPLE) at a concentration of 0.5 g L-1 still managed to reduce the corrosion rate significantly. The corrosion rate increased from its initial value, but the inhibitor efficiency remained noteworthy at 88.62%. As the concentration of TPLE was increased to 2.5 g L-1, the inhibitor efficiency improved to 91.72%. These findings indicate that while the corrosion rate may increase under higher temperatures, the presence of TPLE still confers a considerable level of corrosion inhibition for low carbon steel in sulphuric acid environments. Further research is recommended to delve into the specific mechanisms underlying the temperature-dependent behavior and to optimize the application of TPLE as a corrosion inhibitor in different temperature ranges and industrial conditions. The observed temperature effect suggests that the inhibitor molecules present in *Tradescantia pallida* leaf extract (TPLE) primarily act through a physisorption mechanism. Further analysis of TPLE revealed the presence of various functional groups, including OH, C=O, and aromatic rings, among others. These functional groups have been widely recognized for their efficacy in enhancing the adsorption of inhibitor molecules onto metallic substrates. This suggests that the corrosion inhibition properties of TPLE can be attributed to the adsorption of its constituent compounds onto the surface of low carbon steel, forming a protective layer that hinders the corrosion process. The identification of these functional groups provides valuable insights into the underlying mechanisms of TPLE's corrosion inhibition and opens up avenues for potential modifications and optimization of the extract for enhanced performance. Future investigations should focus on elucidating the specific interactions between the inhibitor molecules and the metallic surface, as well as exploring the long-term stability and compatibility of TPLE in practical corrosion prevention applications.

Keywords: corrosion, inhibitor efficiency, extract, adsorption, physisorption

1. Introduction

Metals and their alloys find wide range of applications in human activities as a result of their excellent mechanical and electrical properties (Loto and Olowoyo, 2019; Parthipan *et al.*, 2018; Verma *et al.*, 2018; Anupama *et al.*, 2017). In order to preserve the desired quality and working condition of these metal substrates, there is need to adopt some preventive measures to protect them from aggressive and hostile environments. Corrosion is probably the most common undesired phenomenon that causes metals to deteriorate and lose mechanical properties (Zhu *et al.*, 2020; Mai *et al.*, 2016). This natural process originates from the electrochemical interaction of metals with the corrosive environment. Sulfides, oxides, and others are generated through reactions between the metal surface and the corrosive medium (El Ibrahim *et al.*, 2020; Kicir *et al.*, 2016; Mai *et al.*, 2016; Singh *et al.*, 2016). Among metals and alloys, low carbon (mild) steel is the most widely used in the oil, food, energy, chemical, and construction industries due to its relatively low cost, availability and excellent mechanical properties such as high resistance, durability, and toughness, among others. Due to huge costs associated with the repair or replacement of corroded metals especially in the oil and gas industries (Ledan *et al.*, 2017), corrosion of metals has become a critical environmental challenge which has gained more attention in recent times. Finding solutions to problems related to the corrosion of steel, mostly low carbon steel therefore becomes pertinent. The use of natural products or organic extracts of plant leaves, seeds and nuts, flowers, and stem barks as corrosion inhibitors to protect metal materials from hostile environments has been widely reported by researchers (Haldhar *et al.,* 2021; Ahanotu *et al.*, 2020). These extracts contain several phytochemicals and active organic molecules with electron-rich regions and heteroatoms (O, N, S, etc.) which facilitate the adsorption of these active molecules leading to the formation of a protective layer on the surface of substrate (Patel *et al.,* 2013). Some of the organic inhibitor molecules also contain polar functional groups which are responsible for physisorption (Miralrio and Vázquez, 2020).

It is pertinent to state that the inhibition performance of most plant extracts is a function of concentration of the extract molecules, temperature of the system, extraction solvent and period of immersion (Ghahremani *et al.*, 2021; Ahanotu *et al.*, 2020; Ebenso *et al.*, 2008). Researchers have reported that the extracts from plant materials are locally available, give a wide range of green inhibitors, and are more environmentally acceptable and friendly than inorganic inhibitors which are toxic and associated with environmental concerns. In order to ascertain the efficiency of a given corrosion inhibitor, simple and yet very reliable methods such as gravimetric experiments which involves weight loss measurements (Ahanotu *et al.*, 2022; Oguzie *et al.*, 2010; Ebenso, 2003), gasometric experiments which involves gas evolution measurements (Chitra *et al.*, 2010; Oguzie, 2006), electrochemical experiments which includes potentiodynamic polarization and electrochemical impedance spectroscopy (Solomon *et al.*, 2021; Ahanotu *et al.*, 2020; Onyeachu *et al.*, 2020), thermometric experiments which involves temperature change measurements (Ebenso, 2003), acidimetry which involves measurement of pH changes (Adejo *et al.*, 2019), and lots more are normally used. The inhibition efficiency of different plant extracts is a valuable parameter that gives an insight while choosing an effective extract for a particular intended purpose and this is done by taking into account the surface characterization studies of the protected and unprotected metal substrates using imaging techniques such as atomic force microscopy (AFM) and scanning electron microscopy (SEM) (Ahanotu *et al.*, 2020; Olawale *et al.,* 2018). At the moment, no work has been done on the use of extracts of *Tradescantia pallida* as a corrosion inhibitor for metal substrates. As a contribution to the growing interest in the search for environmentally friendly corrosion inhibitors, this present study sought to investigate the corrosion resistive effect of *Tradescantia pallida* leaf extract in protecting low carbon steel substrates from corrosion in an acidic solution. *Tradescantia pallida,* also known as purple-heart or purple queen, is a tender evergreen perennial, a species of spiderwort plant in the family *Commelinaceae.* native to the northeastern Mexico (Huq, 2015). It is normally grown as an ornamental for its striking dark purple lance-shaped fleshy leaves up to 7 inches long which are covered with pale hairs and produced alternatively on fleshy stems (Menegazzo *et al.,* 2020). This plant is renowned for its ability to effectively remove volatile organic pollutant from the air (Govaerts, 2012; Yang *et al*., 2009).

Figure 1(a-c): Images of *Tradescantia pallida* (Huq, 2015).

Aims and Objectives

The aim of the study "Exploring the efficacy of a potent corrosion suppressant derived from *Tradescantia pallida* (Purple Heart) leaves: A qualitative assessment" is to investigate the effectiveness of using the extract from *Tradescantia pallida* leaves as a natural corrosion suppressant. The study aims to assess the potential of this eco-friendly alternative for preventing corrosion in various applications. The objectives of the study are as follows:

1. To collect and analyze extract of *Tradescantia pallida* leaves to determine the functional groups present and identify any corrosion-inhibiting properties.
2. To conduct laboratory experiments and qualitative assessments to evaluate the efficacy of the corrosion suppressant derived from *Tradescantia pallida* leaves.
3. To compare the performance of the natural corrosion suppressant with existing commercial corrosion inhibitors in terms of effectiveness and cost-efficiency.
4. To assess the environmental impact and sustainability of utilizing *Tradescantia pallida* leaves as a corrosion suppressant, considering factors such as availability, renewability, and biodegradability.
5. To explore potential applications for the natural corrosion suppressant derived from *Tradescantia pallida* leaves in different industries, such as transportation, infrastructure, and manufacturing.
6. To provide recommendations and insights for further research and development of *Tradescantia pallida* leaf-based corrosion suppressants, including potential modifications or combinations with other materials for enhanced effectiveness. By addressing these objectives, the study aims to contribute to the understanding of using natural resources like Tradescantia leaves as a viable solution for corrosion control, offering potential benefits in terms of sustainability, cost-effectiveness, and environmental impact.

Significance of the Research

Exploring the efficacy of a potent corrosion suppressant derived from *Tradescantia pallida* (Purple Heart) leaves is an intriguing topic. Corrosion is a significant global challenge that affects various industries, infrastructure, and even the environment. By investigating the potential of using a natural resource like Tradescantia leaves as a corrosion suppressant, we can align it with several United Nations Sustainable Development Goals (SDGs). Here are a few ways this research can contribute:

1. SDG 9: Industry, Innovation, and Infrastructure: By developing a natural corrosion suppressant, this research promotes innovation in materials science and contributes to the improvement of infrastructure durability.

2. SDG 12: Responsible Consumption and Production: Utilizing *Tradescantia pallida* leaves as a corrosion suppressant aligns with sustainable and eco-friendly approaches. It encourages the use of natural resources as alternatives to harmful chemicals, promoting responsible consumption and production practices.

3. SDG 13: Climate Action: Corrosion in various industries contributes to greenhouse gas emissions and environmental degradation. By effectively suppressing corrosion with a natural resource, we can reduce the environmental impact and work towards mitigating climate change.
4. SDG 17: Partnerships for the Goals: Collaboration between researchers, industry experts, and policymakers is crucial for implementing and scaling up the use of natural corrosion suppressants. This research topic can foster partnerships to collectively work towards achieving the SDGs. Overall, exploring the efficacy of a corrosion suppressant derived from *Tradescantia pallida* leaves not only addresses the significance of corrosion control but also aligns with the broader global goals of sustainable development.

2. Experimental Methods

2.1 Materials preparation

Low carbon steel sheets were obtained from the Engineering Workshop of the Department of Mechanical Engineering, Federal University of Technology, Owerri (FUTO). They were mechanically cut into coupons of dimension 30 mm × 15 mm × 1 mm and each was perforated with a hole of 2.5 mm diameter to allow hanging into the hostile solution with polymeric thread in the gravimetric experiments. The test coupons were then polished and cleaned using emery paper, degreased in absolute ethanol, dried using acetone, weighed and then stored in a moisture-free desiccator prior to use (Oguzie *et al.*, 2004). The hostile acid solution was prepared by taking 27.2 ml research grade concentrated sulphuric acid of 98% certified percent purity and specific gravity of 1.84, and diluting it to mark in a standard 1.0 litre volumetric flask using double-distilled water. Locally harvested and authenticated mature *Tradescantia pallida* leaves (TPL) were washed and dried indoors to a constant weight and then ground to fine powder. Exactly 20.0 g of this powder was put into 500 ml of the hostile solution (0.5 M H_2SO_4) in a round bottom flask and heated under reflux for 2 hours and left to cool overnight. The stock inhibitor solution was obtained by filtration and used to prepare five inhibitor test solutions of concentration 0.5, 1.0, 1.5, 2.0 and 2.5 g L^{-1} respectively.

2.2 Fourier Transform Infrared (FTIR) Characterization

Buck scientific M530 USA FTIR was used for the analysis. This instrument was equipped with a detector of deuterated triglycine sulphate and beam splitter of potassium bromide. The software of the Gram A1 was used to obtain and manipulate the spectrum. Approximately1.0 g of the sample was taken and 0.5 ml Nujol was added. They were mixed thoroughly and placed on a salt pellet. During measurement, FTIR spectra was obtained at frequency region 4000 – 600 cm^{-1} and co-added at 32 scans and at 4 cm^{-1} resolution (Weerd *et al.*, 2004).

2.3 Weight Loss Experiments

Five Erlenmeyer flasks of 250 ml capacity with stoppers were used as the corrosion cells. These were filled with 150 ml of the hostile acid solution and TPL inhibitor test solutions were added to the cells in an increasing concentration range from 0.5 – 2.5 g L^{-1} at approximately 27 ^{0}C. A sixth flask of the same capacity contained only the acid solution and this served as the control experiment. With polymeric thread, the prepared and weighed low carbon coupons were fully immersed inside the six corrosion cells which were thereafter covered with the stoppers in order to stimulate an anaerobic environment. The coupons were retrieved after 3 days, washed appropriately with the aid of brittle brush inside water to remove corrosion products, degreased with absolute ethanol, dried in acetone and re-weighed. The weight loss of each test coupon was taken to be the difference between the initial weight before total immersion and the final constant weight after the removal of corrosion products. This procedure was repeated with fresh set of coupons of the same dimensions at an elevated temperature of 60^{0}C to determine the temperature effect on the corrosion rate. To ensure reproducibility, triplicate gravimetric measurements were taken, averaged and used in subsequent calculations as described elsewhere (Ekpe *et al.*, 1995; Umoren *et al.*, 2008). The weight losses of the test coupons were converted to corrosion rate (R) in $mm\ yr^{-1}$, according to equation 1 below;

$$R = \frac{K\Delta W}{At\rho} \quad (1)$$

where K is a constant with value 8.76 x 10^4. This constant is a factor that converts $cm\ hr^{-1}$ to $mm\ yr^{-1}$ (note, 1 cm hr^{-1} is equal to 87,658.1277 millimeters per year). ΔW is the weight loss in g of the test coupon, A is the total surface area of test coupon determined to the nearest 0.01 cm^2, t is the exposure time (duration of immersion) in *hour*, and ρ is the density of the test coupon in $g\ cm^{-3}$.
The total surface area (TSA) of the coupons was calculated as the total surface area of a cuboid minus area of the drilled cylindrical hole *i.e.,*

$$\text{TSA of metal coupon} = 2[LW + LH + WH] - [\frac{\pi d^2}{2} + \pi dH] \quad (2)$$

where L = length of coupon, W = width of coupon, H = height or thickness of coupon, d = diameter of drilled hole in the coupon.
With L, W, H and d retaining their usual meanings described above, the volume of the coupons was calculated using the expression given in equation (3) as;
Volume of coupon = Volume of a cuboid – Volume of drilled cylindrical hole

$$i.e.\ V = LWH - [\pi r^2 H] \text{ or } LWH - [\frac{\pi d^2 H}{4}] \quad (3)$$

The density, ρ, of each coupon was determined as mass per unit volume, using the initial weight of each coupon before immersion according to equation 4 below.

$$\rho = \frac{m}{V} \quad (4)$$

From the corrosion rate, the percent inhibition efficiency (%IE) of the organic molecules contained in the plant extract was determined using equation 5 below.

$$\%IE = \left[\frac{R_0 - R_i}{R_0}\right] x\ 100 \quad (5)$$

Where R_0 and R_i are the corrosion rate in the absence and presence of the inhibiting molecules, respectively. One assumption in the calculation of degree of surface coverage is that corrosion on the metal surface occurs in the inhibitor uncovered sites, such that covered sites experience zero corrosion rate. The degree of surface coverage (θ) of TPL inhibitor system on the substrate in 0.5 M H_2SO_4 was calculated using Eq. 6 (Oguzie *et al.*, 2004), thus;

$$\theta = \left[\frac{R_0 - R_i}{R_0}\right] \quad (6)$$

3. Results

3.1 Weight loss, Corrosion Rates, Surface coverage and Inhibition Efficiency

The results of weight loss measurements, corrosion rate, percent inhibition efficiency of the extract and surface coverage using TPL extract at 303 K (27^{0}C) and at 333 K (60^{0}C) are presented in Tables 1 and 2 respectively for low carbon steel corrosion in 0.5 M H_2SO_4 solution.

Table 1: Weight losses, corrosion rate, inhibitor efficiency and surface coverage for low carbon steel corrosion in 0.5 M H_2SO_4 solution in the absence and presence of TPL extract at 27 ^{0}C

TPL Extract conc. (g L^{-1})	Weight of test coupon (g)		Weight Loss, ΔW (g)	R (mm/yr)	%IE	Surface Coverage, θ
	0 hr	72hr				
0.0	4.59	2.91	1.68	20.380	–	–
0.5	4.62	4.50	0.12	1.446	92.91	0.929
1.0	4.60	4.49	0.11	1.332	93.46	0.935
1.5	4.58	4.48	0.10	1.216	94.40	0.944
2.0	4.55	4.46	0.09	1.102	94.59	0.946
2.5	4.61	4.54	0.07	0.846	95.85	0.959

Table 2: Weight losses, corrosion rate, inhibitor efficiency and surface coverage for low carbon steel corrosion in 0.5 M H_2SO_4 solution in the absence and presence of TPL extract at 60 ^0C

]	Weight of test coupon (g)		Weight Loss, ΔW (g)	R (mm/yr)	%IE	Surface Coverage, θ
	0 hr	72hr				
0.0	4.54	2.59	1.95	23.918	–	–
0.5	4.50	4.28	0.22	2.722	88.62	0.886
1.0	4.52	4.32	0.20	2.464	89.70	0.897
1.5	4.51	4.32	0.19	2.346	90.20	0.902
2.0	4.53	4.36	0.17	2.090	91.26	0.913
2.5	4.50	4.34	0.16	1.980	91.72	0.917

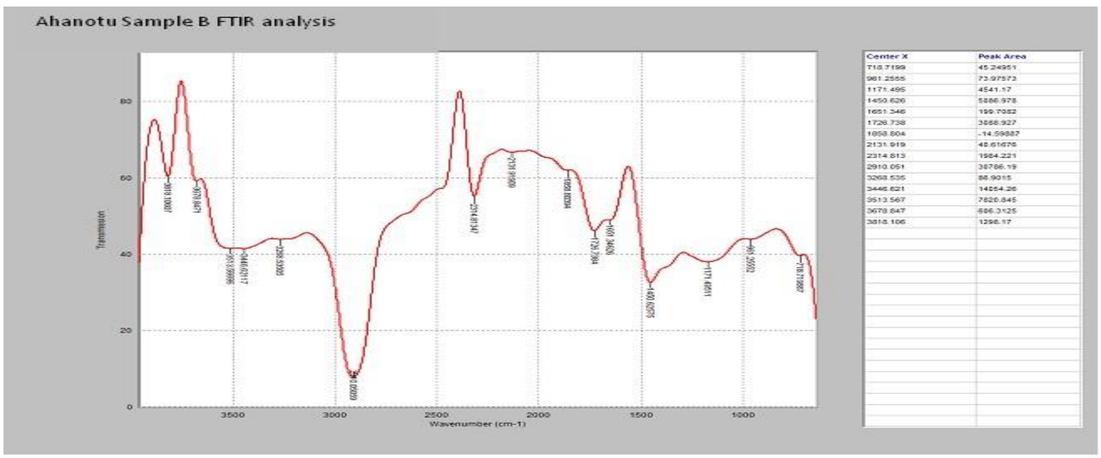


Figure 2: FTIR spectrum of TPL extract

4. Discussions

The evaluation of the performance of Tradescantia pallida leaf (TPL) extract in inhibiting the corrosion of low carbon steel coupons immersed in a 0.5 M sulphuric acid solution for a duration of 3 days at 27°C provides valuable insights into the effectiveness of the extract as a corrosion inhibitor. The weight loss measurements (ΔW) obtained from the initial and final weights of the low carbon steel coupons provide a quantitative assessment of the corrosion resistance offered by TPL extract. The lower the weight loss, the better the corrosion inhibition properties of the extract. From the data presented in Table 1, it is evident that the addition of TPL extract resulted in significantly reduced weight losses compared to the control (no extract). This indicates that the extract effectively protected the low carbon steel coupons from corrosion in the aggressive sulphuric acid environment. The corrosion rate (R) calculated from the weight loss data further supports the corrosion inhibiting potential of TPL extract. A lower corrosion rate corresponds to a higher level of corrosion protection. As observed in Table 1, the corrosion rate of low carbon steel decreased significantly with the addition of TPL extract at varying concentrations. This demonstrates the ability of the extract to effectively impede the corrosion process and preserve the integrity of the metal. The percent inhibition efficiency (%IE) provides a measure of the effectiveness of the TPL extract as a corrosion inhibitor. It quantifies the percentage reduction in corrosion rate achieved with the addition of the extract compared to the control. The data in Table 1 reveals substantial inhibition efficiencies ranging from 88.62% to 95.85% for different concentrations of TPL extract. These high inhibition efficiencies highlight the excellent corrosion inhibiting properties of the extract and its potential for industrial applications. The rate of surface coverage (Θ) is a critical parameter that characterizes the adsorption behavior of the corrosion inhibitor on the metal surface. A higher surface coverage indicates a greater degree of adsorption and protection.

The presence of functional groups such as OH, C=O, and aromatic rings in TPL extract, as identified in the study, suggests favorable interactions with the metal surface, leading to enhanced adsorption and surface coverage. These interactions contribute to the remarkable inhibition efficiencies observed. Overall, the evaluation of TPL extract using parameters such as weight losses, corrosion rates, percent inhibition efficiencies, and surface coverage demonstrates its strong potential as a corrosion inhibitor for low carbon steel in sulphuric acid solutions. The data obtained from this study provide a solid foundation for further investigations and optimization of TPL extract as an eco-friendly and sustainable corrosion mitigation strategy. Further research is recommended to explore the underlying mechanisms of corrosion inhibition by TPL extract, investigate its performance under different environmental conditions, and assess its long-term stability and compatibility with other corrosion prevention strategies. the results clearly indicate the significant impact of *Tradescantia pallida* leaf (TPL) extract on the corrosion rate of the low carbon steel coupons. The comparison between the control cell (blank) and the cell containing 0.5 g L-1 of TPL extract highlights the effectiveness of the extract as a corrosion inhibitor. In the control cell, a substantial mass loss of 1.68 g was observed, leading to a high corrosion rate of 20.380 mm/yr. This indicates the aggressive nature of the sulphuric acid environment on the low carbon steel, resulting in rapid corrosion and material loss. However, in the presence of 0.5 g L-1 of TPL extract, a remarkable reduction in weight loss was recorded. The addition of the extract resulted in a significantly lower weight loss of only 0.12 g, corresponding to a drastic decrease in the corrosion rate to 1.446 mm/yr. This demonstrates the strong corrosion inhibiting properties of TPL extract, as it effectively protected the low carbon steel from the corrosive attack of the sulphuric acid solution. The substantial decrease in corrosion rate observed upon the addition of TPL extract is a testament to its ability to form a protective barrier on the surface of the metal. This barrier hampers the corrosive reactions between the metal surface and the sulphuric acid, thereby reducing the corrosion rate and preserving the integrity of the low carbon steel. These findings highlight the promising potential of TPL extract as a highly effective and environmentally friendly corrosion inhibitor for low carbon steel in sulphuric acid environments. Further investigations can explore the optimization of the extract concentration, as well as assess its performance under different experimental conditions, to fully unlock its corrosion inhibition capabilities. The high percent inhibition efficiency of 92.91% at the concentration of 0.5 g L-1 of *Tradescantia pallida* leaf (TPL) extract reflects its excellent performance in suppressing the corrosion of the low carbon steel coupons. The extract demonstrated remarkable effectiveness in inhibiting the corrosion process, resulting in a significant reduction in the corrosion rate. As the concentration of TPL extract was increased from 0.5 g L-1 to 2.5 g L-1, a corresponding decrease in the corrosion rate was observed. The corrosion rate dropped significantly to 0.846 mm/yr at the highest concentration of 2.5 g L-1. This indicates that higher concentrations of TPL extract provide enhanced corrosion protection, leading to a notable decrease in the rate of corrosion. Furthermore, the percent inhibition efficiency increased proportionally with the higher concentration of TPL extract. At 2.5 g L-1 of the extract, the percent inhibition efficiency reached an impressive value of 95.85%. This signifies the extract's ability to effectively inhibit the corrosion process and provide a high level of protection to the low carbon steel coupons. These results demonstrate the concentration-dependent behavior of TPL extract as a corrosion. Hence, TPL extract can be described as a very potent, reliable and benign inhibitor that could be deployed to protect low carbon steel substrates from acid attack.

At a higher temperature of 60^0C, similar results were observed and recorded as seen in Table 2. It was observed that the corrosion rate was higher at 60^0C relative to the results obtained at 27^0C without and with the TPL extract additive. This is understandable because it has been established elsewhere that for some inhibitors, corrosion rate decreases and inhibition efficiency increases with increase in the concentration of the inhibitor but both parameters increase and decreases at elevated temperatures (Ahanotu *et al.*, 2022; Solomon *et al.*, 2021; Umoren *et al.*, 2021; Onyeachu *et al.*, 2020; Madueke and Iroha, 2018). Consequently, at 60^0C, the corrosion rate of 23.918 mm/yr was recorded in the absence of the TPL extract (blank) and 2.722 mm/yr at 0.5 g L^{-1} resulting to a percent inhibition efficiency of 88.62%. Temperature effects, however, did not negate the concentration effect of the inhibiting organic molecules, hence the corrosion rate of 1.980 mm/yr was recorded at 2.5 g L^{-1} of the TPL extract, producing a percent inhibition efficiency of 91.72%. It has been reported that decrease in surface coverage and protection efficiency of inhibitors with increase in temperature is often an indication that the inhibitor molecules and the metal surface interacted by physisorption mechanism involving electrostatic interaction between charged molecues (Madueke and Iroha, 2018). Therefore, *Tradescantia pallida* leaf extract could actually function as an effective inhibitor to suppress the corrosion of low carbon steel in an acid environment.

3.2 FTIR Characterization

Available reports on literature reveals that *Tradescantia pallida* leaves are rich in flavonoids, tannins, alkaloids, and terpenoids. These plant secondary metabolites have active OH functional group and aromatic rings (Huq, 2015). This is an agreement with the FTIR spectrum shown in Figure 2. The spectrum a reveal the prominent functional groups contained in the sample. The absorption band at 3600 – 3450 cm^{-1} indicates O-H stretch of an alcohol or phenol. The strong band at 2950 – 2850 cm^{-1} indicates sp^3 (saturated) C-H stretch of an aliphatic chain, the band at 1729 cm-1 represents a C=O stretch of an aldehyde while the band at 1450 cm_{-1} indicates C=C stretch of an aromatic ring.

The heteroatom (oxygen) present in the OH functionality and the pi electron system of the aromatic rings play significant role *via* synergistic effect in enhancing the adsorption of the inhibitor molecules on metallic substrates, creating a barrier that suppresses the corrosion reaction (Gruyter, 2021; Eddy *et al*., 2012).

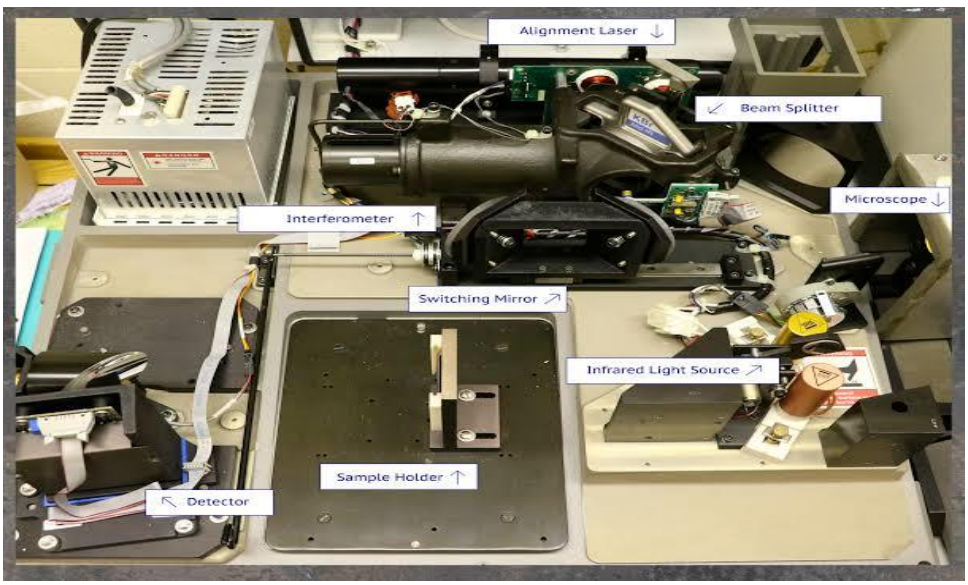
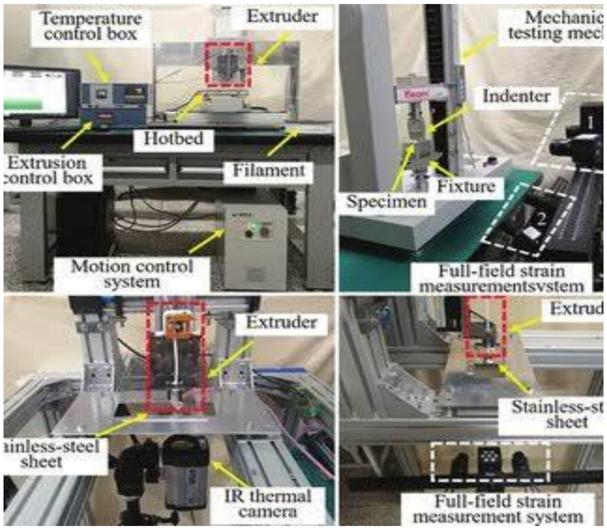


Fig 3: Mechanical Text Machines



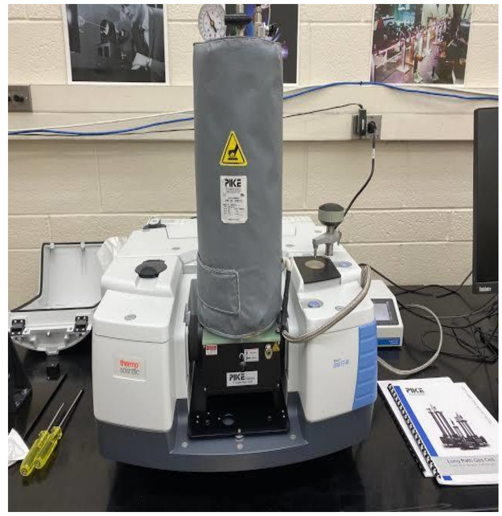


Fig 4:Application of Samples of Mechanical Text Machines of FTIR

Fig 5: Advanced Physics Lab FTIR

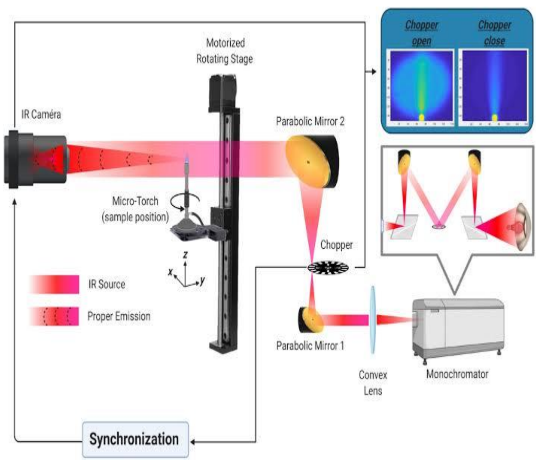


Fig 6: Applications

Fig 7: FTIR Spectroscopy Lab Analysis

Conclusion

In conclusion, this study has successfully explored the corrosion resistance properties of *Tradescantia pallida* leaf (TPL) extract as a potential corrosion inhibitor for low carbon steel in an acid environment. The results demonstrated that TPL extract exhibits remarkable effectiveness in protecting low carbon steel from acid attack, particularly in the challenging conditions of 0.5 M sulphuric acid. The inhibitor showed potent corrosion inhibition capabilities, significantly reducing the corrosion rate and exhibiting high inhibitor efficiencies ranging from 88.62% to 95.85%, depending on the dosage and temperature. Moreover, the presence of functional groups such as OH, C=O, and aromatic rings in TPL extract suggests a physisorption mechanism, facilitating the adsorption of inhibitor molecules onto the metal surface. This knowledge opens up possibilities for further optimization and modification of TPL extract to enhance its performance as a sustainable and environmentally friendly corrosion inhibitor. Overall, this research establishes *Tradescantia pallida* leaf extract as a promising and benign alternative for protecting low carbon steel in hostile acid environments. Further studies are encouraged to explore the long-term stability, compatibility, and cost-effectiveness of TPL extract in practical applications, as well as to investigate its performance under various corrosive conditions and in combination with other corrosion mitigation techniques. The findings of this study provide compelling evidence that increasing the concentration of *Tradescantia pallida* leaf (TPL) extract enhances the efficiency of the inhibiting molecules present in the extract. This correlation suggests that the corrosion resistance capabilities of TPL extract in protecting low carbon steel from dissolution in sulphuric acid solution at the specified temperatures significantly improve with higher extract concentrations.

The dose-dependent behavior of TPL extract highlights its potential for customization and optimization, allowing for the development of tailored corrosion inhibition strategies. By adjusting the concentration of TPL extract, it becomes possible to achieve higher levels of protection against corrosion, thereby extending the lifespan and durability of low carbon steel in hostile acid environments.

These results underscore the significant potential of TPL extract as a sustainable and environmentally friendly corrosion inhibitor for industrial applications. The use of natural extracts, such as TPL, not only offers effective corrosion protection but also aligns with the growing emphasis on eco-friendly alternatives in the field of corrosion control.

In conclusion, this research demonstrates the efficacy of *Tradescantia pallida* leaf extract as a potent and customizable corrosion inhibitor for low carbon steel in sulphuric acid solutions. Further investigations should focus on exploring the underlying mechanisms governing the corrosion inhibition process, optimizing the extract concentration, and evaluating the long-term performance and compatibility of TPL extract in practical applications.

The temperature effect observed in this study revealed a clear relationship between the temperature of the aggressive environment and the rate of corrosion, as well as the percent inhibition efficiency of *Tradescantia pallida* leaf extract (TPLE). As the temperature increased, the rate of corrosion of low carbon steel also increased, while the percent inhibition efficiency decreased. This behavior strongly suggests that a physisorption mechanism is at play in the corrosion inhibition process. Further investigation into the composition of TPLE revealed the presence of various functional groups, including OH, C=O, and aromatic rings, among others. These functional groups have been well-documented for their effectiveness in enhancing the adsorption of inhibitor molecules onto metallic substrates. The presence of these functional groups in TPLE further supports the physisorption mechanism observed in this study. The combination of the temperature effect and the presence of these functional groups in TPLE highlights the complex interplay between temperature and molecular interactions in corrosion inhibition. This knowledge opens up avenues for future research to delve deeper into the specific mechanisms that govern the adsorption behavior of TPLE on low carbon steel surfaces under different temperature conditions. In conclusion, this study has shed light on the temperature effect and the presence of functional groups in *Tradescantia pallida* leaf extract, demonstrating their role in the physisorption mechanism and their potential to enhance the adsorption of inhibitor molecules on metallic substrates. Further research is warranted to gain a comprehensive understanding of the temperature-dependent behavior and to optimize the application of TPLE as a corrosion inhibitor in various temperature ranges and industrial settings.

Recommendation

Based on the study "Exploring the efficacy of a potent corrosion suppressant derived from *Tradescantia pallida* (Purple Heart) leaves: A qualitative assessment," here are some recommendations aligned with the United Nations Sustainable Development Goals (SDGs):

1. **Recommendation aligned with SDG 9:** Industry, Innovation, and Infrastructure: - Further research should be conducted to optimize the extraction process of the corrosion suppressant derived from *Tradescantia pallida* leaves, enhancing its efficiency and scalability. - Collaboration between researchers, industry experts, and infrastructure developers should be facilitated to explore the integration of *Tradescantia pallida* leaf-based corrosion suppressants in various infrastructure projects.

2. **Recommendation aligned with SDG 12:** Responsible Consumption and Production: - Promote awareness and education about the benefits of using natural corrosion suppressants derived from *Tradescantia pallida* leaves to encourage responsible consumption and production practices. -

Encourage industries to adopt sustainable practices by considering the use of eco-friendly corrosion suppressants as alternatives to chemical-based inhibitors.

3. **Recommendation aligned with SDG 13:** Climate Action: - Conduct a life cycle assessment of *Tradescantia pallida* leaf-based corrosion suppressants to evaluate their carbon footprint and environmental impact compared to traditional corrosion inhibitors. - Advocate for the adoption of natural corrosion suppressants as a climate-friendly solution to reduce greenhouse gas emissions associated with corrosion prevention.

4. **Recommendation aligned with SDG 17:** Partnerships for the Goals: - Foster collaborations between academia, industry, and government agencies to drive the development, standardization, and implementation of *Tradescantia pallida* leaf-based corrosion suppressants on a wider scale. - Establish partnerships between corrosion control experts and sustainable development organizations to raise awareness about the benefits of using natural resources for corrosion prevention. By following these recommendations and aligning them with the respective SDGs, the study can contribute to sustainable development efforts, promote responsible consumption and production practices, reduce environmental impact, and foster partnerships for achieving the SDGs.

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