

## Research Article

### Corrosion Inhibition of Mild Steel by Various Plant Extracts in Acid Media

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**Abstract:** The aim of this study is to investigate the corrosion inhibition of some plant extracts on mild steel in selected media. The plant extracts investigated are Okazi leaf (*Gnetum africanum*), Utazi leaf (*Gongronema latifolium*) and Elizabeth leaf (*Chromolena odoratum*). The selected media are 1M HCL and H<sub>2</sub>SO<sub>4</sub> and the corrosion rate on the mild steel was investigated using mass loss method. Results were obtained at intervals of 24, 48, 72 and 96 h, respectively. The corrosion rate and inhibition efficiency were calculated. The results revealed that Elizabeth leaf (*Chromolena odoratum*) has the best inhibition efficiency on mild steel followed by Okazi leaf (*Gnetum africanum*) and Utazi leaf (*Gongronema latifolium*) which also showed good inhibition efficiency.

**Keywords:** Acid media, corrosion inhibition, elizabeth leaf (*Chromolena odoratum*), mild steel, okazi leaf (*Gnetum africanum*), utazi leaf (*Gongronema latifolium*), weight loss

## INTRODUCTION

The corrosion of metals is an unavoidable but controllable process. In many industries corrosion cost billions of dollars each year for prevention, replacement and maintenance (Roberge, 2008). Acid solutions are widely used in acid pickling and industrial cleaning. Hydrochloric acid and sulphuric acid are widely used for this purpose and most acid media cause metal corrosion (Bentiss *et al.*, 2006; Khaled and Hackerman, 2003; Quraishi and Sardar, 2003). To avoid the attack of acid to the metal, inhibitors are generally added. Corrosion inhibitors are substances which when added in small concentrations to corrosive media decrease or prevent the reaction of the metal with the media. It has been observed that adsorption depends mainly on certain physicochemical properties of the inhibitor group such as functional groups, electron density at the donor atom,  $\pi$ -orbital character and the electronic structure of the molecule. Though many synthetic compounds showed good anticorrosive activity, most of them are highly toxic to both human beings and environment (Raja and Sethuraman, 2008). The known hazardous effects of most synthetic corrosion inhibitors are the motivation for the use of some natural products as corrosion inhibitors. Plant extracts have become important because they are environmentally acceptable, inexpensive, readily available and renewable. Moreover, they can be extracted by simple procedures with low cost. Plants are source of naturally occurring compounds and are mostly known to have inhibition action, some with complex molecular structure and

having different chemicals, biological and physical properties. Their extracts have become important and studies reveal that most organic compounds especially those with nitrogen, sulphur, phosphorous and oxygen show significant inhibition efficiency (Bellaouchou *et al.*, 2001; Muñoz *et al.*, 2010; Ameer and Fekry, 2010; Ameer *et al.*, 2002; Khamis *et al.*, 2000).

Several corrosion inhibition studies of mild steel by plant extracts in acidic media has been carried out and reported. Hui *et al.* (2012) has proved the use of herbs as new type of green inhibitors for acidic corrosion of steel.

Elyn Amira *et al.* (2011) have contributed significantly to the green mitigation by investigating several plants and their different body parts as corrosion inhibitors. Most researchers are focusing on natural products as corrosion inhibitors viz., *Gossipium hirsutum* L. (Arukalam and Obidiegwu, 2011), *Cola acuminata* and *Camellia sinensis* (Loto and Popoola, 2012), *Citrullus vulgaris* Peel (Petchiammal *et al.*, 2012) and *Rograpis paniculata*, *Jatropha curcas* (Deepa Rani and Selvaraj, 2012), *Stevia rebaudiana* (Nnabuk *et al.*, 2012), *Hibiscus sabdariffa* calyx (Khalid Hasan and Edrah, 2011) Rosemary Extract (Taleb and Mehad, 2011) Eggplant Peel (Vinod Kumar *et al.*, 2011), *Psidium guajava* (Nnanna *et al.*, 2010) *Azadirachta indica* (Eddy and Mamza, 2009), *Strychnos nuxvomica* (Singh *et al.*, 2010). Okazi leaf (*Gnetum africanum*) is traditionally a wild vine and is considered to be a wild vegetable. It is widely distributed in Nigeria, Cameroun, Central Africa Republic, Equitorial Guinea and Gabon. This vegetable

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is important ingredients in preparing soup in many homes in the South-south and Southeast of Nigeria. Utazi leaf (*Gongronema latifolium*) is an herbaceous shrub, with flowers usually yellow and the stem yields characteristic milky exudates. It is commonly grown in Nigeria and is locally called utasi by the Efiks, Ibibios and Quas; utazi by the Igbos and Arokeke by the Yorubas. The Efiks and Quas in Cross River State of Nigeria use *Gongronema latifolium* leaf extract in the treatment of malaria, laxative, diabetes and hypertension. Elizabeth leaf (*Chromolaena odorata*) belongs to the family Asteraceae. Its common names in Nigeria include "Awolowo", "Independence weed", Siam weed, trifid weed, bitter bush. It is a rapidly growing perennial herb. It is a multi-stemmed shrub up to 2.5 m tall in open areas. It has soft stems but the base of the shrub is woody. In shady areas it becomes etiolated and behaves as a creeper, growing on other vegetation. It can then become up to 10 m tall. The plant is hairy and glandular and the leaves give off a pungent, aromatic odour when crushed. This study aims to find an environmentally safe and inexpensive inhibitor for the corrosion of mild steel in acidic media and the weight loss technique was used to calculate the inhibition efficiency and correction rate.

## MATERIALS AND METHODS

The steel rod was tested in the present study with a length of 50 mm and a diameter of 12 mm. The test aqueous solutions contained HCL and H<sub>2</sub>SO<sub>4</sub> with 1 M concentrations. Triple distilled water was used for preparing all solutions. In all measurements, mechanically polished electrode was used. Polishing was affected using successively finer grade of emery papers (600-1200 grade). About 25 g of dried and powdered leaves of each plant; Okazi leaf (*Gnetum africanum*), Utazi leaf (*Gongronema latifolium*) and Elizabeth leaf (*Chromolena odaratum*) were refluxed with ethanol for about 5 h and was kept overnight to completely extract the basic components. The insoluble residues were removed and the ethanol evaporated. The resultant material obtained was dried, powdered and weighed accurately by digital micro-balance. From the weight of extracted mass as above, different concentrations of 5, 10, 15 and 20 mL, respectively of the plant extracts were separately put into four beakers. The first beaker was kept plain, without any extract addition (control experiment). Twenty pieces of the steel rod were then weighed for initial weight and immersed in each of the 1M HCL and H<sub>2</sub>SO<sub>4</sub> concentration. Four coupons were then suspended with rope in each of the beakers and were left for various time intervals (24, 48, 72 and 96 h, respectively). This process was repeated for the Utazi leaf (*Gongronema latifolium*) and Elizabeth leaf (*Chromolena odaratum*) extracts. The above procedure was also carried out for mild. The weight loss was used to calculate the Corrosion Rate (CR) in milligrams per square centimeter per hour.

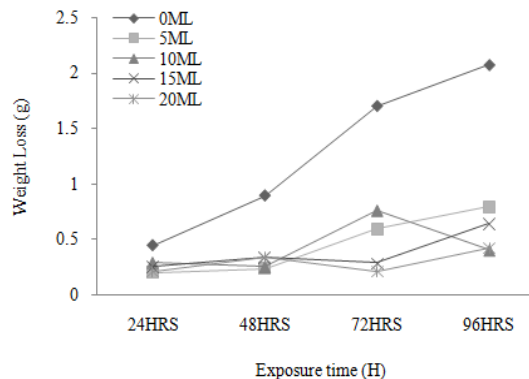


Fig. 1: Variation of weight loss with exposure time for okazi leaf (*Gnetum africanum*)

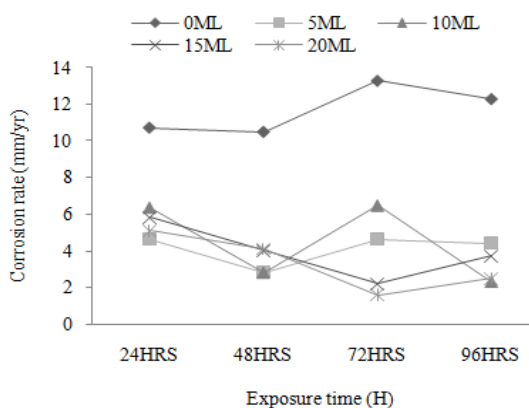


Fig. 2: Variation of corrosion rate with exposure time for okazi leaf (*Gnetum africanum*)

## RESULTS AND DISCUSSION

**Okazi leaf (*Gnetum africanum*) in 1M HCL for mild steel:** The results obtained for the variation of weight loss with exposure time for the mild steel specimens immersed in 1 M HCL with varied concentrations of added Okazi leaf (*Gnetum africanum*) extract is presented Fig. 1.

The result obtained show a great value of weight loss for the test media without *Gnetum africanum* extract. The addition of *Gnetum africanum* extract to the test media resulted in reduction of weight loss. The difference in weight loss for the test media with and without *Gnetum africanum* extract was not much for the 24 h interval, but from 24 to 96 h there was an increase in weight loss for the media without *Gnetum africanum* extract (control experiment) and a decrease in weight loss for the media with *Gnetum africanum* extract. The *Gnetum africanum* extract shows a good inhibition behavior on the weight loss of mild steel in 1M hydrochloric acid. These results are consistent with those reported by Obiukwu *et al.* (2013).

Figure 2 shows the variation of corrosion rate with exposure time for mild steel immersed in 1M HCL and addition of different concentrations of okazi leaf (*Gnetum africanum*). Corrosion rates were very slow

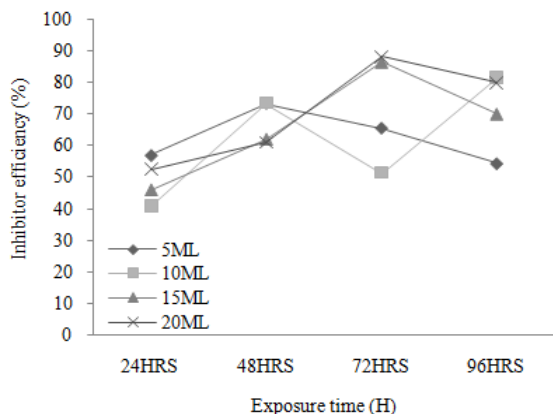


Fig. 3: Variation of inhibitor efficiency with exposure time for okazi leaf (*Gnetum africanum*)

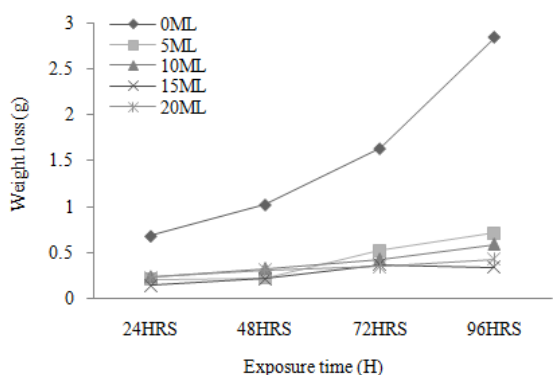


Fig. 4: Variation of weight loss with exposure time for okazi leaf (*Gnetum africanum*)

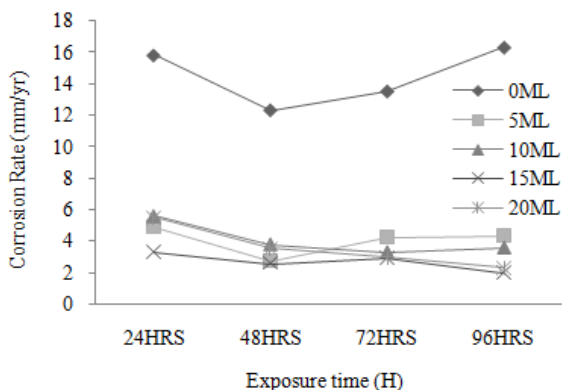


Fig. 5: Variation of corrosion rate with exposure time okazi leaf (*Gnetum africanum*)

with the four different *Gnetum africanum* extract concentrations achieving values ranging from 4.63, 2.80, 4.60 and 4.40 mm/year (for 5 mL), 6.38, 2.80, 6.50 and 2.30 g (for 10 mL), 5.82, 4.00, 2.20 and 3.70 mm/year (for 15 mL) to 5.10, 4.10, 1.60 and 2.50 mm/year (for 20 mL). The control experiment gave higher corrosion rate values throughout the experimental period. These results confirm that plant

extract of the *Gnetum africanum* possesses corrosion-inhibiting property. It is not certain, however, whether the optimum concentration needed for more effective corrosion inhibition have been reached with any of the three concentrations used.

Figure 3 shows the graph of variation of inhibitor efficiency with exposure time. The highest inhibitor efficiency of 87.97 and 86.46% for the concentration of extracts was obtained with the 20 and 15 mL concentration of *Gnetum africanum* on after 72 h of the experiment but this came down to just 79.67 and 69.92%, respectively on after 96 h of the experiment. For the 5 mL concentration there was increasing inhibition efficiency for the 24-48 h and a decrease in the 72-96 h. The 10 mL concentration showed unstable inhibition efficiency throughout the experimental period.

**Okazi leaf (*Gnetum africanum*) corrosion inhibition in 1M H<sub>2</sub>SO<sub>4</sub> for mild steel:** The results obtained for the variation of weight loss 1M H<sub>2</sub>SO<sub>4</sub> is presented Fig. 4. From the graph, the control experiment has the highest magnitude of weight loss because *Gnetum africanum* extract was not added. The addition of *Gnetum africanum* extracts to the test medium reduced corrosion significantly throughout the experimental period. The results obtained for the 5, 10, 15 and 20 mL, respectively *Gnetum africanum* extract addition to the test medium all similar trend in weight loss, indicating that little extract concentration have inhibition effect. The results confirmed the very good effect of the *Gnetum africanum* solution extract on the corrosion inhibition of mild steel in 1M H<sub>2</sub>SO<sub>4</sub>.

Figure 5 shows the graph of variation of corrosion rate. The *Gnetum africanum* extracts addition to the test medium reduced corrosion rate significantly throughout the experimental period compared to the control experiment. The results obtained for the 5, 10, 15 and 20 mL, respectively *Gnetum africanum* extract addition to the test medium have close corrosion rate value. The results confirmed the effectiveness of the *Gnetum africanum* solution extract on the corrosion rate of mild steel in 1M H<sub>2</sub>SO<sub>4</sub>. The extract concentration of 15 mL addition appeared to be the best, having a weight loss value of 0.14, 0.21, 0.37 and 0.34 g and respectively for 24 to 96 h, respectively, followed by 20, 10 and 5 mL, respectively conc. of *Gnetum africanum*.

Figure 6 shows the graph of inhibitor efficiency for mild steel immersed in 1M H<sub>2</sub>SO<sub>4</sub> and addition of different concentrations of Okazi leaf (*Gnetum africanum*). The 15 mL concentration of *Gnetum africanum* extracts had the highest inhibitor efficiency at the 4<sup>th</sup> day (96 h) of the experiment achieving a value of 87.73%. The value of inhibition efficiency of 10 mL and 20 mL conc. *Gnetum africanum* extracts increased each day, from 24 to 96 h. The 15 mL conc. of *Gnetum africanum* extracts had same range of value from day 1 (24 h) to day 3 (72 h) and had a great increase in inhibition efficiency on the 4<sup>th</sup> day (96 h). The inhibition efficiency of 5 mL conc. of *Gnetum*

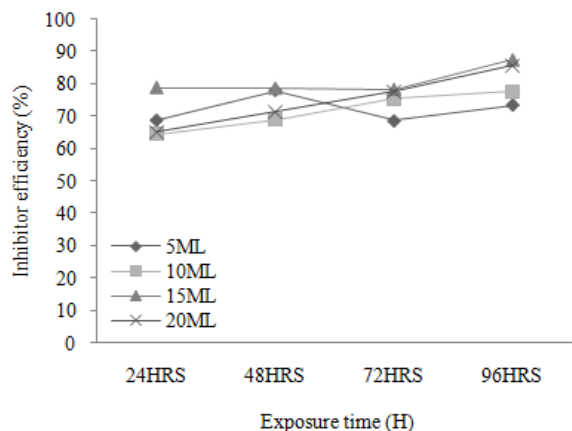


Fig. 6: Variation of inhibitor efficiency with exposure time okazi leaf (*Gnetum africanum*)

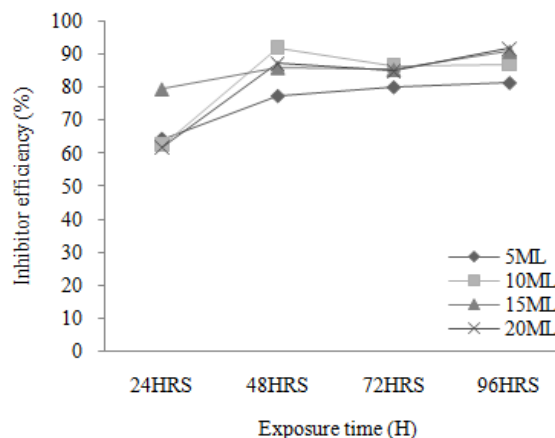


Fig. 9: Variation of inhibitor efficiency with exposure time for utazi leaf (*Gongronema latifolium*)

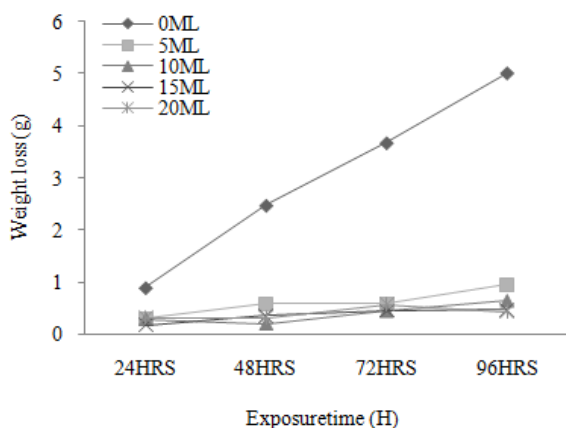


Fig. 7: Variation of weight loss with exposure time for utazi leaf (*Gongronema latifolium*)

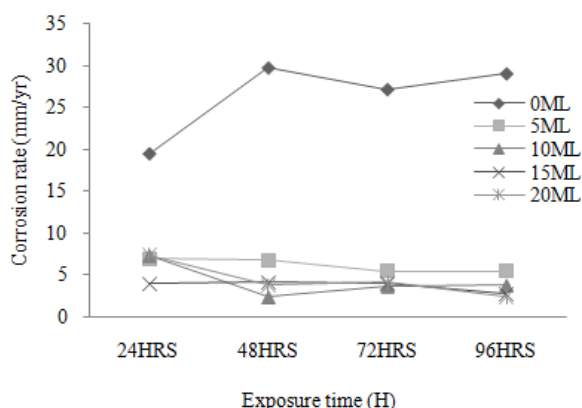


Fig. 8: Variation of corrosion rate with exposure time utazi leaf (*Gongronema latifolium*)

*africanum* extracts was unstable. It had an increase from the 1<sup>st</sup> day to the 2<sup>nd</sup> day, a decrease in inhibition efficiency from the 2<sup>nd</sup> day to the 3<sup>rd</sup> and from the 3<sup>rd</sup> day to the 4<sup>th</sup> day the inhibition efficiency increase. The different conc. of *Gnetum africanum* extracts showed

good inhibition efficiency throughout the duration of the experiment. Thus, *Gnetum africanum* extracts has good inhibition efficiency.

**Utazi leaf (*Gongronema latifolium*) corrosion inhibition in 1M H<sub>2</sub>SO<sub>4</sub> for mild steel:** The results obtained for the variation of weight loss, corrosion rate and inhibitor efficiency with exposure time, respectively for the mild steel specimens immersed in 1M H<sub>2</sub>SO<sub>4</sub> with varied concentrations of Utazi leaf (*Gongronema latifolium*) extract is presented Fig. 7 to 9.

Figure 7 shows the graph for the variation of weight loss. Low weight loss were achieved with the 5, 10, 15 and 20 mL, respectively concentrations of *Gongronema latifolium* extracts with values ranging from 0.46, 0.98, 1.30 and 1.66 g (for 5 mL), 0.45, 0.83, 1.55 and 1.80 g (for 10 mL), 0.54, 0.76, 1.35 and 1.67 g (for 15 mL) and 0.34, 0.77, 1.54 and 1.73 g (for 20 mL) at 24, 48, 72 and 96 h, respectively. The *Gongronema latifolium* concentration addition performed better than the control experiment where no extract was added throughout the experimental period. These results confirmed that the plant extract exhibited corrosion inhibition synergism and also proved effective in corrosion inhibition performance. From the graph the concentration with 15 mL concentration showed the best weight loss behavior. This was followed by the 20, 10 and 5 mL, respectively.

From Fig. 8, it can be observed that the highest corrosion rate for day 1 to 4 occurred at the media without *Gongronema latifolium* extract (control experiment). The media with *Gongronema latifolium* extract had a low corrosion rate compared with the values obtain from the control experiment from day1 to day 4. The media with 15 mL concentration of *Gongronema latifolium* plant extract had a closed range of corrosion rate throughout the period of the experiment. It had the least corrosion rate on the 1<sup>st</sup>, 3<sup>rd</sup> and 4<sup>th</sup> day, respectively of the experiment. The result of obtained through the experiment shows that 15 mL

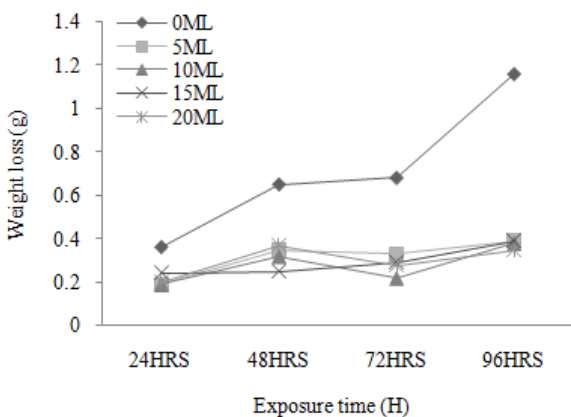


Fig. 10: Variation of weight loss with exposure time utazi leaf (*Gongronema latifolium*)

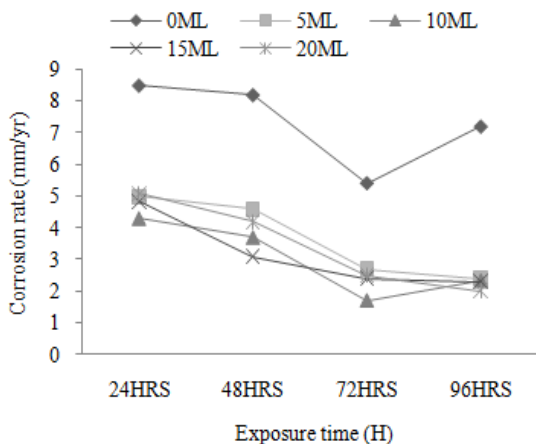


Fig. 11: Variation of corrosion rate with exposure time utazi leaf (*Gongronema latifolium*)

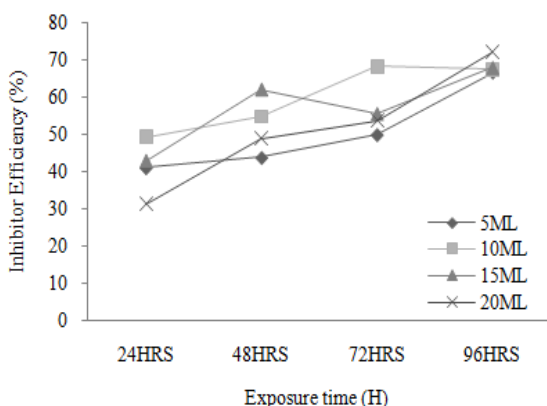


Fig. 12: Variation of inhibitor efficiency with exposure time for utazi leaf (*Gongronema latifolium*)

concentration of *Gongronema latifolium* had the least corrosion rate.

From Fig. 9, the inhibitor efficiency against exposure shows that the highest inhibition efficiency was recorded for 10 mL conc. of *Gongronema*

*latifolium* on the day 2 (48 h) of the experiment, before a sudden drop on the 3<sup>rd</sup> day of the experiment and maintained that range for the 4<sup>th</sup> day of experiment. The 15 mL conc. of *Gongronema latifolium* had the highest inhibition efficiency on the first day and maintained same range of value from 1<sup>st</sup> day to the 3<sup>rd</sup> day and had an increase on the last day of the experiment. Five milliliter and 20 mL concentration of *Gongronema latifolium* plant extract had an increased in inhibition efficiency from 1<sup>st</sup> day to the 4<sup>th</sup> day. *Gongronema latifolium* showed great inhibition efficiency in 1M sulphuric. The best conc. *Gongronema latifolium* of plant to be used in 1 M sulphuric acid media on mild steel is 15 mL conc. this is because it had a high value of inhibition efficiency during the period of the experiment.

**Utazi leaf (*Gongronema latifolium*) corrosion inhibition in 1M HCL for mild steel:** The results obtained for the variation of weight loss, corrosion rate and inhibitor efficiency with exposure time respectively for the mild steel specimens immersed in 1M HCL with varied concentrations of Utazi leaf (*Gongronema latifolium*) added extract is presented in Fig. 10 to 12.

Figure 10 shows the graph of weight loss against exposure time. The value of weight loss obtained from the control experiment was greater than those with *Gongronema latifolium* plant extract from the 1<sup>st</sup> day to the 4<sup>th</sup> day. The values increased with increase in days. From the result obtained, *Gongronema latifolium* plant extract was able to reduce the weight loss of mild steel in 1M hydrochloric acid. The different values obtained from the media with different concentration of *Gongronema latifolium* of plant extract showed that the least weight loss of 0.19 g occurred on the 1<sup>st</sup> day (24 h) of the experiment for the 10 mL concentration. The other concentrations of *Gongronema latifolium* have the same amount of weight loss from the 1<sup>st</sup> day to the 4<sup>th</sup> day of the experiment.

From Fig. 11, the graph of variation of corrosion rate shows that the corrosion rates are low. The plant extract concentrations achieved values which range from 5, 4.6, 2.7 and 2.4 mL for the 5 mL conc. of plant extract; 4.3, 3.7, 1.7 and 2.33 for 10 mL, 4.86, 3.1, 2.4, 2.3 for 15 mL, 5.1, 4.19, 2.5, 2 for 20 mL from 1<sup>st</sup> to 4<sup>th</sup> day, respectively. The control experiment without any extract addition gave higher corrosion rate values throughout the experimental period. These results confirm that the *Gongronema latifolium* possesses corrosion-inhibiting property. It is not certain, however, whether the optimum concentration needed for more effective corrosion inhibition have been reached with any of the three concentrations used.

From Fig. 12, the graph of inhibitor efficiency against exposure showed that the highest inhibition efficiency of 72.20% was recorded for 20 mL concentration of *Gongronema latifolium* on the 4<sup>th</sup> (96 h) which started with an efficiency of 31.41% on the 1<sup>st</sup> day of the experiment. The 5, 10 and 20 mL,



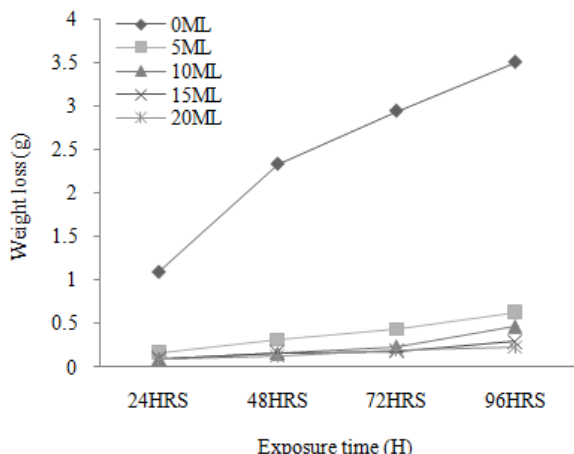


Fig. 13: Variation of weight loss with exposure time elizabeth leaf (*Chromolena odoratum*)

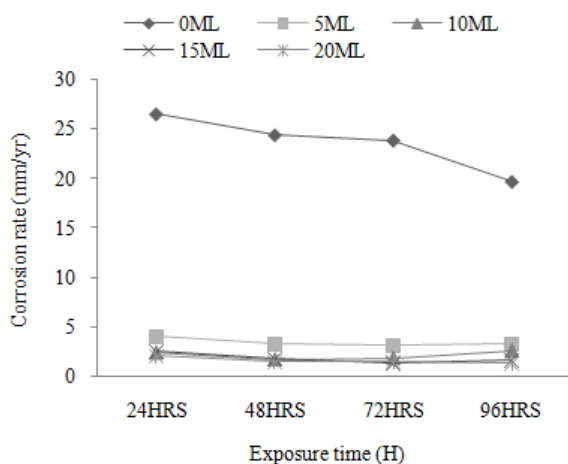


Fig. 14: Variation of corrosion rate with exposure time elizabeth leaf (*Chromolena odoratum*)

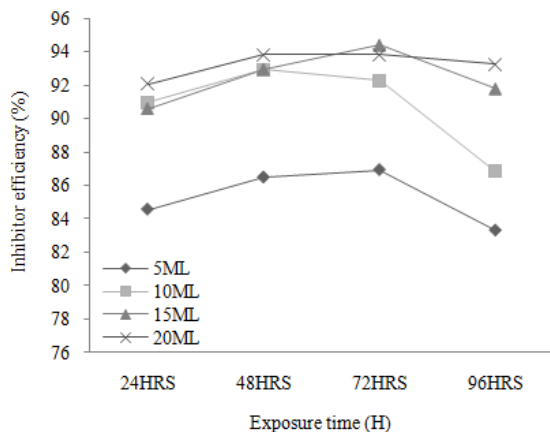


Fig. 15: Variation of inhibitor efficiency with exposure time elizabeth leaf (*Chromolena odoratum*)

respectively showed an increasing trend from the first day of the experiment down to the last day of the

experiment but that of the 15 mL showed an unstable trend pattern throughout the experimental period. At the last day of the experiment, the four concentration with the juice extract all fall within same range. From the result obtain it shows that the various concentration of *Gongronema latifolium* has good inhibition efficiency when used in 1M hydrochloric media on mild steel. But for more effective inhibition the 20 mL concentration of *Gongronema latifolium* is recommended.

**Elizabeth leaf (*Chromolena odoratum*) corrosion inhibition in 1M H<sub>2</sub>SO<sub>4</sub> for mild steel:** The results obtained for the variation of weight loss, corrosion rate and inhibitor efficiency with exposure time respectively for the stainless steel specimens immersed in 1M H<sub>2</sub>SO<sub>4</sub> with varied concentrations of Elizabeth leaf (*Chromolena odoratum*) added extract is presented Fig. 13 to 15.

From Fig. 13, the graph of the control experiment without *Chromolena odoratum* clearly shows highest weight loss throughout the experimental period. The media with *Chromolena odoratum* had a low weight loss from the 1<sup>st</sup> day to the 4<sup>th</sup> day. This shows that the *Chromolena odoratum* has a great influence in the weight loss of mild steel in 1M sulphuric acid. The various conc. of *Chromolena odoratum* plant extract used also showed an increase in weight loss with increase to exposure time. There was a decrease in weight loss with increase in conc. of *Chromolena odoratum* plant extract used. Therefore the 20 mL had the least weight loss for the different exposure time.

From Fig. 14, the graph of variation of corrosion rate shows control experiment without any *Chromolena odoratum* extract (0 mL) addition having the highest corrosion rate values, achieving 26.53, 24.42, 23.88 and 19.72 mm/year for 1<sup>st</sup> day to the 4<sup>th</sup> day respectively. The addition of the various concentrations of the *Chromolena odoratum* extract shows significant reduction in the recorded corrosion rate values, which indicate the magnitude of corrosion rate reduction. In this case, it can be said that a reasonable degree of corrosion inhibition of the test specimen in the acid medium was provided. Three different concentrations (10, 15 and 20 mL, respectively) of the *Chromolena odoratum* extract gave very close values of corrosion rate, however, the 5 mL *Chromolena odoratum* extract addition had a higher corrosion rate 4.09, 3.3, 3.12 and 3.31 (mm/year) from the 1<sup>st</sup> day to the 4<sup>th</sup> day, respectively. The least corrosion rate was recorded with the use of 20 mL conc. of *Chromolena odoratum* plant for mild steel when used in 1M sulphuric acid media.

Figure 15 shows the values of inhibitor efficiency against exposure time. The 15 mL concentration of *Chromolena odoratum* extract recorded the highest inhibition efficiency of 94.43% on the 3<sup>rd</sup> day of the experiment. The 20 mL conc. of *Chromolena odoratum*

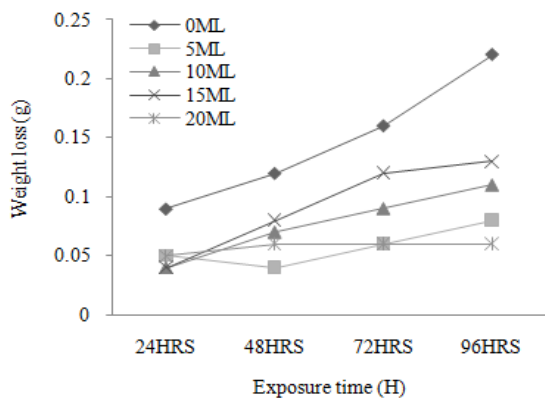


Fig. 16: Variation of weight loss with exposure time elizabeth leaf (*Chromolena odoratum*)

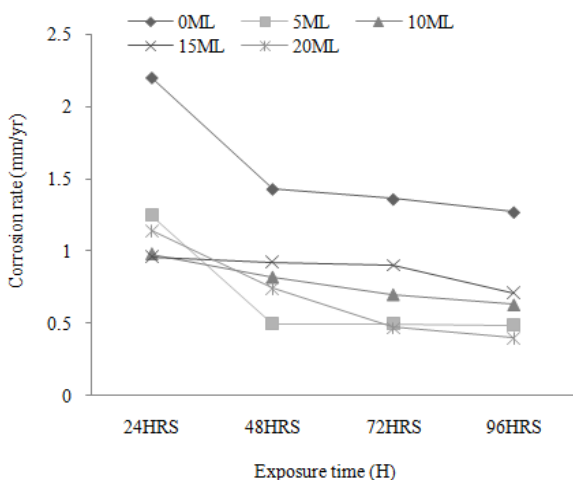


Fig. 17: Variation of corrosion rate with exposure time for elizabeth leaf (*Chromolena odoratum*)

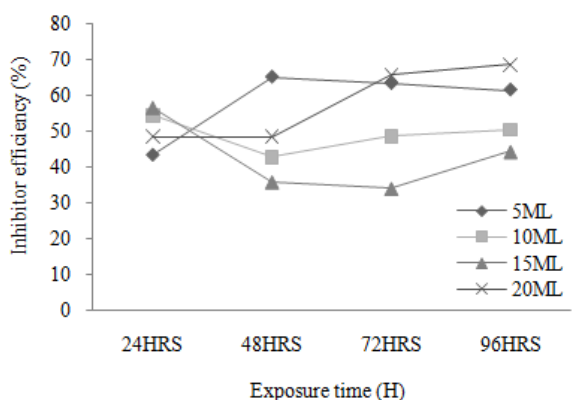


Fig. 18: Variation of inhibitor efficiency with exposure time for elizabeth leaf (*Chromolena odoratum*)

had the inhibitor efficiency of 92.03, 93.82 and 93.26%, respectively for the 1<sup>st</sup>, 2<sup>nd</sup> and 4<sup>th</sup> day, respectively. The drop of inhibition efficiency on the last day of the experiment could be associated with the weak test medium at that period due to its

weakening by the corrosion deposit which stifled the corrosion reactions. The inhibitor efficiency of the various *Chromolena odoratum* extract in 1M sulphuric acid can be arranged in increasing order from 5, 10, 15, 15 and 20 mL, respectively thus showing that 20 mL conc. of *Chromolena odoratum* the has the best inhibitor efficiency during the experimental period.

**Elizabeth leaf (*Chromolena odoratum*) corrosion inhibition in 1M HCL for mild steel:** The results obtained for the variation of weight loss, corrosion rate and inhibitor efficiency with exposure time respectively for the stainless steel specimens immersed in 1M HCL with varied concentrations of Elizabeth leaf (*Chromolena odoratum*) added extract is presented in Fig. 16 to 18.

The acid test medium with 20 mL concentration of *Chromolena odoratum* extracts addition showed the best weight loss inhibition effect of the immersed specimens as shown in Fig. 16. It achieved weight loss values of 0.05, 0.06, 0.06 and 0.06 g for the 24, 48, 72 and 96 h, respectively. For most days of the experimental period, the extract with 5 mL concentration addition to the test medium performed better than the 10 and 15 mL extract concentration addition, though it achieved a comparative lower weight loss value of 0.04 g on the 2<sup>nd</sup> day of the experiment. In general, an apparent corrosion inhibition of the test specimen was achieved when the results of the tests with the different extracts concentration addition were compared with the results of the tests performed without extracts addition.

Figure 17 shows the decreasing trend of the corrosion rate with the exposure time, an indication of the weakening of the test environment by the corrosion deposit, which stifled the corrosion reactions. It is known that the *Chromolena odoratum* are very astringent-a property which is associated with the presence of tannin. The presence of tannin to a reasonable concentration in the plant extract would have been largely responsible for the exhibited corrosion inhibition property of this extract. The test without plant extract addition has a high corrosion rate. All the four different concentrations showed little difference in corrosion rates; the decreasing corrosion rates with the exposure time, was due to the weakening of the test medium by plant extract *Chromolena odoratum*. From the result it was observed that 20 mL tends to be the best concentration with the plant extract followed by 5, 10 and 15 mL, respectively.

In Fig. 18, the highest inhibitor efficiency of 68.50% for the *Chromolena odoratum* concentration of extracts was obtained with the 20 mL concentration on the 4<sup>th</sup> day of the experiment and this came with an increasing trend from the first day of the experiment down to the last day of the experiment period. The 10 and 15 mL conc. of the *Chromolena odoratum* showed

a reduction trend in from the day 1 of the experiment to the day 2. Then slight increasing inhibition efficiency from second day to the last day of experiment. While the 5 mL conc. of the *Chromolena odoratum* extract showed an increasing trend from the first day to the second day and then a slight reduction in inhibition efficiency from the second day to the last day of the experiment. Thus from the result obtained, the concentration with the best inhibition efficiency throughout the experimental period can be said to be the 20 mL concentration followed by 5 and 10 mL and the least inhibition efficiency is that of 15 mL.

### CONCLUSION

On the basis of the experimental results obtained, it can be drawn that the different plant extracts acts as good green corrosion inhibitor and can be used to retards the corrosion rate of mild steel if the appropriate concentration is used. Among the various plant extract used, it was observed that Elizabeth leaf (*Chromolena odoratum*) has the best inhibition efficiency in mild steel in both acidic media (HCL and H<sub>2</sub>SO<sub>4</sub>) followed by Okazi leaf (*Gnetum africanum*) and Utazi leaf (*Gongronema latifolium*) which also showed good inhibition efficiency. Corrosion rate increased with time of exposure to the corrosive medium (inhibited or none inhibited). Comparing the different concentrations (5, 10, 15 and 20 mL, respectively) of Okazi leaf (*Gnetum africana*) extract at different time intervals, it can be concluded that; In 1M HCL acid on mild steel, a maximum of 87.97 and 76.47% inhibition efficiency was obtained making use of 15 mL concentration and 20 mL concentration respectively providing low inhibition weight loss and corrosion rate. In 1M H<sub>2</sub>SO<sub>4</sub> acid on mild steel, a maximum of 85.89 and 67.08% inhibition efficiency was obtained making use of 20 mL concentration and 10 mL concentration respectively providing very low inhibition weight loss and corrosion rate. Comparing the different concentration (5, 10, 20 and 20 mL respectively) of Utazi leaf (*Gongronema latifolium*) plant extract at different time intervals, it can be concluded that; In 1M HCL acid on mild steel, a maximum of 68.52% and inhibition efficiency was obtained making use of 10 mL concentration, providing low inhibition weight loss and corrosion rate. In 1M H<sub>2</sub>SO<sub>4</sub> acid on mild steel, a maximum of 91.92 and 60.68% inhibition efficiency was obtained making use of 15 mL concentration, providing very low inhibition weight loss and corrosion rate. Comparing the different concentration (5, 10, 20 and 20 mL, respectively) of Elizabeth (*Chromolena odoratum*) plant extract at different time intervals, it can be concluded that; In 1M HCL acid on mild steel, a maximum of 68.50 and 90.95% inhibition efficiency was obtained making use of 15 mL concentration and 20 mL concentration respectively, providing low inhibition weight loss and

corrosion rate. In 1M H<sub>2</sub>SO<sub>4</sub> acid on mild steel, a maximum of 94.43 and 58.03% inhibition efficiency was obtained with 20 mL concentration, providing a low weight loss and corrosion rate.

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