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Melon (*Cucumismelo*) and Groundnut (*Arachishypogaea*) Peel Extracts as Corrosion Inhibitors for Mild Steel in Hydrochloric Acid Solution.

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ABSTRACT
The corrosion inhibition of mild steel in 2M hydrochloric acid solution by Melon (*Cucumismelo*)(MPE) and Groundnut (*Arachishypohaea*) peel extracts (GPE) at room temperature has been investigated using weight loss method. Inhibition efficiencies of 94.40% and 92.64% for2M HCl concentration was observed for GPE and MPE respectively. Generally, the weight loss of the coupons decreases at different concentrations of HCl solutions while the inhibition efficiencies of the inhibitors (MPE and GPE) increased with increasing inhibitor concentrations.

Keywords: *Cucumismelo, Arachishypogaea*, corrosion, inhibitors

INTRODUCTION
The use of environmentally benign materials like plant leaf extract, bacteria and fungi for the synthesis of nanoparticles offers copious benefits of eco-friendliness and compatibility for pharmaceutical and biomedical applications as they do not require toxic chemicals in the synthesis protocols. Chemical synthesis methods lead to the presence of some toxic chemicals absorbed on the surface that may have adverse effect in the medical applications (Zweng*et al.*, 2009).Naturally occurring substances as inhibitors of acid cleaning process has continued to receive attention as replacement for synthetic organic inhibitors (Smitha*et al*., 2009). The greatly expanded interest on naturally occurring substances is attributed to the fact that they are cheap, readily available, ecologically friendly, and possess no threat to the environment. In addition, they are biodegradable and renewable source of materials. Recent literature has shown that plant materials such as *Azadirachtaindica* (Oguzie, 2008), *Occimumviridis* (Oguzie, 2008), *Strychnosnux-vomica* (Raja *et al*., 2009), *Prosopis cineraria* (Sharma *et al*., 2008), *Hibiscus sabdariffa*extract (Oguzie, 2008) olives leaves (El-Etre, 2007) *Daturastramonium* (Raja *et al*., 2007)*Aloe vera extract* (Abiola and James, 2009) as well as *Phyllantusamarus extracts* (Okafor *et al.*, 2008) are effective inhibitors for metal in aggressive solutions. Our research group has recently reported the corrosion inhibitive effectiveness of metals by *Dacroydesedulis* (Umoren*et al*., 2008) *Pachylobusedulis* (Umoren *et al*., 2008) *Vignaunguiculata* (Umoren *et al*., 2008) *Gum Arabic* (Umoren et al., 2008) *Raphiahookeri* (Umoren*et al.,* 2008) and the latest on *Ipomoea invulcrata* (Obot*et al*., 2009).

The present work was designed as a contribution to the growing interest on environmentally benign corrosion inhibitors to study the corrosion inhibition of mild steel in Hydrochloric acid solutions by Melon (*Cucumismelo*) and Groundnut (*Arachishypogaea*) peel extracts at room temperature using weight loss measurement. The paper is organized into **four sections**: In **section 1**, we present a general introduction on the use of plant as inhibitors; the experimental procedures including the various methods adopted are discussed in **section 2**; our findings, observations and discussions are presented in **section 3** and the paper was concluded with a brief summary of our work in **section 4**.

MATERIALS AND METHOD
Materials Collection
The mild steel used was locally purchased from a metal shop at Akim Timber Market, Calabar. The Melon and Groundnut peels were also sourced from Watt Market, calabar road, Calabar, Cross River Stata, Nigeria.

Preparation of specimen
The mild steel was mechanically press-cut at the Department of works, University of Calabar, into coupons of 4x5 cm. A round hole was bored in the middle of the upper edge of the 4x5 cm coupon

in order to be firmly held by a hook during the weight loss measurement. All the metal coupons were polished using emery paper (sand paper) of different grades for smoothness, degreased with acetone and properly stored as describe by (Obot*et al.*, 2009)

Preparation of Melon and Groundnut peels

The collected melon and groundnut peels were thoroughly washed with distilled water, chopped into pieces, and sun dried for days, ground into powder using an electric blender and stored in well labeled air tight containers. The MPE and GPE 3g of the powder were ashed separately in a furnace at 40°C using crucible for 6 hours. The ashes obtained by heating MPE and GPE were re-grinded separately for 30 mins. then stored in a dry place. Stock solutions of the MPE and GPEwere prepared as reported by (Abiola *et al.*, 2009). Then 3g of powdered ash of the MPE and GPE was refluxed in 100 ml of 2 M HCl solution for 3 h. The refluxed solution was allowed to stand for 8 h, filtered and stored. The filtrate was diluted with appropriate quantity of 2 M HCl to obtain inhibitor test solutions of 10–50 %v/v concentrations.

Weight loss measurement

The simplest way of measuring the corrosion rate of a metal is to immerse the sample in the test medium (HCl Acid solution) and measure the loss of weight of the material as a function of time (Umoren *et al.*, 2008), Five glass beakers of 100 ml capacity were labeled A to E, each containing 0.5 M, 1.0 M, 1.5 M, 2 M and 2.5 M Hydrochloric acid solutions respectively. The pre-weighed coupon samples were immersed into the corrodent after 1 hour of time interval, the specimens were taken out and are again and cleaned in water, washed in washing liquor and dried in acetone before weighing. This experiments was done for 5 hours by simply re-introduction of the metal coupons into the solution at every 1 hour time interval. From the initial and final readings. The weight loss corrosion rate (CR) and inhibitor efficiency were calculated from the formula given below.

$$CR = \frac{\text{Weight loss x 534}}{\text{Density x Area x Time}}$$

Where,
Weight loss in mg
Density of the mild steel/coupon = 7.85 g/cm^3
Area is that of the coupon in square inches, (in^2)
Time is the exposure time in hrs.

The efficiency of the inhibitor was computed using the following equation:

Inhibitor Efficiency, IE $= \frac{W_0 - W_1}{W_0} \text{ x } 100$

Where, W_0 = weight loss without inhibitor
W_1 =Weight loss with inhibitor

RESULTS AND DISCUSSIONS

Effect of corrodent concentration on mild steel corrosion

The influence of the corrodent concentrations on mild steel corrosion is shown in **Figures 3.1a** and **3.1b.** It is observed that the mild steel corrodes in different concentrations of HCl solutions. This is because of the decrease in the original weight of the coupons. The corrosion is attributed to the presence of water, air and hydrogen ion, which accelerates the corrosion process (Ita and Offiong, 1997).

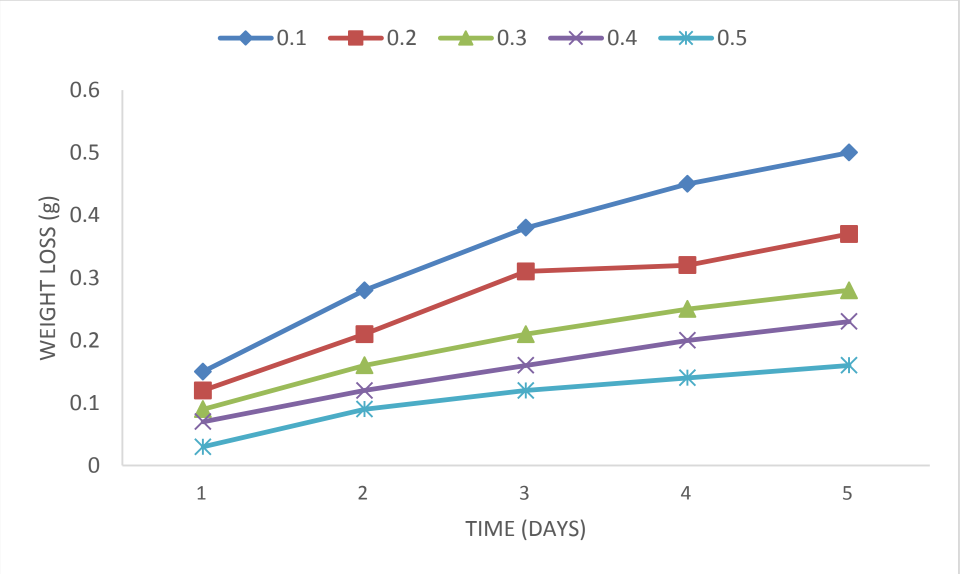

Figure 3.1a: Variation of Weight loss (g) against Time (days) for GPE

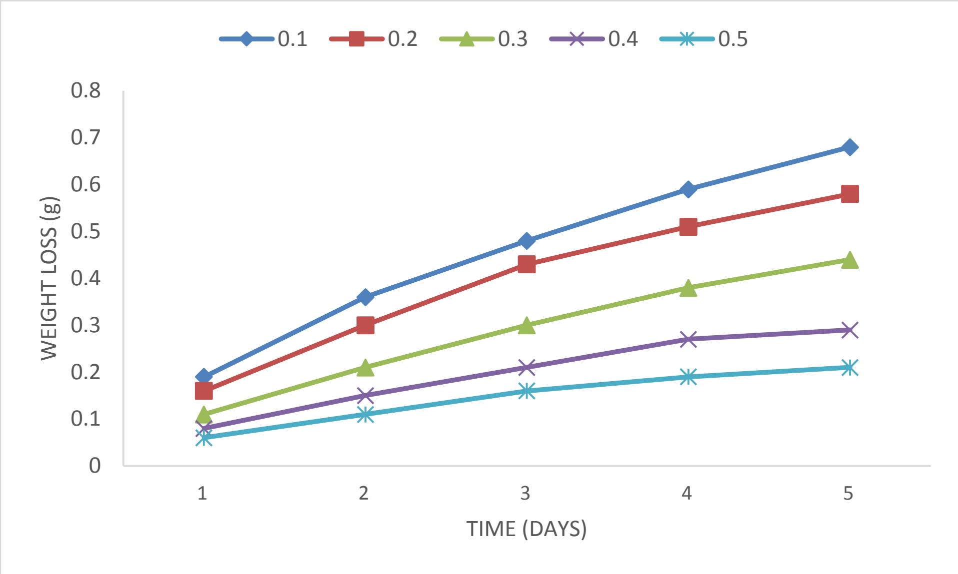

Figure 3.1b: Variation of Weight loss (g) against Time (days) for MPE

Effect of HCl concentrations on corrosion rates

The plots of corrosion rates versus concentration of HCl solutions are shown in **Figures 3.2a** and **3.2b**. The corrosion rates decrease linearly with HCl solutions. The corrosion rates which is dependent on the weight loss of the mild steel coupons was also observed to decrease with the duration of the experiments and the concentrations of the HCl solutions. This was also reported by Ita and Offiong, (1997)

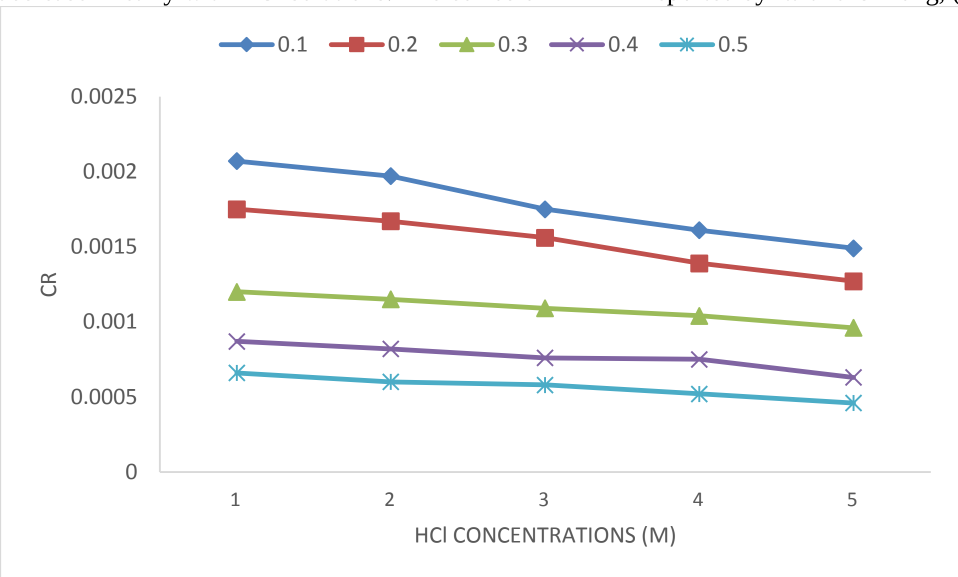

Figure 3.2a: Variation of Corrosion Rates ($gcm^{-2}hr^{-1}$) against HCl concentrations for MPE

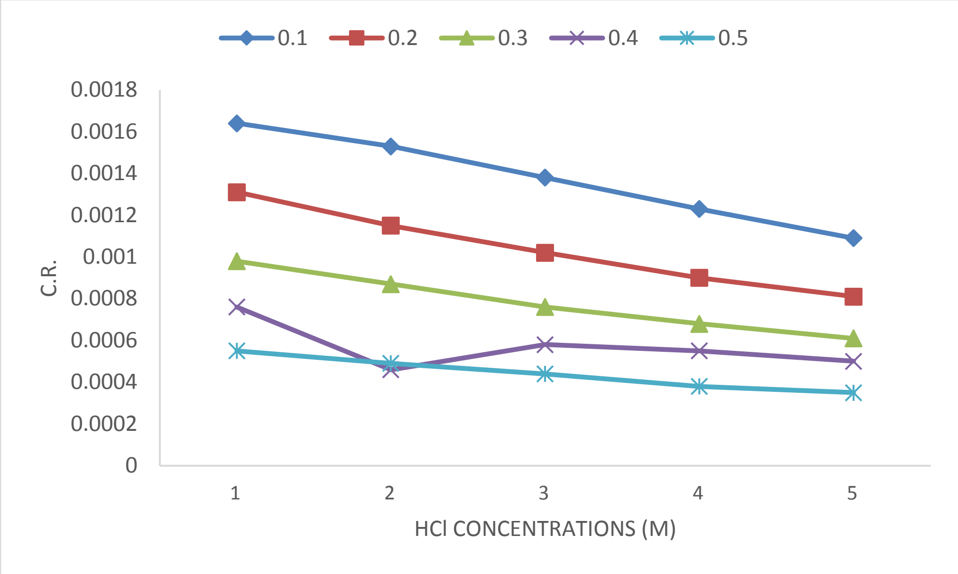

Figure 3.2b: Variation of Corrosion Rates (gcm-^{2}hr-^{1}) against HCl concentrations for GPE

Effect of inhibitor concentration on inhibition efficiency

Figures 3.3a and 3.3b depicts the inhibition effects of GPE and MPE on mild steel. The inhibition efficiencies of MPE and GPE are found to increase with increase in inhibitor concentrations. GPE has the highest inhibiting efficiency of 94.40% as compared to MPE with inhibitor efficiency of 92.64%. However, both extracts possessed strong inhibiting properties to corrosion.

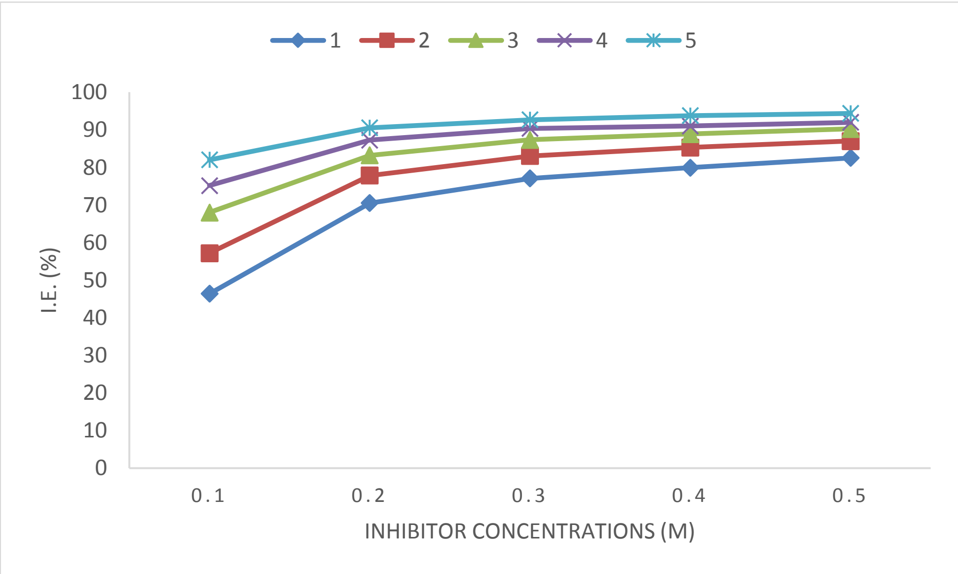

Figure 3.3a: A plot of Inhibitor Efficiency (%) versus Inhibitor Concentrations (M) for GPE

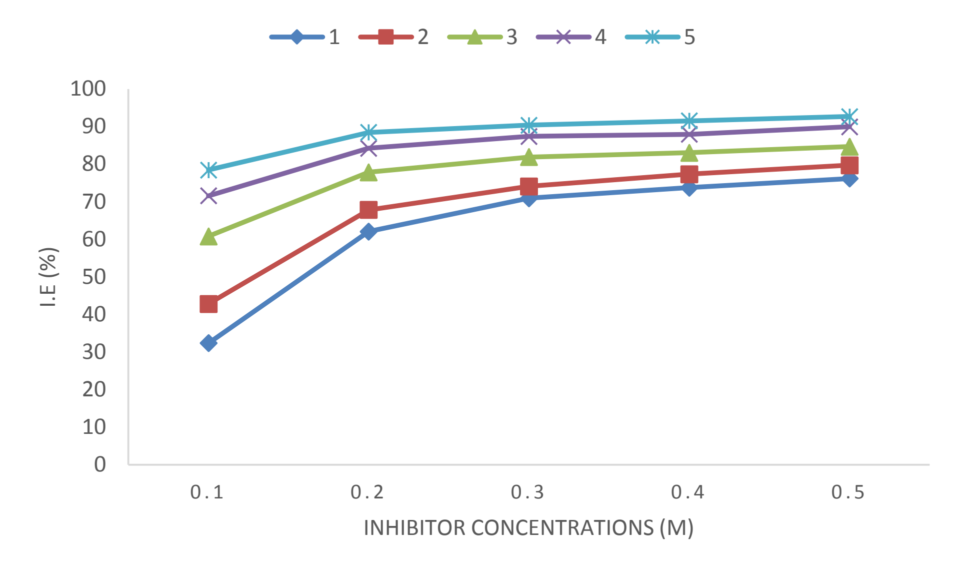

Figure 3.3b: A plot of Inhibitor Efficiency (%) versus Inhibitor Concentrations (M) for MPE

Comparison of Corrosion Inhibition Efficiency of the Inhibitors Studies.

The inhibitory actions of MPE and GPE reveals that GPE exhibits better corrosion inhibition tendency than MPE extracts. The highest inhibition efficiency exhibited by GPE is 94.40% as compared to MPE with efficiency of 92.64%.It is speculated that inhibition efficiency could be a function of chemical bond formation between the inhibitor and the mild steel surface. The difference in the inhibitory efficiency of GPE and MPE can be attributed to the difference in their phytochemical contents and other related surface active chemical compounds as reported by (Prabasheela *et al*., 2015) for *Arachishypogaea* and (Arora *et al.*, 2011) for *Cucumismelo*.

CONCLUSION

The present study shows that the corrosion of mild steel in 2M HCl solution without inhibitor increases with increasing HCl concentrations at room temperature. The inhibitors used (GPE and MPE) slow down the corrosion rates, probably by being chemically adsorbed onto the mild steel surface. The inhibition efficiency increases with an increase in inhibitor concentrations at room temperature. GPE exhibits higher inhibition efficiency than MPE as shown in this paper.

Novelty in corrosion study falls within the frame of characterization of inhibitors and to proposed active specie, inhibition mechanism, surface morphology studies and sorption mechanism as well as surface coverage studies.

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