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# Corrosion Inhibition Performance of Copper Alloy by the Influence of Natural Extracts (Prawn Shell Extract, *Muntingia* Fruit Extract) in the Presence of Methylene Blue Dye Effluent

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**ABSTRACT:** The inhibition potentials of two natural extracts (Prawn shell extract, *Muntingia* fruit extract) was investigated by evaluating the corrosion behavior of the copper alloy immersed in Methylene blue dye effluent solution containing natural extract. Linear polarization resistance, corrosion current charge transfer resistance, double layer capacitance and impedance were utilized to evaluate the corrosion inhibition and adsorption properties of the natural extract. Scanning Electron Microscopy studies (SEM) provided the confirmatory evidence of improved provided surface condition, due to adsorption, for the corrosion protection. Impedance measurement has shown that the change in the impedance parameter like charge transferred resistance with the addition of extract is due to the adsorption active molecules leading to the formation of a protective layer on the surface of the Cu Alloy.

**KEY WORDS:** Corrosion, Polarization, Impedance, Natural extracts, Cu Alloy, Methylene Blue Dye

## I. INTRODUCTION

Metals are widely used in human activities due to excellent mechanical and electrical properties[1-4]. In order to preserve the desired state of these metals, their prevention maintenance is a priority. Corrosion is probably the most desired phenomenon that leads the metals to become weaker[5,6]. 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 corrosive medium[6-9]. Mild steel is most widely used in oil, food, energy, chemical, construction industries due to its different application, most of which based on its excellent mechanical properties. This metal shows high mechanical resistance, durability and toughness, among others, which makes it a highly available material and at a relatively low cost. However the versatility of mild steel and its performance is continually being threatened as it is subjected to corrosive environmental degradation. To the lesser extent, copper alloy are studies as well. The high cost associated with corrosion, due to the replacement of rusted metals, can be reduced by using corrosion inhibitors[10].

The use of many inorganic and synthetic inhibitors to resist the corrosion, but their used is now marred by their toxicity and high cost of manufacturing. This has prompt researchers to explore other areas to produce eco friendly, cheap and biodegradable green corrosion inhibitor to replace the inorganic and synthetic inhibitors. The use of plant extract, fruits extract, biomass waste as green corrosion inhibitors to reduce the corrosion rate of metals and receiving strong preference [11]. This present work is undertaken to evaluate the corrosion resistance of copper alloy by using two natural extract like shrimp waste extracts, *Muntingia* fruit extract in Methylene blue dye effluent. To investigate the corrosion behavior of mild steel and copper alloy in dye effluent by polarization study and AC impedance spectra, Scanning Electron Microscopy studies (SEM).

**II. METHODOLOGY**

**2.1 Sample preparation**

Alloy specimen namely, Cu Alloy was put to use as Test material for this study .The Chemical Composition of the alloy is presented in Table 1.

**Table.2.1. Types of wires used and their composition**

S.NO	Types of work	Composition (%)
1	Cu Alloy	Cu – 85.0 %, Zn – 5.0 % ,Pb -5.0 % ,Sn –5.0 %

**2.2 Methylene Blue Dye**

Methylene blue used as blank solution as well as inhibitor.

**2.3. Preparation of test solution**

The Dye effluent was used as corrosion medium to discover the inhibition potential of two natural extracts such as Prawn shell extract, Muntingia fruit extract.



**Boiled the dried shrimp shell and filtered that extract**



**Boiled the dried muntingiacalabura fruit and filtered that extract**

**2.4. Inhibitor System**

- ❖ 100ml of natural extract of Prawn shell, Muntingia fruit in a standard measuring flask.
- ❖ 40 ml of natural extracts were mixed with 60 ml of Dye effluent (blank) in a standard measuring flask. This solution mixture was used to assess the corrosion resistance of metal alloy by way of various electrochemical and surface characterization studies.

**Table.2.2 Various Environment**

S.No	Natural Extract	Environment
1	Prawn shell	a) Blank b) Prawn shell extract c) Blank + Prawn shell extract
2	Muntingiacalabura fruit	a) Blank b) Muntingiacalabura fruit extract c) Blank + Muntingiacalabura fruit extract



**Table.2..3 Environment for surface examination study**

S.No	Specimen	Natural Extract	Environment
1	Cu Alloy	Prawn shell	a) Blank b) prawn shell extract c) Blank + Prawn shell extract
		Muntingiacalabura fruit	a) Blank b) muntingiacalabura fruit extract c) Blank + muntingiacalabura fruit extract

**III. RESULTS AND DISCUSSION**

**3.1. Analysis of polarisation curve**

Potentiodynamic polarization study is used to explore the corrosion inhibition (CI) of metals and alloys. When CR decreases, there is increase in linear polarization resistance (LPR) and decrease of corrosion current ( $I_{corr}$ ). Hence, when anodic reaction is predominantly controlled, there is shift in corrosion potential ( $E_{corr}$ ) to anodic side-noble side (less -ve side or +ve side) and when cathodic reaction is predominantly controlled, there is shift of  $E_{corr}$  to active side (more -ve side). If both, anodic and cathodic reactions are predominantly controlled (mixed type of inhibition), then the shift in  $E_{corr}$  is less (within 50 mV/decade). Figure 1.1 illustrates the polarization curves (Tafel plots) of Cu alloy evaluated in various test solutions at a room temperature.

**3.1.1. Cu Alloy – Prawn Extract**

The polarization curves of Cu alloy is immersed in various test solution are shown in figure 1.1, 1.2. The corrosion parameters namely corrosion potential ( $E_{corr}$ ), Tafel slopes (bc;ba), corrosion current ( $I_{corr}$ ), Linear Polarization Resistant (LPR) are given in table 3.1.

**Table 3.1: Corrosion parameters of Cu Alloy immersed in various test solution for Polarization study**

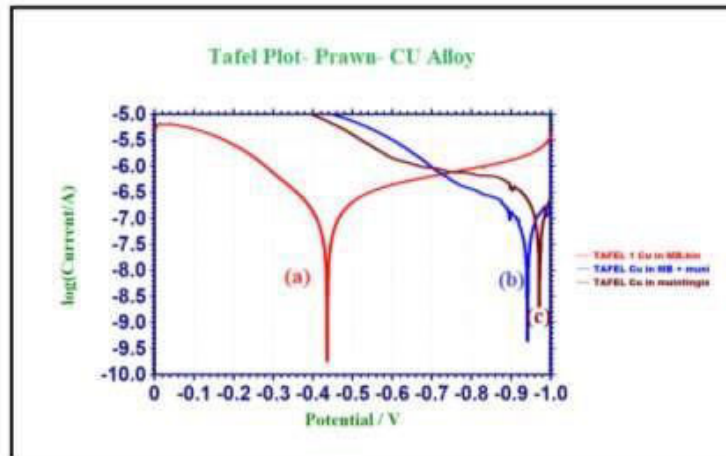
Alloy	System	$E_{corr}$ mV/SCE	bcV/decade	ba V/decade	LPR ohm cm <sup>2</sup>	$I_{corr}$ A/cm <sup>2</sup>
Cu	Blank	-436	0.2433	0.1654	278358	$1.538 \times 10^{-7}$
	Prawn	-931	0.2369	0.6260	184815	$4.864 \times 10^{-7}$
	<b>Blank + Prawn</b>	<b>-840</b>	<b>0.1634</b>	<b>0.1718</b>	<b>442398</b>	<b><math>8.231 \times 10^{-8}</math></b>
	Blank	-436	0.2433	0.1654	278358	$1.538 \times 10^{-7}$
	Muntingia	-971	0.1590	0.2176	113449	$3.521 \times 10^{-7}$
	Blank +Muntingia	-941	0.2013	0.3348	227775	$2.400 \times 10^{-7}$

When Cu Alloy immersed in Blank, LPR value 278358 ohm cm<sup>2</sup>. The corrosion current ( $I_{corr}$ ) is  $1.538 \times 10^{-7}$  A/cm<sup>2</sup>. The corrosion potential ( $E_{corr}$ ) value is -436 mV vs SCE. When Cu alloy immersed in blank and Prawn extract system, the LPR value is increases to 442398 ohm cm<sup>2</sup> and the corrosion current value is  $8.231 \times 10^{-8}$  A/cm<sup>2</sup> further decreases. This indicates that corrosion resistance of Cu alloy increases in Blank + prawn System,. Thus the polarization study leads to the conclusion that Cu Alloy is immersed in various test solution, the decreasing order of corrosion resistance of Cu Alloy is as follows:



**Blank + Prawn extract > Blank**

In this medium of the Cu Alloy in Blank +Prawn, increases.

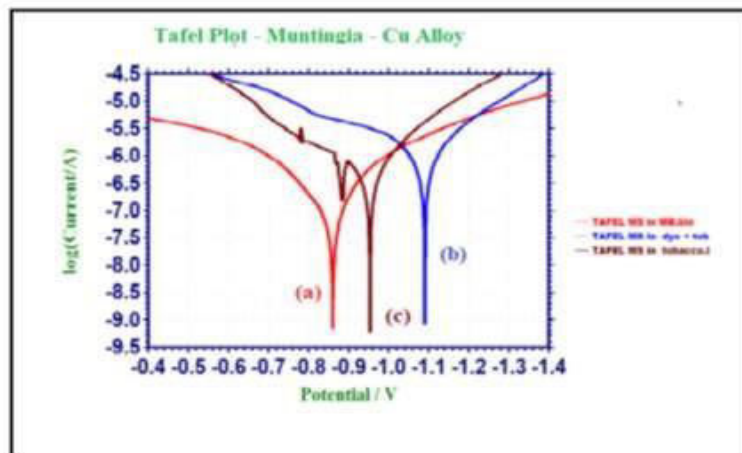


**Figure.3.1 Polarization curve of Cu alloy immersed in various test solution (a) Dye effluent; (b) Prawn extract ; (c) Dye effluent + Prawn extract**

**3.1.2. Cu Alloy – Muntingia Extract**

The polarization curves of Cu Alloy immersed in various test solution are shown in fig 3.2. The corrosion parameters namely corrosion potential ( $E_{corr}$ ), Tafel slopes (bc; ba), corrosion current ( $I_{corr}$ ), Linear Polarization Resistant (LPR) are given in table 4. When Cu Alloy immersed in Blank, LPR Value is 278358 ohm  $cm^2$ . The corrosion current ( $I_{corr}$ ) value is  $1.538 \times 10^{-7} A/cm^2$ . The corrosion potential( $E_{corr}$ ) value is -436 mV vs SCE. When compared to the one in Blank system and Muntingia extract LPR Value further increases to 227775 ohm  $cm^2$ , corrosion current ( $I_{corr}$ ) value is  $2.400 \times 10^{-7} A/cm^2$ , Further increases. This indicates that corrosion resistance of Cu Alloy increases in Blank + Muntingia extract system. Thus the polarization study leads to the conclusion that when Cu alloy immersed in various test solution, the decreasing order of corrosion resistance of Cu alloy is as follows:

**Blank + Muntingia extract < Blank + Prawn extract**



**Figure.3.2 Polarization curve of Cu alloy immersed in various test solution (a) Dye effluent; (b) Muntingia extract; (c) Dye effluent + Muntingia extract**



3.2 AC Impedance spectral study

The AC impedance spectra of Cu alloy immersed in various test solution are shown in figure 3.3 and 3.5 (Nyquist plot) and figure 1.4 and 1.6 (Bode plot).The corrosion parameters are given table 3.2.

Table.3.2: Corrosion parameters of Cu alloy immersed for AC impedance spectra

Alloy	System	Nyquist Plot		Bode plot	
		R <sub>t</sub> ohm cm <sup>2</sup>	C <sub>dl</sub> F/cm <sup>2</sup>	IMP value Log z/ohm	Phase Angle
Cu	Blank	23796	2.1432× 10 <sup>-10</sup>	1.084	37.73
	Prawn extract	4286	1.214× 10 <sup>-9</sup>	1.077	63.76
	<b>Blank + Prawn extract</b>	<b>421111</b>	<b>1.2076× 10<sup>-9</sup></b>	<b>1.082</b>	<b>65.22</b>
	Blank	23796	2.1432× 10 <sup>-10</sup>	1.084	37.73
	Muntingiaextract	2097	1.6628× 10 <sup>-9</sup>	1.082	73.97
	Blank + Muntingiaextract	7234	7.0500× 10 <sup>-10</sup>	1.082	88.86

3.2.1 Cu Alloy – Prawn Extract

When Cu alloy is immersed in Dye effluent the charge Transfer Resistance (R<sub>t</sub>) value is 23796 ohm cm<sup>2</sup>. The Double layer capacitance (C<sub>dl</sub>) value is 2.1432 x10<sup>-10</sup> F/cm<sup>2</sup>. The Impedance log (Z/ohm) value is 1.084. When Cu alloy is immersed in Blank + Prawn extract system the Charge Transfer Resistance (R<sub>t</sub>) increases to 421111 ohm cm<sup>2</sup>.The Double Layer capacitance (C<sub>dl</sub>) value decreases to 1.2076x10<sup>-9</sup> F/cm<sup>2</sup>. The impedance log (Z/ohm) value is 1.082. This indicates that the corrosion resistance of Cu alloy in Blank + Prawn extract system further increases. Thus AC impedance spectra lead to the conclusion that the corrosion resistance of Cu alloy immersed in various test solution decreases in the following order.

**Blank + Prawn extract > Blank > Prawn extract**

Thus AC impedance spectra leads to the conclusion that Cu alloy having higher corrosion resistance for **Blank + Prawn extract**. The reason for it is because in this medium the corrosion resistance of Cu alloy increases.

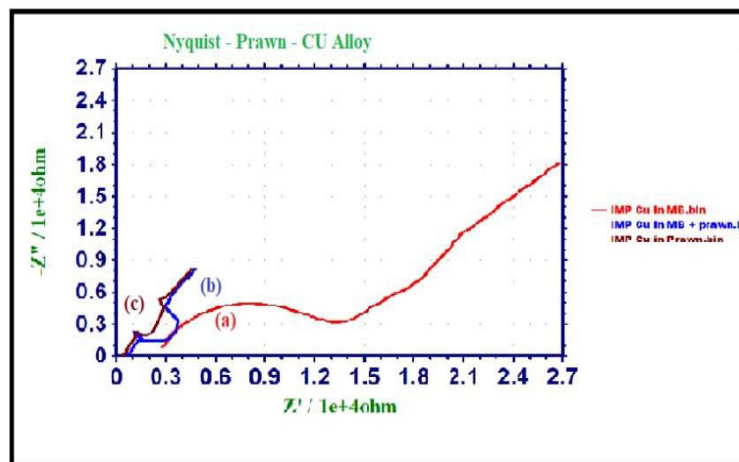


Figure : 3.3 AC Impedance Spectra For Cu Alloy Immersed in (a)Dye Effluent; (b) Dye Effluent + Prawn Extract (c) Prawn extract (Nyquist Plot)

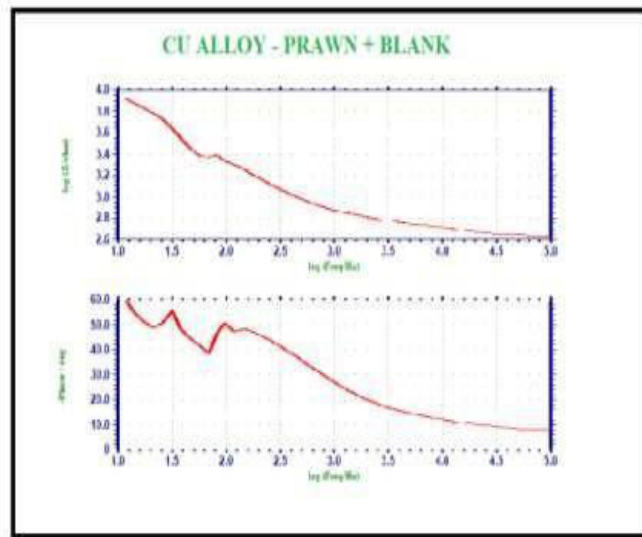


Fig : 3.4 AC Impedance Spectra For Cu Alloy Immersed In (a)Dye Effluent;  
(b) Dye Effluent +Prawn Extract (Bode Plot)

### 3.2.2 Cu Alloy – Muntingia extract

When Cu alloy is immersed in Dye effluent the charge Transfer Resistance ( $R_c$ ) value is 23796 ohm  $cm^2$ . The Double layer capacitance ( $C_{dl}$ ) value is  $2.143 \times 10^{-10}$  F/ $cm^2$ . The Impedance log (Z/ohm) value is 1.084. When MS alloy is immersed in Blank + Muntingia extract system the Charge Transfer Resistance ( $R_c$ ) decreases to 7234 ohm  $cm^2$ . The Double Layer capacitance ( $C_{dl}$ ) value decreases to  $7.0500 \times 10^{-10}$ . The impedance log (Z/ohm) value is 1.082. This indicates that the corrosion resistance of Cu alloy in Blank + Muntingia fruit extract system further decreases. Thus AC impedance spectra lead to the conclusion that the corrosion resistance of Cu alloy immersed in various test solution decreases in the following order.

**Blank + Muntingia extract > Blank > Muntingia extract**

Thus AC impedance spectra leads to the conclusion that Cu alloy having lower corrosion resistance for Muntingia extract. The reason for it is because in this medium the corrosion resistance of Cu alloy decreases.

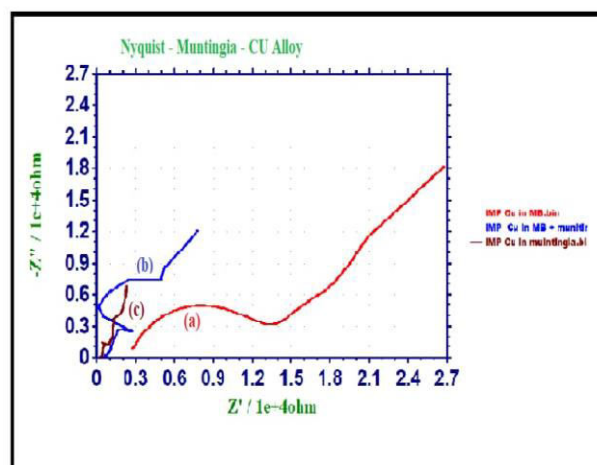


Figure : 3.5 AC Impedance Spectra For Cu Alloy Immersed In (a) Dye Effluent; (b) Dye Effluent + Muntingia Extract; (c) Muntingia Extract (Nyquist Plot)

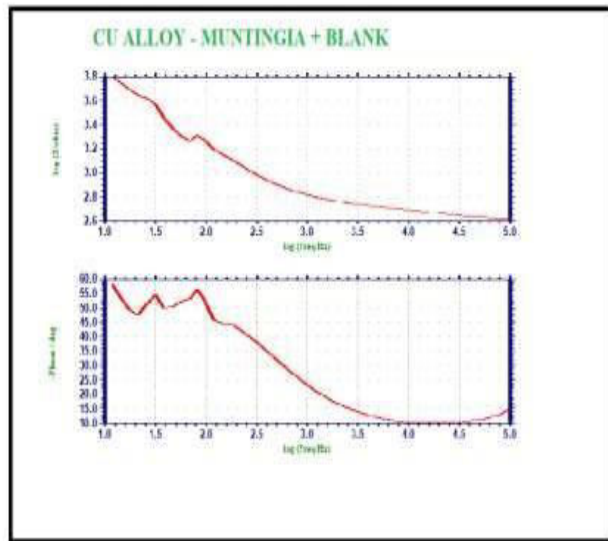


Figure: 3.6 AC Impedance Spectra For MS Alloy Immersed In (a) Dye Effluent;  
(b) Dye Effluent + Muntingia Extract (Bode Plot)

### 3.3 Scanning Electron Microscopic (SEM) Studies

The two dimensional representation of the surface gives the nature of the protective film formed on Metal surface. Give the SEM images of polished surface of Cu alloys exposed for one day in dye effluent for the uninhibited and inhibited. In comparing SEM microgram of Cu alloy, there was rough surface for uninhibited solution and smooth surface for inhibited solution with extract of Dye effluent in forming an insoluble complex of Cu Prawn extract on the surface. Thus, it had become free from corrosion. The inhibitor effectively controls the dissolution of Cu alloy. In Fig 1.7(b), the manufacturing defects on surface were noticeable as well as the scratches imprint that could be attributed to mechanical polishing by Cu course polishing paper.

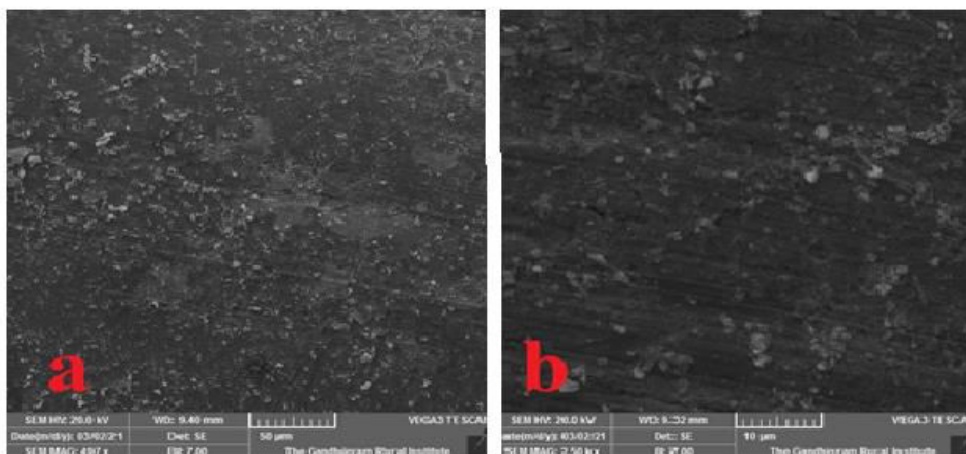


Figure.3.7 SEM Image (A) Polished Copper; (B) Cu + Blank + Prawn Extract

## IV. CONCLUSION

The natural products are used as inhibitor Cu alloy affected by Methylene blue dye effluent .The electrochemical reaction occurring on the alloy’s surface, lead to the formation of chemical compound .the chemical





reaction lead to the materials with the under degradation. The corrosion is the deterioration of a material due to interact with its environment .It is the process in which metallic atoms leave the metal or form compounds in the presence of water and gases. Alloy can be corroded by the direct reaction of metal to a chemical.

Corrosion is a global problem that has played building, monuments, equipment and infrastructure for centuries. The systematic analysis of natural extracts as corrosion inhibitors and also use of various electrochemical techniques, examination techniques besides. The polarization studies, AC impedance spectra and SEM. so as to bring out some useful conclusion regarding the mechanistic aspects of corrosion inhibition by Cu alloy.

The surface analytical studies like SEM provide better understand about the reaction takes place on the metal surface. The order of corrosion inhibition of alloy using Prawn extract system as experiment by polarization study and AC impedance spectra. The both studies used Cu alloy happened to show high corrosion resistance. (Cu + Methylene blue dye effluent + prawn extract).The highest resistance to corrosion of two of the Cu alloy was shown by prawn extract. The practitioner can use the outcomes of our experiment to decide or recommend to their corrosion inhibition of natural products to maintain the corrosion is Cu alloy.

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