Influence of Tannin Concentration from Banana Peel as Iron Inhibition in Hydrochloric Acid Solution

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Keywords: Banana Peel, Tannin, Corrosion Rate, Inhibition Efficiency.

Abstract: Banana peel contains tannin that could be used as corrosion protection of iron. This study aims to determine the effect of tannin from banana peel on corrosion inhibition of iron plate in 3% hydrochloric acid solution. The banana peel used in this study is unripe Awak Banana peel. The variables observed are soaking method, inhibitor concentration and immersion time, and the parameters studied are corrosion rate of iron and corrosion inhibition efficiency. In this experiment, the lowest corrosion rate and highest inhibition efficiency are obtained on immersion of iron for 12 days in hydrochloric acid solution and addition of 9 g of tannin inhibitor. In this condition the corrosion rate is 7.2578 mpy and the corrosion inhibition efficiency is 97.79%. The results showed that tannin from Awak banana peel could be used as corrosion inhibition of iron in hydrochloric acid solution.

1 INTRODUCTION

Corrosion is the most common problem found on a daily life, both in the household and in industry. Corrosion is the degradation of the destruction of the quality of metallic properties through a natural electrochemical reaction and it happens because of chemical phenomena with the environment. Corrosion can't be stopped but can be controlled, so various attempts are done to inhibit corrosion (Darmokoesoemo *et al*., 2018). Organic inhibitors or commonly referred to as green inhibitors are a safe type of inhibitor because they have an eco-friendly or biodegradable, economical, and widely available in nature. The plants that can be used as organic inhibitors are plants that have antioxidant properties, such as containing flavonoid compounds, tannins, ascorbic acid, phenolic, and others (Chancay and Poosaran, 2009).

In this study, the corrosion inhibitor used is unripe Awak banana peel (*Musa paradisiacal var. Awak*). Unripe banana peels have a tannin content about 6.48%, almost mature banana peels about 4.97 % and ripe banana peel about 4.69% (Tartrakoon *et al*., 1999). Tannins protect the iron from corrosion in hydrochloric acid (HCl) solution due to the adsorption of tannins onto the iron surface (Agi *et al*., 2018; Madhu *et al*., 2018). Tannin inhibits the oxidation of Fe^{2+} ions to iron oxides and avoid corrosion inhibition (Al-Amiery *et al*., 2014). Banana peel is very potential to be used as a corrosion inhibitor because it has high antioxidant (Gopal *et al*., 2015). Wang, et al. vary the addition of a corrosion inhibitor concentration and the results obtained that the efficiency of the inhibitor is higher with increasing inhibitor concentration (Wang *et al*., 2016). Al-Moubaraki, et al. vary the time of immersion metal plates in the media and the results obtained that the longer the immersion time, the corrosion rate of metal will be higher (Al-moubaraki *et al*., 2015). Based on the above study, this study is aimed to develop banana peel tannin as iron corrosion inhibitor in HCl medium. In this experiment, the influence of tannin concentration from Awak banana peel and duration of immersion of iron in HCl solution will be investigated experimentally.

2 METHODS

2.1 Qualitative Analysis of Tannins on Extracts

Materials used in this study are iron specimen (Fe) with the size 1 cm x 2 cm x 0.2 cm, 3% HCl solution of 50 ml as medium, Awak banana peel (*Musa*

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paradisiacal var. Awak) from Pringgan Market Medan, distilled water, methanol, $FeCl_3$, ethyl acetate, and the equipment used in this research include beaker glass, rotary vacuum evaporator, Whatman no 41 filter paper, oven, blender, and analytical balance. In this experiment, the smooth iron surface is washed with detergent and distilled water, then dried in an oven at 110 ° C for 2 hours so that the iron does not contain water.

In this study, the unripe Awak banana peel is dried in the air to remove the water content then the banana peel is cut into small pieces about 1 cm, then dried in the sun for 3 days. Banana peel is put in an oven at 80 ^oC. Banana peel is blended to be powder and sieved by using sieve tray of 50 mesh. The powder is macerated with methanol at a ratio of 7:1 for 24 hours then filtered by using filter paper of Whatman no 41. The filtrate is removed with a rotary vacuum evaporator at a temperature of 65^oC into a paste form. The crude extract is analyzed qualitatively. The crude extract of banana peel is dissolved with ethyl acetate, stirred until dissolved, then settled to form precipitate. The precipitate is filtered and then washed again with ethyl acetate until the filtrate is clear. The insoluble precipitate in ethyl acetate is tannin. Iron is then immersed in a 3% HCl of 50 ml without the presence of tannin and with additions of 1 gram, 3 gram, 5 gram, 7 gram, and 9 gram of tannin. The immersion durations are 3 days, 6 days, 9 days, and 12 days. Then the rate of corrosion reaction and the corrosion inhibition efficiency are calculated.

The corrosion rate, CR (mils/year or mpy) is determined by equation (1) (Ali and Hamedh, 2016):

$$CR=\frac{KW}{DAt} \quad (1)$$

where K is constant (3.45 x 10^6), W is mass loss (g), D is density (g/cm^3), A is surface area (cm^2), and t is immersion time (hours).

The corrosion inhibition efficiency is determined by equation (2) (Ali and Hamedh, 2016):

$$\text{Inhibition Efficiency (\%)} = \frac{C_{R0}-C_{Ri}}{C_{R0}} \text{ x } 100\ \% \quad (2)$$

where C_{Ri} is corrosion rate with inhibitor (mils/year) and C_{R0} is corrosion rate without inhibitor (mils/year).

Corrosion rate determination is carried out by following the steps:

1. After the corrosion process is carried out within a certain time, the pH of the medium is measured with a pH meter and set as the final pH
2. Corrosion products are removed from corrosion media, and dried in an oven at 110 ^oC for 2 hours, then weighed as final mass

2.2 Tannins Content Analysis with UV-Vis Spectrophotometer

Determination of tannin levels in Awak banana peel is carried out using UV-Vis Spectrophotometer, and absorbance is observed in wave numbers 765 nm.

2.3 Immersion of Iron Plate in HCl Solution without Inhibitors

Immersion of iron plate in HCl solution without inhibitor is carried out in accordance with the following steps:

1. The mass of the iron plate is weighed as the initial mass
2. The iron plate is soaked in 50 mL of 3% HCl solution
3. The pH of the medium is measured with a pH meter and set as the initial pH
4. The iron plate that has been soaked is stored for 3 days, 6 days, 9 days, and 12 days, then the corrosion rate and inhibition efficiency are determined by equation 1 and equation 2.

2.4 Immersion of Iron Plate in HCl Solution with Addition of Inhibitors

Immersion of iron plate in HCl solution with inhibitor is carried out in accordance with the following steps:

1. The mass of the iron plate is weighed as the initial mass
2. The iron plate is soaked in 50 mL of 3% HCl solution
3. Awak banana peel tannins are added 1 g, 3 g, 5 g, 7 g, and 9 g, respectively
4. The pH of the medium is measured with a pH meter and set as the initial pH
5. The iron plate that has been soaked is stored for 3 days, 6 days, 9 days, and 12 days, then the corrosion rate and inhibition efficiency are determined by equation 1 and equation 2.

3 RESULTS AND DISCUSSION

3.1 Fourier Transform-Infrared (FTIR) Analysis of Awak Banana Peel

In this study, FTIR is used to analyze chemical compounds of Awak banana peel compound. Based on the analysis, the banana peel compound could be seen in Figure 1. This figure shows us the presence of hydroxyl group (OH) in the area of 3398.5 cm^{-1}. This FTIR result analysis is similar to the results obtained by Zhao, et al., 2017 (Zhao *et al*., 2018). Hence, this FTIR result analysis indicates that Awak banana peel contains tannins.

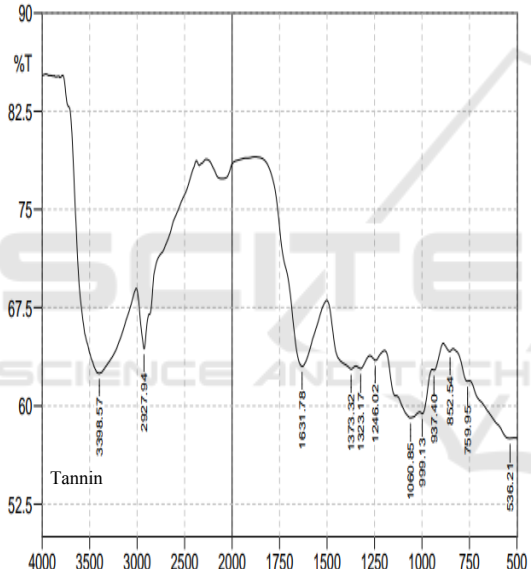

Figure 1: FTIR Analysis of Awak banana peel.

3.2 Tannins Content Analysis Awak Banana Peel with UV-Vis Spectrophotometer

Analysis using UV-Vis spectrophotometer is a qualitative analysis to determine the levels of tannins contained in the Awak banana peel. The spectrophotometer is operated at a wave number of 765 nm for its absorbance. Tannins on banana peels are identified by observing the maximum wave number absorbed by the Awak banana peel extract. The results of UV-Vis spectrophotometer analysis on the Awak banana peel extract are seen in Figure 2.

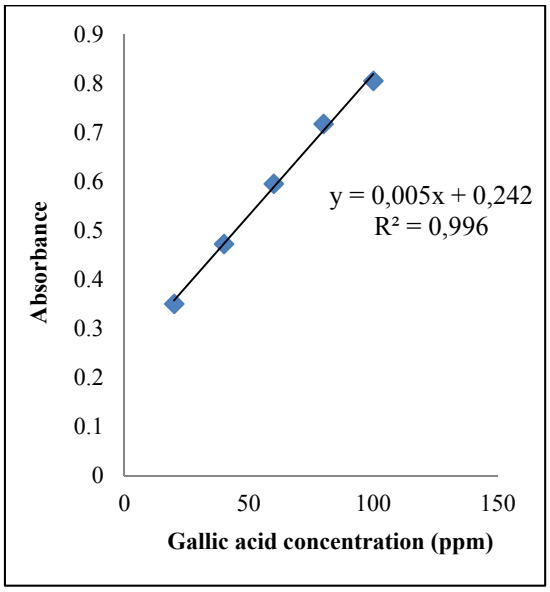

Figure 2: Standard Curve of UV-Vis Spectrophotometry Analysis.

3.3 Effect of Tannin Concentration of Banana Peel on Corrosion Rate of Iron

The effect of tannin concentration of banana peel on corrosion rate of iron could be seen in Figure 3. The presence of tannin is very influential to reduce the corrosion rate of iron in HCl solution. This result is consistent with the theory that the absorption at the metal surface increases with increasing inhibitor concentration (Umoren *et al*., 2015). The presence of electrons in the oxygen atoms of the hydroxyl group of inhibitors increase the interaction of the inhibitors formed on the iron surface. The presence of a hydroxyl group in the inhibitor molecule could decrease the corrosion rate (Hassan and Zaafarany, 2013). The lowest corrosion rate is obtained on immersion of iron for 12 days in HCl solution and addition of 9 g of tannin inhibitor. In this condition, the corrosion rate is 7.2578 mpy. Hence, the tannin from Awak banana peel could be used as corrosion inhibition of iron in HCl solution.

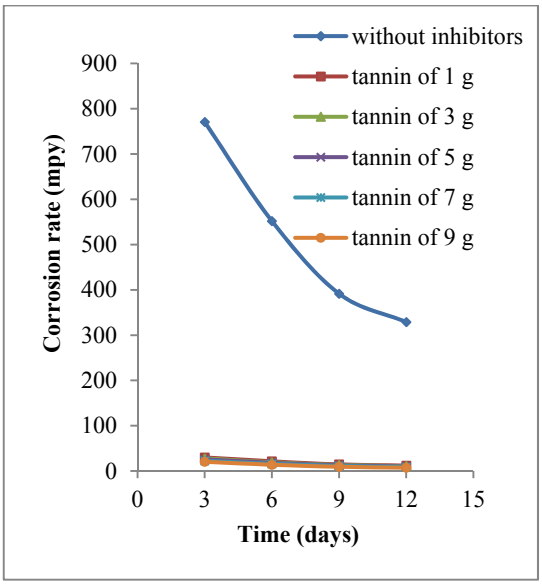

Figure 3: Effect of Tannin Concentration of Banana Peel on Corrosion Rate of Iron.

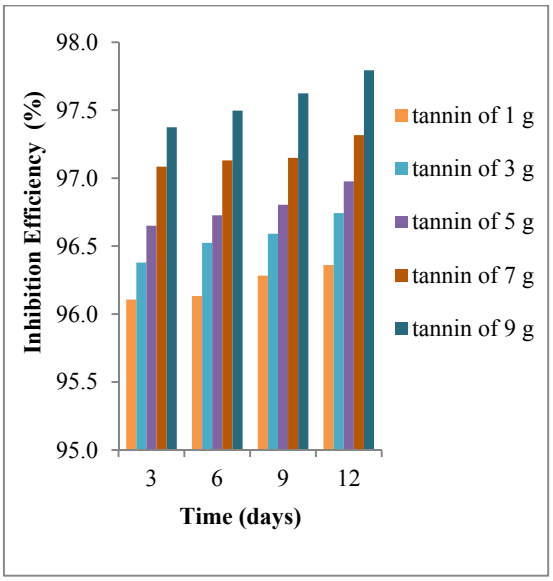

Figure 4: Effect of Tannin Concentration of Banana Peel on Inhibition Efficiency of Iron.

3.4 Effect of Tannin Concentration of Banana Peel on Inhibition Efficiency of Iron

Figure 4 describes the effect of tannin concentration of banana peel on inhibition efficiency of iron. This figure shows us that the highest inhibition efficiency is achieved in addition tannin of 9 g and the lowest in addition tannin of 1 g. In this condition the corrosion inhibition efficiency is 97.79%. The inhibition efficiency of iron increases with the increase of tannin content. This result in accordance with the theory that the inhibition efficiency depends on the concentration of tannin and the duration of contact between metal with corrosive medium (Khadom *et al*., 2018 and Rondang et al., 2015.

4 CONCLUSION

The corrosion rate of iron plate decreases with the addition of tannin inhibitor from Awak banana peel in a corrosive media of 3% HCl solution. The corrosion rate decrease with the increase of tannin content and the inhibition efficiency of iron increases with the increase of tannin content. The lowest corrosion rate about 7.2578 mpy and the highest inhibition efficiency about 97.79 % are achieved on the addition of tannin inhibitor of 9 g and immersion duration of 12 days.

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