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EFFECT OF THE ADDITION OF INHIBITORS OF KIRINYUH LEAF *(Chromolaena Odorata)* IN METHANOL EXTRACT ON CORROSION RATE OF ASTM 36 STEEL

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Abstract: Kirinyuh leaves *(Chromolaena Odorata)* contain alkaloids, saponins, flavonoids, phenols, and tannins with the potential as a natural inhibitor that can be used to inhibit the rate of corrosion. Kirinyuh leaf extract inhibitors were added at various concentrations of 100 ppm, 200 ppm, 300 ppm, 400 ppm, and 500 ppm, which were sprayed onto the sample surface before being soaked for seven days. Calculation of the corrosion rate using the method of *weight loss (weight loss)*. The results showed that kirinyuh leaf extract effectively inhibited the corrosion rate. The smallest corrosion rate value was found in the sample with the addition of 400 ppm inhibitor concentration, which was 2.053 ppm. Meanwhile, an efficiency inhibitor was also found in the same concentration of inhibitor that is equal to 87%.

Keywords: *Kirinyuh, Natural Inhibitors, ASTM A36, Loss of Weight*

INTRODUCTION

One problem that has always received special attention in the industrial field is corrosion. Corrosion is a process of material deterioration and a decrease in the quality of a material due to the influence of chemical and electrochemical reactions with environmental conditions. Proper corrosion protection design and ongoing maintenance are important factors in preventing corrosion. Therefore, knowledge of corrosion is very important given the current industrial developments. The use of metal in industrial and technological developments has a very large role, one of which is the use of ASTM A36 Steel metal. ASTM A36 steel is widely applied in parts construction, such as ship hulls [1]. The hull of the ship is a part that will experience direct contact with seawater. Sea water can be a factor in the corrosion process.

One method of inhibiting the process of corrosion is by using corrosion inhibitors. In general, corrosion inhibitors come from synthetic chemicals, which are dangerous, relatively expensive, and not environmentally friendly [2]. It will cause environmental pollution, which is bad for living things. Therefore, chemical inhibitors need to be replaced with natural inhibitors that are environmentally friendly, cheap, easy to obtain, and can be renewed. In general, natural inhibitors used by researchers contain antioxidant compounds. Antioxidant compounds at small concentrations can significantly inhibit or prevent oxidation [3].

The organic inhibitor is a protective layer of adsorbed molecules on the metal surface, which becomes a barrier to dissolving the metal in the electrolyte solution. Since the metal surface covered is proportional to the concentration of the inhibitor, the concentration of the inhibitor in the solution/medium is critical. For example, a concentration of 0.05% sodium benzoate or 0.2% sodium cinnamate is effective in water at a pH of 7.5 and contains 17 ppm NaCl or 0.5% by weight of ethyl octanol [7]. Its effectiveness depends on its chemical makeup, molecular structure, and affinity for the metal surface. Since film formation is an adsorption process, temperature and pressure are important factors. Organic inhibitors will be adsorbed based on the ionic charge of the inhibitor and the charge on the metal surface. Cationic, anionic, and sulfonate-sulphonate inhibitors will be adsorbed first, depending on whether the metal is negatively or positively charged.

In English, the kirinyuh plant *(Chromolaena odorata)* is called *Siam Weed* and is a very widespread prairie weed in Indonesia. Kirinyuh is thought to have spread in Indonesia since the 1910s, not only in dry land or mountains but also in swamps and other wetlands[8]. Kirinyuh originates from South and Central America, then spreads to the tropics of Asia, Africa, and the Pacific, and is classified as an invasive weed. This plant is a woody shrub that can develop quickly and form groups that can prevent the development of other plants. It is very detrimental because it can reduce the capacity of grazing land [9].

Kirinyuh leaves contain terpenoids and have antioxidant activity. Alkaloids, tannins, steroids, terpenoids, and flavonoids are the ingredients contained in Eupatorium odoratum, which have been reported by Akin Miladun et al. (2007) to have antioxidant and antibacterial activity. Meanwhile, according to the study of Tran et al. (2011), Chromolaena odorata leaf extract contains

flavonoids and alkaloids [10]. Flavonoid compounds can reduce and keep metal ions from becoming free radicals [5]. Based on this, kirinyuh leaves have the potential as a natural inhibitor that can be used to inhibit the rate of corrosion.

RESEARCH METHODS

Preparation of Kirinyuh Leaf Extract Inhibitors

Organic inhibitors begin by preparing kirinyuh leaves, which are dried at room temperature until the leaves are brown and easily crushed. After that, grind the kirinyuh leaves using a blender to produce kirinyuh leaf powder. After obtaining kirinyuh leaf powder, the powder is mixed with 1000 ml of 96% methanol solution and soaked for 3x24 hours. After that, separate the filtrate and residue by filtering it using filter paper. The filtrate was then evaporated using a rotary evaporator at a speed of 200 rpm and a temperature of 70º C to produce a concentrated extract. The concentrated extract from the rotary evaporator was then made into a 1000 ppm mother liquor. A 1000 ppm mains solution is prepared by taking 1 gram of concentrated kirinyuh leaf extract and mixing it with 1000 ml of distilled water. After obtaining the mother liquor, it is then diluted into concentrations, namely 100 ppm, 200 ppm, 300 ppm, 400 ppm, and 500 ppm. Then the solution is sprayed onto each steel sample that has been prepared according to the concentration, then let stand for 15 minutes to dry.

Phytochemical Testing of Kirinyuh Leaf Extract

1. Flavonoid

Testing The test was carried out by taking 2 mL of each leaf sample and heating it for about 5 minutes. After heating, each was added with 0.1 gram of Mg metal and 5 drops of concentrated HCl. If each solution forms a yellow-orange to-red color, it is positive for containing flavonoids.

Tannin Test

The test was carried out by taking 2 mL of each leaf sample, then heating it for about 5 minutes. FeCl3 was added to each$_3$ 1%If each solution formed greenish brown or blackish blue. It means it contains tannins.

2. Alkaloid Test

The test was carried out by taking 2 mL of each leaf sample into 2 different test tubes. After that, each extract was added with 5 drops of reagent Dragendorff. If each solution forms an orange-white precipitate, then it is positive for alkaloids.

3. Saponin Test

The test is carried out by taking 2 ml of extract and adding 3-5 ml of distilled water. Then shake vigorously and let it stand for 30 seconds-10 minutes. The result is positive for saponins if the stable foam that is formed has a height of 1-10 cm within 30 seconds.

ASTM A36 Steel Sample Preparation The

The sample used was A36 steel which was cut into 16 pieces with a size of 20 mm (p) x 20 mm (l) x 6 mm (t). After that, the sample was cleaned to remove the oxide layer on the sample's surface using sandpaper. After all the samples were cleaned, they were washed using acetone to remove any inherent impurities and then distilled water for the final stage of washing to make them completely clean. Length, width, and thickness were measured using a vernier caliper, while the initial mass of the sample was measured using a digital analytical balance.

Preparation of Seawater Medium The

seawater used is seawater taken from Labuan Badas, Sumbawa district. Then it is poured into the Erlenmeyer flask, which is put into a plastic container that can accommodate it according to ASTM G31-72 standards. There will be four places for the marinade container, then measured, salinity, initial pH, and volume. The minimum volume of solution to soak the sample is (0.2-0.4 ml/mm^2) x (sample surface area).

RESULTS AND DISCUSSION

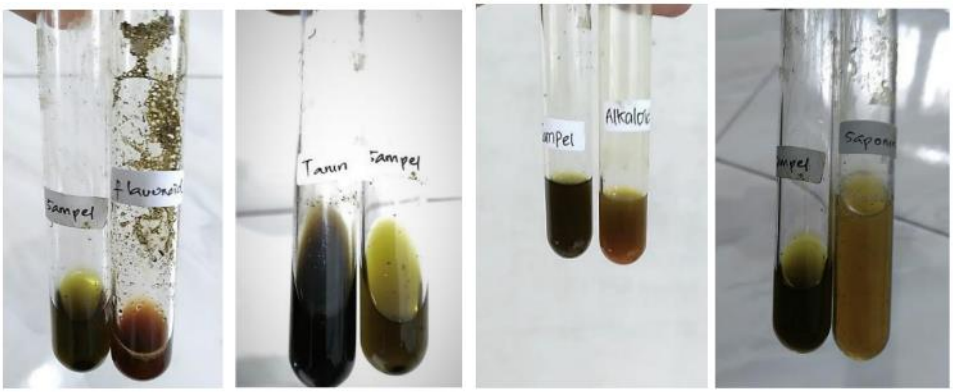
Results of Kirinyuh Leaf Methanol

The leaf methanol extract was kirinyuh evaporated using a rotary evaporator to produce concentrated kirinyuh leaf extract (Figure 1). Then it is diluted according to the required concentration and then sprayed onto the sample that has been prepared. The inhibitor solution sprayed onto the steel sample will adhere to the steel surface. It will prevent further corrosion processes because the kirinyuh leaf extract will be absorbed on the surface and protect the surface [12-14]. It is because the flavonoid and tannin molecules adsorbed on the surface of the steel plate form a protective film on the surface of the steel plate) [15], this adsorption will become a barrier separating the iron surface from the corrosion medium.

Extract Phytochemical Test Results of Kirinyuh Leaf Extract

This test aims to determine the presence of secondary metabolite compounds in kirinyuh leaves. The metabolites tested were flavonoids, tannins, alkaloids, and saponins. The test was carried out after the evaporation process was then carried out by phytochemical testing. The results of the phytochemical test of kirinyuh leaf extract are as follows figure 2.

Figure 1. leaf Kirinyuh



a b c d

Figure 2. Phytochemical test results (a) Flavonoids, (b) Tannins, (c) Alkaloids, (d) Saponins

Figure 2 shows a change in the color of the kirinyuh leaf extract sample after the phytochemical test. It shows that kirinyuh leaf extract contains secondary metabolites, flavonoids, tannins, and alkaloids. In sample (a), the color changes to orange, which means the sample contains flavonoids. In sample (b), the color changes to blackish blue, which means the sample contains tannins. In sample (c), there is an orange precipitate, which means the sample contains alkaloids. However, sample (d) did not indicate the presence of saponins because the sample did not foam after being treated. Secondary metabolites play a role in the inhibition process [16].

Table 1. Phytochemical Test Results of

Secondary Metabolites	Reactants	Yield
Flavonoid	HCL	Very Much
Tannin	$FeCl_3$ 1%	Lots
Alkaloids	of Dragendorff	Few
Saponins	Aquades	None

Table 1 shows that the results of the phytochemical test showed that kirinyuh leaf extract contains secondary metabolite compounds, such as flavonoids, tannins, and alkaloids).

Seawater Salinity Seawater

A refractometer can determine salinity by obtaining a salinity level of 26.6 ppt. Seawater was taken in Labuhan Badas, Sumbawa. Salinity (salt content) is an important aspect affecting the corrosion process. If the salinity of seawater is higher, the corrosion rate will be higher. Salt is a chemical compound that is both oxidizing and reducing, so automatically, if the level of salt content is greater, it will accelerate the corrosion rate [17].

Visual Observation of Samples Visual

observation of samples was carried out after immersion. Visual observation of these samples aims to determine the differences and conditions between samples without inhibitors or 0 ppm and samples after using 100 ppm, 200 ppm, 300 ppm, 400 ppm, and 500 ppm inhibitors. Figure 3 shows the condition of the sample image after immersion according to the concentration inhibitor.

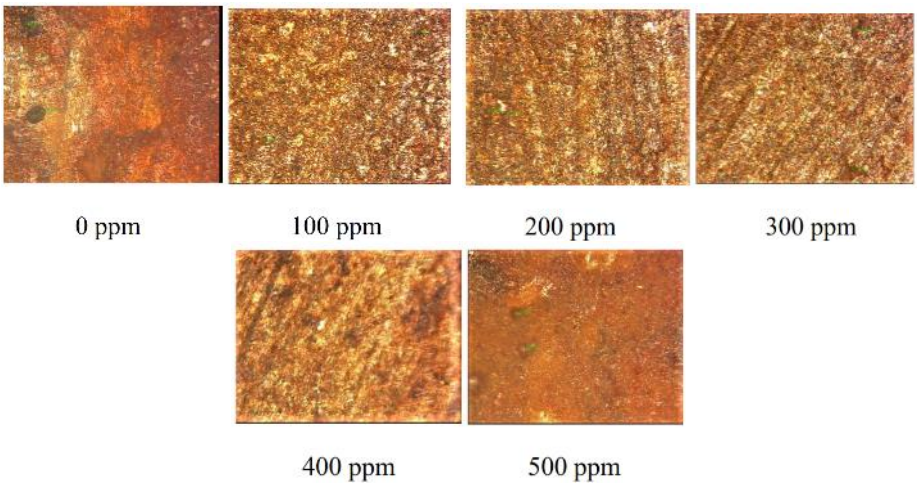


Figure 3. Sample microstructure magnification 40 microns

Figure 3 shows that it can be seen the results of observations using an optical microscope. In the samples that did not use inhibitors, namely in figure 0 ppm, damage due to corrosion was very clearly visible, which was marked by a peeling surface and looked rougher compared to samples of 100 ppm, 200 ppm, 300 ppm, 400 ppm, and 500 ppm. In the samples using inhibitors, almost all of the surfaces were corroded. It was indicated by the color of the sample's surface, which turned reddish brown, and the surface was rough when touched. It is because corrosion causes the metal surface to become uneven. After all, the protective film on the metal surface peels off [18].

Based on Figure 3, it can also be seen the type of corrosion that occurs in ASTM A36 steel. The type of corrosion that occurs in ASTM A36 steel immersed in seawater for seven days is a type of uniform corrosion characterized by the entire surface of the sample being covered by corrosion [19].

Corrosion Rate Results

In this study, corrosion rate testing was carried out by immersing A36 steel in seawater. It aims to determine the corrosion rate by calculating the lost mass weight. Sixteen steel samples were soaked with varying concentrations of inhibitors, namely 100 ppm, 200 ppm, 300 ppm, 400 ppm, and 500 ppm. Each concentration used three steel samples and one steel sample without inhibitors. It aims to get more accurate results. Before immersion, the sample surface area, initial weight, and immersion time were first calculated using the weight loss *method*. The graph of sample weight loss based on inhibitor concentration is as follows figure 4.

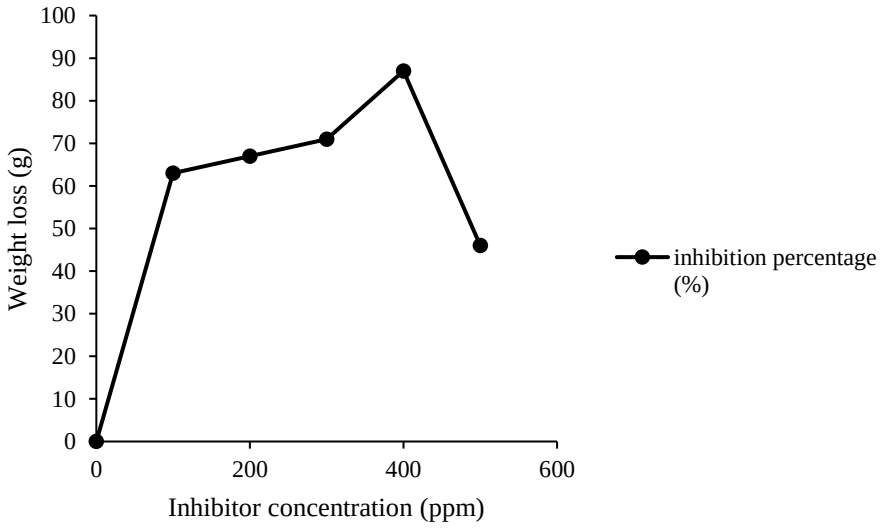


Figure 4. Weight loss based on inhibitor concentration

Figure 4 shows that the difference in sample weight decreased after seven days of immersion. The sample's weight loss is affected by immersion time with corrosive media, both using inhibitors

and not using inhibitors. The highest weight loss occurred in samples that did not use inhibitors, namely 0.08 g, while the smallest loss occurred in samples with a concentration of 400 ppm, namely 0.01 g. After obtaining the difference in weight then is calculated, the following is a graph of the corrosion rate.

Based on Figure 5, it can be seen that a sharp decrease occurred between samples that did not use inhibitors and samples that used 100 ppm inhibitors. The decrease that occurred was from 16,350 mpy then decreased to 6,131 mpy. It indicates that there is a change in the corrosion rate that occurs in the sample due to the addition of an inhibitor of kirinyuh leaf extract to the steel sample. Then with the addition of a greater inhibitor, the value of the corrosion rate will also experience a higher decrease. At a concentration of 200 ppm the corrosion rate again decreased, namely 5.314 mpy. At a concentration of 300 ppm the corrosion rate also decreased, namely 4.701 mpy, and the largest decrease occurred at a concentration of 400 ppm, namely 2.053 mpy. This concentration is the optimum concentration, where at this concentration, the complex compound formed is perfect so that the complex layer that protects the metal from the oxidation process that is formed also increases. This decrease was due to the presence of tannins and flavonoids contained in kirinyuh leaf extract, which were sprayed onto the steel samples before immersion, where these compounds could form a layer on the sample surface. This inhibitor forms a thin layer on the surface of the sample, which will become a barrier that separates the surface of the sample from the corrosion medium so that it can reduce or suppress the corrosion rate [20]. Figure 5 shows a directly proportional relationship between the corrosion rate and weight loss. However, in Figure 5 indicates that the corrosion rate increased at 500 ppm inhibitor concentration, namely 8,830 mpy. The capacity of its functional group to be adsorbed on the steel surface being maximum and cannot form a stable, protective layer. Other than that, the organic compounds in kirinyuh leaf extract undergo degradation. It is indicated by the increased corrosion products produced. Once the corrosion rate is known, then the efficiency of the inhibitor is calculated.

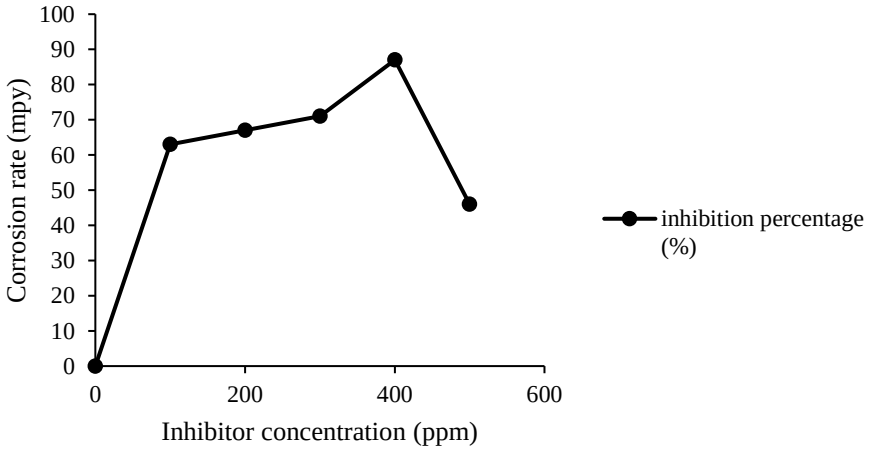


Figure 5. Corrosion rate based on inhibitor concentration

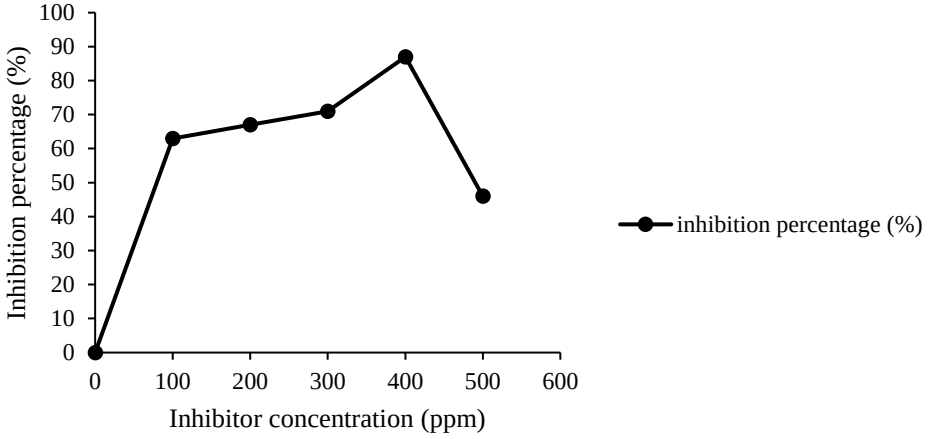


Figure 6. The inhibition efficiency of the test sample

Figure 6 depicts how the inhibitor's concentration affects the inhibition's efficiency. At inhibitor concentrations of 100 ppm to 400 ppm, the inhibition efficiency value is more significant, namely 63% to 87%. It is due to the effect of the inhibitor concentration on the steel sample before immersion. The higher the inhibitor, the greater the inhibition efficiency value. However, the inhibitor's ability or inhibition efficiency to protect steel from corrosion will be lost at specific concentrations. The capacity of its functional group to be adsorbed on the steel surface is maximum and cannot form protective, as seen in Figure 7 at an inhibitor concentration of 500 ppm. The corrosion rate again decreased by 46%.

CONCLUSION

Inhibitors from kirinyuh leaf extract can reduce the corrosion rate of ASTM A36 steel in seawater media. The highest corrosion rate was found in samples without using an inhibitor, which was 16,350, and the lowest corrosion rate was found in samples with the addition of 400 ppm inhibitor concentration, which was 2,053. In general, efficiency increases with the amount of inhibitor concentration added. Efficiency is 87% with the addition of 400 ppm inhibitor concentration.

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