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Utilization Of Guava Leaves Extract (*Psidium Guajava*) As Ecofriendly Corrosion Inhibitor For Iron

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Abstract: *The use of a green inhibitor from guava leaves extract as an alternative to environmentally friendly metal corrosion inhibitors has been carried out. The guava leaves extracted by 96% ethanol in the maserator for 4 days with occasional shaking and two rejuvenations. The inhibitor performance test was carried out using 2 types of water (wells and sea), as well as variations in extract concentrations of 3%, 10% and 25%. Through phytochemical testing results, it was found that the active secondary metabolite components contained in guava leaves are flavonoids, terpenoids, and tannins. Increasing the concentration of guava leaves extract in well and sea water samples, reducing the value of the corrosion rate. In seawater, the use of 25% leaves extract, there was a weight increase of nails only 0.165% of the initial weight compared with no extract which was 10.75% of the initial weight. Furthermore, the greatest inhibitor efficiency occurred at 25% extract concentration, which was 96.39% in well water media and 97.07% in sea water media. Therefore, guava leaves have the potential to be used as future green inhibitor applications.*

Keywords: *corrosion inhibitors, ecofriendly, guava, secondary metabolites*

1. INTRODUCTION

As one of the supporting materials, the use of iron in the development of technology and industry is currently very large. As we already know, iron is widely used in the oil and natural gas industry, namely as a pipe for the exploration and production process (Hu et al., 2018). In addition, because it has good mechanical properties, iron material can be used in building and shipbuilding industry applications. However, in everyday life many factors cause this iron usability to decrease. One of the causes of this is the corrosion of iron. This corrosion is enough to cause losses, namely maintenance costs, material replacement costs, plant shutdown, loss production, and others. So far, the use of inhibitors to reduce corrosion rates has been widely developed (Akbar et al., 2018; Askari et al., 2018). The advantage is that the addition of this inhibitor is very useful in materials that do not allow coating protection and cathodic protection methods to be used. The inhibitor works by absorbing ions or molecules that are rich in free electrons into the metal surface through the formation of complex compounds. This will reduce the rate of diffusion of the reactants into the metal surface and increase the electrical resistance of the metal surface (Rassouli et al., 2018).

So far, several types of inhibitors that have been widely used in industrial applications are synthetic chemical inhibitors. These inhibitors are generally made from compounds containing silicates, phosphates, borates, dichromate, molybdate, chromate, tungstate, and arsenic (Rochliadi et al., 2015; Akbar et al., 2017). However, these compounds are environmentally friendly, toxic, and expensive. To overcome this problem, the development of an alternative corrosion inhibitor that is environmentally friendly or better known as the green inhibitor has been widely used. Basically, green inhibitors contain elements of P, S, N, O, and elements that have free electron pairs (Moradi et al., 2018). Research on green inhibitors using gelatin in steel in HCl solution media has been reported (Haruna et al., 2018). Gelatin can inhibit corrosion by up to 15% HCl. Other studies through the manufacture of N-isonicotinamido-3-methoxy-4-hydroxybenzalaldimine (IM) based on vanillin and isoniazid, can resist corrosion with inhibitor efficiency reaching 93% at 120 mg / L (Mo et al., 2018). The use of black pepper as a metal corrosion inhibitor has also been carried out, the effectiveness of the green inhibitor is because the extract contains nitrogen from the alkaloid group which forms complex compounds on the surface of iron (Verma et al., 2018). Another study showed that lawsonia extract was used as an inhibitor in iron carbon in 3.5% NaCl media. The extract gave an efficiency of 91.01% at a concentration of 800 ppm. Lawsonia extract is rich in O elements from polyphenols in the form of flavonoids (Askari et al., 2018).

The results of a review of the chemical composition and activity of the Guava (*Psidium guajava*) plant showed that, on the Guava leaves, Avicularin contained flavonoids (Wang et al., 2018; Chakraborty et al., 2018). As is known, flavonoids are polyphenol class secondary metabolites that are rich in element O. So far there are no studies related to the application of components of guava leaves as corrosion inhibitors. Therefore, in this case the researcher wants to study the Guava leaves as a potential to be used as a green inhibitor.

2. EXPERIMENTAL

Tools

The tools used include rotary evaporator, glass equipment in the laboratory, 40 mesh sieve, blender, analytic balance, filter paper, iron nails sold on the market, sandpaper, roll tissue, funnel, label paper, drop pipette.

Materials

Furthermore, the materials used in this study were red guava leaves, guava leaves, chemicals used in technical ethanol (96%), hydrochloric acid (HCl), well water, and sea water.

Methods

Guava Leaves Extraction Process

The ingredients of fresh guava leaves are made by simplicia through drying by aerated. Simplicia powder is made with a grinding machine. 200 g of guava leaves simplicia powder was extracted by using 1 liter 96% ethanol in the maserator for 4 days with occasional shaking and two reassembles. The extract obtained was concentrated using a rotary vacuum evaporator at a temperature between 60-70°C until the extract was rather concentrated. Then proceed with concentration in the water bath to concentrated extract. The concentrated extract was dissolved in 100 mL distilled water and then added 100 mL of n-hexane separated by liquid-liquid extraction in the separating funnel until the n-hexane fraction was obtained and concentrated. The n-hexane insoluble fraction was added with 100 mL ethyl acetate and separated until the ethyl acetate fraction and water fraction were then concentrated.

Inhibitor Performance Testing

Iron nail samples were cleaned using sandpaper then dipped in 0.01 N HCl solution. Then rinsed with alcohol, washed with aquadest, dried and weighed (Wo). Anticorrosion performance testing on guava leaves extract was carried out using 2 different types of water, namely using well water and sea water. At first 4 corrosion testing places were labeled with iron nails I, iron nails II, iron nails III, and iron nails IV. Then each one is filled with 10 mL of well water, then 4 other places with the same label as before, but filled with sea water. Then into each place, 1 iron nail rod has been cleaned and weighed. Then in places 2, 3 and 4, each of which was filled with sea water and a well of 10 mL was added with an inhibitor solution with a concentration of 3%, 10% and 25%, respectively, for 7 days. The iron nails that have been soaked are then removed, washed, dried, and weighed (Wf) to find out the weight gain in the iron. Then the corrosion rate and the effectiveness of the inhibitor are calculated.

3. RESULT AND DISCUSSION

Guava Leaves Extraction Process

Extraction of guava leaves is done by maceration method. First the leaves are cleaned, then cut into small pieces, after that the guava leaves are dried until they are completely dry. After the leaves dry, then the simplicia powder is made by grinding using a grinding machine without using water. The 200 g of guava leaves simplicia powder was then extracted using 1 liter 96% ethanol in the maserator for 4 days with occasional shaking and two rejuvenations. Extracts from black guava leaves are found. The extract was then concentrated using a rotary vacuum evaporator at a temperature between 60-70°C until the extract was rather concentrated.

Figure 1. Extraction process of guava leaves

Testing the Existence of Secondary Metabolites

Phytochemical testing needs to be done to ensure the secondary metabolite components contained in guava leaves such as alkaloids, flavonoids, saponins, terpenoids, steroids, tannins and polyphenols. For more clear results can be seen in table 2 and figure 1. The first secondary metabolite test is the alkaloid test. The basic principle of this test is the formation of brownish orange deposits on the bottom of the tube from the solution with orange color (Dragendorff Reagent). In guava leaves extract only shows the color of yellowish solution without precipitate. Furthermore, in the flavonoid test, using concentrated Mg and HCl powders produced a red solution of guava leaves extract which indicated a positive result (Chakraborty et al., 2018).

Then, the saponin test produce a solution with a stable foam formation as high as ± 1.5 cm, which indicates a positivetive result. The same thing was shown in the steroid test, through Lieberman Burchard reagent, guava leaves extract did not show a green color which means a negative result. However, it shows a purple color that indicates the presence of terpenoids. The next test for secondary metabolites is the polyphenol test and tannin test (Wang et al., 2018). Polyphenol test results using a color test produce a solution of bluish green color, which indicates a positive result. However, the polyphenol test in guava leaves extract produces a yellowish color, this indicates a negative result. Whereas for tannins produce a greenish purple color, this indicates that guava leaves extract contains tannin compounds.

Table 1. Test results of secondary metabolites of guava leaves extract through phytochemicals

Compound	Color if the result is positive	Color observed	Information
Alkaloid	Orange precipitation	Yellowish Solution	Negative
Flavonoid	Red or orange	Brownish red	Positive
Saponin	Foam	foam	Positive
Steroid	Dark blue or blackish green	Yellowish	Negative
Terpenoid	Purple	Purple greenish	Positive
Tanin	Deep bluish green	Purple greenish	Positive
Polifenol	Bluish green	Yellowish	Negative

From the results of phytochemical tests that have been carried out, qualitatively flavonoid compounds have been shown to exist in guava leaves which are characterized by the formation of yellowish changes from pink to reddish brown. From the various references obtained, the flavonoid components of guava leaves are in a form that corresponds to figure 2 (Wang et al., 2018; Chakraborty et al., 2018). Therefore, being convinced that guava leaves taken from the area where the researcher is domiciled, contain secondary metabolite components which are potential to be used as green inhibitors.

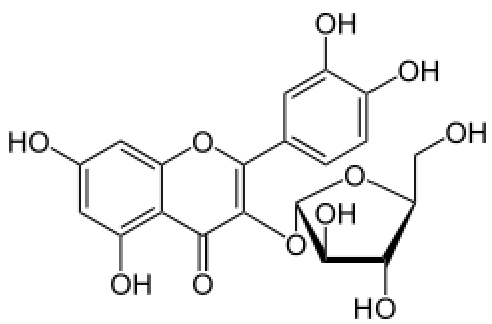

Figure 2. Avicularin structure of flavonoid in guava leaves

Inhibitor Performance Testing

Inhibitor performance has been tested with guava leaves extract on iron nails, which are applied to 2 different types of water media, namely well water and sea water. This test is carried out within a period of immersion for 7 days. Figure 3 shows the color gradations that are quite striking from the 4 place. Seen place a) shows the level of corrosion that is almost similar between the two types of water. After 7 days, the entire nail in the place is dried to weigh the mass. Then the difference in mass after 7 days and the initial mass of nails is a mass of increase in nails (rust mass) shown in Figure 4. The inhibitor performance measurements were carried out in 3 experiments for each type of water and the concentration of the extract, so that percent error is also attached to the graph to show accuracy measurement.

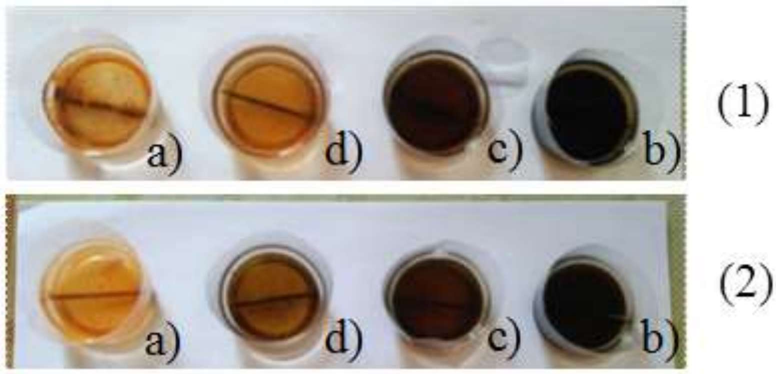

Figure 3. Immersion of iron nails in water 1) well 2) sea, with the addition of 1 guava leaves extract 1) 0% 2) 3% 3) 10% and 4) 25%, for 7 days

From the experiment it was found that in place a) (which does not have guava leaves extract), using both well water and sea water, the weight of the nail increases. The average weight value increased by 0.4 g in the well water medium and 0.56 g in the sea water media. This happens because there is no addition of guava leaves extract that is used as a natural anti-corrosion inhibitor, so that the rust is very much. Furthermore, in a place containing guava leaves extract, namely place b), place c) and place d) there is no significant addition of nail weight. Where in place b) with 3% guava leaves extract, there was an increase in the weight of nails which were originally 5.013 g to 5.233 g in the well water medium and 5.315 g to 5.455 g. In fact, in place d) with 25% of leaves extract, showed a weight increase of nails of 0.165% of the weight of the nail at first well water media and 0.235% of the weight of the nail media at first seawater.

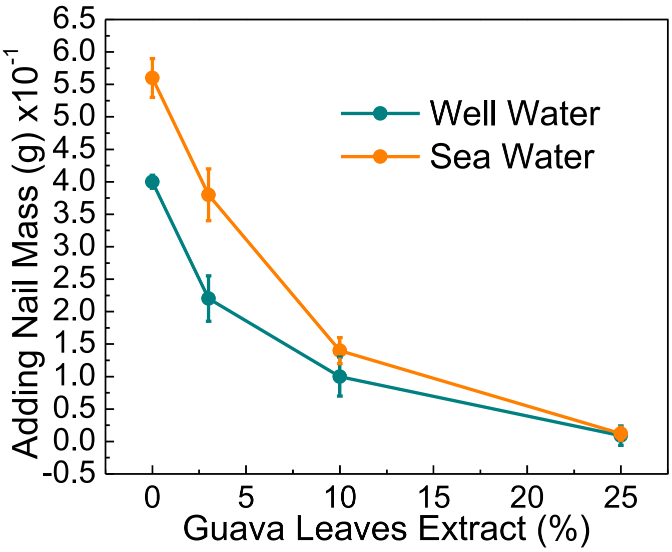

Figure 4. Graph of adding metal masses to nails during 7 days of immersion

This proves that guava leaves extract can be used as a green inhibitor which can inhibit the corrosion of iron in both well water and seawater media, as evidenced by the increasing weight of nails compared to iron nails that are not given inhibitors. Increased inhibitor concentrations cause more inhibitor molecules to be adsorbed on the metal surface, providing more surface coverage with compounds acting as adsorption inhibitors. The greater the concentration of guava leaves extract that is used as a corrosion inhibitor, the addition of nail weight decreases even not even at all, the weight of nails before soaking and after soaking almost does not show any difference.

Determination of Corrosion Rate and Effectiveness of Inhibitors

To determine the inhibitory ability of guava leaves and leaves extract on the iron corrosion rate qualitatively, the corrosion rate of iron was determined by dividing the addition of iron mass to the outer surface of the nail and time. The effect of variations in the concentration of guava leaves extract on immersion of iron nails in well water media and seawater media can be seen in Table 2. Based on the results of the study of corrosion rate, for the solution that was not extracted, the fastest corrosion rate occurred at a concentration of 0% that is equal to 0.000607 g/cm^2.day in well water media and 0.000849 g/cm^2.day in sea water media. As guava leaves extract increases, the corrosion rate becomes slower. The slowest corrosion rate occurs at a concentration of 25% which is equal to 0.0000136 g/cm^2.day in the well water medium and 0.0000182 g/cm^2.day in the medium of sea water.

Table 2. Corrosion rates in iron nails with various concentrations of guava extract and type of water

Extract (%)	Well Water			Sea Water		
	Nail Mass		Corrosion rate (g/cm^2.day)	Nail Mass		Corrosion rate (g/cm^2.day)
	Initial (g)	End (g)		Initial (g)	End (g)	
0	5.702	6.102	0.000607	5.208	5.768	0.000849
3	5.013	5.233	0.000334	5.492	5.872	0.000576
10	5.315	5.415	0.000152	5.315	5.455	0.000212
25	5.424	5.433	0,0000136	5.083	5.095	0,0000182

Then, after obtaining iron nail corrosion rate, the next step is to determine the effectiveness of corrosion inhibition of iron metal. The potential of guava leaves extract as a corrosion inhibitor on iron nails in well water and sea water can be determined based on the value of inhibition efficiency that can be calculated so that the value of inhibition efficiency is shown as shown in Figure 5. Based on the picture, the greatest inhibitor efficiency occurs at 25% concentration extract that is 96.39% in well water and 97.07% in sea water media. The smallest inhibitor efficiency occurs when the concentration of 3% is 11.96% in the medium of well water and 7.35% in the medium of sea water.

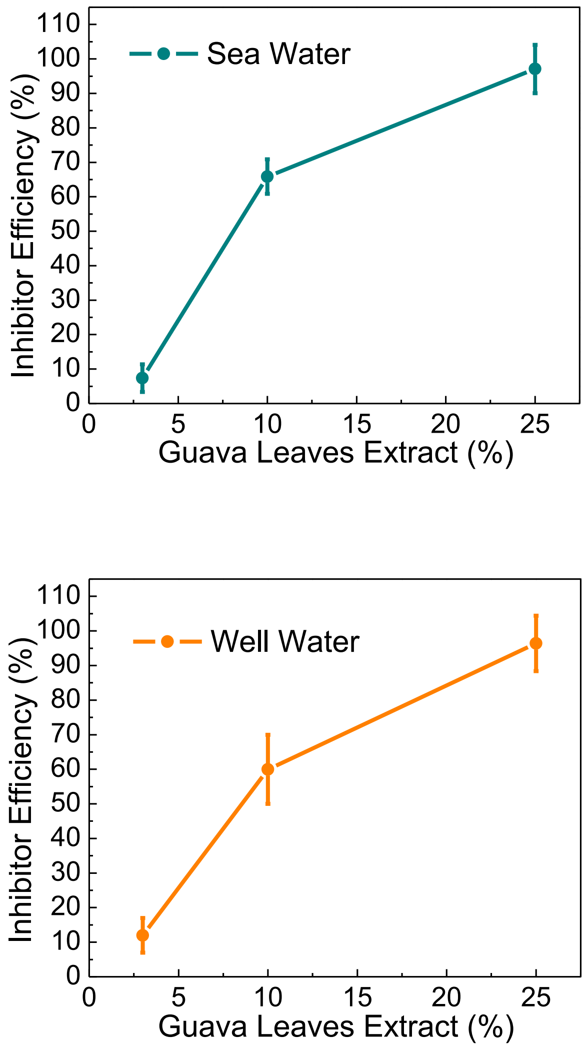

Figure 5. Graph of efficiency of inhibition of guava leaves extract

Increased inhibitor concentrations cause more inhibitor molecules to be adsorbed on the metal surface, providing more surface coverage with compounds acting as adsorption inhibitors (Akbar et al., 2017; Haruna et al., 2018; Saviour et al., 2018). Increases in chemical inhibitor concentrations tend to be directly proportional to the increased efficiency of inhibition (Mahidashti et al., 2018; Wysocka et al., 2018). In terms of molecular structure, the value of good inhibition efficiency can be caused by the presence of heterocyclic/aromatic structures and the results obtained indicate that the active compounds of flavonoids in guava leaves extract play an active role in increasing inhibitor efficiency.

4. CONCLUSION

The components of active secondary metabolites contained in guava leaves are flavonoids, terpenoids, saponin, and tannins. This was demonstrated through a series of photochemical screening tests on leaves extracts. Increasing the concentration of guava leaves extract in well and sea water samples, reducing the value of the corrosion rate as a function of the addition of nail weight. The use of 3% guava leaves extract resulted in the addition of nail weight from 5.013 g to 5.233 g at the well water medium and 5.492 g to 5.872 g. In fact, with 25% of the leaves extract, the weight gain of the nails was 0.165% of the weight of the nail in the medium of well water and 0.235% of the weight of the nail in the medium of sea water. Furthermore, the greatest inhibitor efficiency occurred at 25% extract concentration, which was 96.39% in well water media and 97.07% in sea water media. Therefore, guava leaves has the potential to be used as a future green inhibitor application.

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REFERENCES

Akbar, S. A., Mardhiah, A., Saidi, N., & Lelifajri, L. (2017). Sintesis Dan Karakterisasi Polianilina (PANI) Dengan Variasi Doping Asam Kuat Menggunakan Metoda Elektrodeposisi, *Prosiding Seminar Nasional USM (pp. 557–559). Aceh, Indonesia*. DOI: https://ojs.serambimekkah.ac.id/index.php/semnas/article/view/433

Akbar, S. A., Rochliadi, A., Suendo, V., Saidi, N., Lelifajri., & Mardhiah, A. (2018). A Raman Spectroscopy Study Of The Polyaniline Electrode On Zn-Polyaniline Rechargeable Batteries, Rasayan J. Chem. 11(4), 1525-1531. DOI: http://dx.doi.org/10.31788/RJC.2018.1144064

Askari, M., Aliofkhazraei, M., Ghaffari, S., & Hajizadeh, A. (2018). Film Former Corrosion Inhibitors For Oil and Gas Pipelines - A Technical Review. *J Nat Gas Sci Eng*. 58, 92-114. DOI: https://doi.org/10.1016/j.jngse.2018.07.025

Chakraborty, S., Afaq, N., Singh, N., & Majumdar, S. (2018). Antimicrobial activity of Cannabis sativa, Thuja orientalis and Psidium guajava leaves extracts against methicillin-resistant Staphylococcus aureus. *J. Integr. Med*. 16(5), 350-357. DOI: https://doi.org/10.1016/j.joim.2018.07.005

Haruna, K., Obot, I. B., Ankah, N. K., Sorour, A. A., & Saleh, T. A. (2018). Gelatin: A Green Corrosion Inhibitor for Carbon Steel in Oil Well Acidizing Environment. *J Mol Liq*. 264, 515-525. DOI: https://doi.org/10.1016/j.molliq.2018.05.058

Hu, W., Li, C., & Shchukin, D. G. (2018). Ceramic Honeycomb-Like Alumina Film as Corrosion Inhibitor Carrier and Mechanism Analysis. *Colloids Surf*. A. 555, 237-245. DOI: https://doi.org/10.1016/j.colsurfa.2018.06.071

Mahidashti, Z., Shahrabi, T., & Ramezanzadeh, B. (2018). The Role of Post-Treatment of An Ecofriendly Cerium Nanostructure Conversion Coating by Green Corrosion Inhibitor on The Adhesion and Corrosion Protection Properties of The Epoxy Coating. *Prog Org Coat*. 114, 19-32. DOI: https://doi.org/10.1016/j.porgcoat.2017.09.015

Mo, S., Li, L. J., Luo, H, Q., & Li, N. B. (2017). An Example of Green Copper Corrosion Inhibitors Derived from Flavor and Medicine: Vanillin and Isoniazid, *J Mol Liq*. 242, 822-830. DOI: https://doi.org/10.1016/j.molliq.2017.07.081

Moradi, M., Song, Z., & Xiao, T. (2018). Exopolysaccharide Produced by Vibrio Neocaledonicus Sp. As A Green Corrosion Inhibitor: Production and Structural Characterization. *Mater Sci Technol*. 34, 2447-2457. DOI: https://doi.org/10.1016/j.jmst.2018.05.019

Rassouli, L., Naderi, R., & Mahdavain, M. (2018). Study of The Impact of Sequence of Corrosion Inhibitor Doping in Zeolite on The Self-Healing Properties of Silane Sol–Gel Film, *Ind. Eng. Chem. Res.* 66, 221-230. DOI: https://doi.org/10.1016/j.jiec.2018.05.033

Rochliadi, A., Akbar, S. A., & Suendo, V. (2015). Polyaniline/Zn as secondary battery for electric vehicle base on energy return factor, *Proceedings of the Joint International Conference on Electric Vehicular Technology and Industrial, Mechanical, Electrical and Chemical Engineering (ICEVT & IMECE)* (pp. 353–358). Surakarta, Indonesia. DOI: https://doi.org/10.1109/ICEVTIMECE.2015.7496686

Saviour, A., Umoren., Abdullah, A., Ahmary, A., Gasem, Z. M., & Solomon, M. M. (2018). Evaluation of Chitosan and Carboxymethyl Cellulose as Ecofriendly Corrosion Inhibitors for Steel. *Int. J. Biol. Macromol*. 117, 1017-1028. DOI: https://doi.org/10.1016/j.ijbiomac.2018.06.014

Verma, C., Ebenso, E. E., Bahadur I., & Quraishi, M. A. (2018). An Overview on Plant Extracts as Environmental Sustainable and Green Corrosion Inhibitors for Metals and Alloys in Aggressive Corrosive Media. *J Mol Liq*. 266, 577-590. DOI: https://doi.org/10.1016/j.molliq.2017.02.111

Wang, L., Lu, F., Liu, Y., Wu, Y., & Wu, Z. (2018). Photocatalytic Degradation of Organic Dyes and Antimicrobial Activity of Silver Nanoparticles Fast Synthesized by Flavonoids Fraction of Psidium Guajava L. Leaves. *J Mol Liq*. 263, 187-192. DOI: https://doi.org/10.1016/j.molliq.2018.04.151

Wysocka, J., Cieslik, M., Krakowiak, S., & Ryl, J. (2018). Carboxylic Acids As Efficient Corrosion Inhibitors of Aluminium Alloys In Alkaline Media. *Electrochim. Acta*. 289, 175-192. DOI: https://doi.org/10.1016/j.electacta.2018.08.070