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THE EFFECT OF SNAKEFRUIT EXTRACT (*SALACCA ZALACCA*) IN INHIBITING THE RELEASE OF CHROMIUM (Cr) AND NICKEL (Ni) ION FROM STAINLESS STEEL ORTHODONTIC WIRE TO SALIVA

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ABSTRACT

Objective: People are not yet aware of the risk of using orthodontic appliances. It may cause corrosion in the mouth due to the metal ions released that can compromise the human body. Snake fruit seeds containing cellulose and antioxidants could inhibit the corrosion process. The aim of this study was to determine the effect snake fruit extract (*Salacca zalacca*) in inhibiting the release of chromium (Cr) and nickel (Ni) ions from stainless steel orthodontic wire to saliva.

Methods: This study used an experimental laboratory study with post-test control group design and stainless steel orthodontic wires with a diameter of 0.42 mm. The samples were artificial saliva that divided into 2 groups, one group without treatment and three groups were given snake fruit extract with a concentration of 100 ppm, 300 ppm and 500 ppm, respectively. Cr and Ni ion release was measured using Atomic Absorption Spectrophotometry. The collected data were then analyzed using computer software.

Results: The results showed that Cr ion release value in the control group was the lowest while in the treated group with a concentration of 100 ppm, and 500 ppm were the same. The Ni ions release in the treated group, with a concentration of 300 ppm showed the lowest value.

Conclusion: This study concluded that Snakefruit seeds extract effectively inhibits the Ni ions release from stainless steel orthodontic wire at a concentration of 300 ppm.

Keywords: Stainless steel orthodontic wires, Chromium, nickel, Snakefruit seeds extract, Artificial saliva

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INTRODUCTION

Malocclusion is an important issue in the field of dental health, especially in the field of orthodontics in Indonesia. Malocclusion is a deviation from normal occlusion, where there is a discrepancy between the dental arch and the jaw arch that occurs in the upper jaw and the lower jaw, its clinical features are crammed, protrusion crossed both anterior and posterior [1].

One of the tool components used in orthodontic treatment is orthodontic wire. There are several types of orthodontic wire that can be used, among others, titanium nickel wire, stainless steel, CuNiTi, and beta titanium. Each wire has different characteristics [2]. Stainless steel orthodontic wire is the most commonly used wire currently in orthodontic treatment. Stainless steel wire is also known as corrosion-resistant steel containing iron (Fe), carbon (C), chromium (Cr), and nickel (Ni). The price is also more economical, but different manufacturing processes can affect the level of corrosion resistance of stainless steel wire [3].

The ingredients used in dentistry should have certain characteristics such as biological safety and function, adequate tissue response, and corrosion resistance. In the field of orthodontic dentistry, alloys that are often used as components (nickel and chromium) have been identified as cytotoxic, mutagenic, and allergenic. Although this is still rare, it requires consideration and early handling [4, 5].

In the process of corrosion of stainless steel materials in the oral cavity, the release of metal ions that can enter the body and cause effects such as carcinogenic, allergenic, mutagenic and cytotoxic. Corrosion is visible when it occurs for a long time but microorganisms in a long time can be detected by corrosion in the presence of oxidation and reduction processes resulting in the release of ions from the constituents [6].

The corrosion process can be avoided by the addition of inhibitor materials consisting of organic and inorganic inhibitors. Inhibitors derived from inorganic natural materials are safer and biocompatible in the body. Antioxidant compounds play an important role in the body's defence against the adverse effects of free radicals. Free radicals are caused by tissue damage due to oxidation process [7, 8].

Antioxidants are defined as compounds capable of delaying, slowing or inhibiting oxidation reactions. One of the natural ingredients that are said to have a large antioxidant content are salak seeds. The results of the phytochemical tests showed that the seeds contained flavonoid and tannin compounds and little alkaloids. The ethanol extract bark beans have antioxidant activity with IC_{50} value of 229.27±6.35 mg/ml [7, 8].

Based on the description above, the conducted study tests the chemical content of seed extract salak that can play a role in inhibiting the release of chromium and nickel ions from stainless steel orthodontic wire which is released in saliva.

MATERIALS AND METHODS

Material

This laboratory experiment research was conducted at Phytochemical Laboratory of Hasanuddin University Faculty of Pharmacy, Biochemistry Laboratory Faculty of Mathematics, Hasanuddin University and Analytical Chemistry Laboratory Faculty of Mathematics, Hasanuddin University. Salak fruit seeds were destroyed using a scar machine to produce salak seed powder. Salak seed powder was then diluted with methanol 99% for five days. The mixture was passed through a filter paper and the filtrate was evaporated using a rotary evaporator to obtain a viscous extract.

Salak seed extracts were made into three different concentrations, 100 ppm, 300 ppm, and 500 ppm, by dissolving the extract in artificial saliva. These solutions were the treatment groups. The sample consisted of four groups: one control group without the addition of inhibitor materials and three groups of treatment with the addition of inhibitor materials of each concentration of 100 ppm, 300 ppm, and 500 ppm. Then the control and treatment groups were then tested on orthodontic wire immersion for one day the files are located in the tool incubator at a temperature of 37 ° C. then the filtrate is the result of soaking and then weighed equally on each sample then diluted with the addition of 65% HNO_3 and heated to produce a clear colourless filtrate. The sample of the destruction result is then filtered and left for 1 x 24 h to produce a ready-to-measure sample. The sample is then measured using atomic absorption spectrophotometry (SSA) with 3 times injection measurements on each sample to determine the average number in each sample absorbance measurements. All the results of further research done processing and data analysis using the computer program and then analyzed.

RESULTS AND DISCUSSION

This study examined the effect of extracts of salak seeds in inhibiting the release of chromium (Cr) ions and nickel (Ni) from stainless steel orthodontic wire in saliva, the results of the research of metal ion release measurements can be seen that the immersion of stainless steel orthodontic wire in the treatment group with the addition of seed extract of bark at concentrations of 100 ppm, 300 ppm, 500 ppm has no effect in inhibiting the release of chromium (Cr) ions. While the measurement of nickel ions (Ni) produced different results, where there was a decrease in the release of nickel ions (Ni) in the treatment group with a concentration of 300 ppm. So it can be concluded that there is an effect of the extract of salak seed *(Salacca zalacca)* in inhibiting the release of nickel ions (Ni) from the wire stainless orthodontic steel at saliva is best at a concentration of 300 ppm.

Table 1: Differences in Cr release ions that occur after immersion

Sample code	Absorbance	[Cr] (mg/l)	Weight of sample (G)	Vol samples (ml)	[Cr] mg/kg	[Cr] (%)
	0.0000					
Saliva	0.0000	0.000	10.0282	25	0.00	0.00000
	0.0000					
Average	0.0000					
	0.0000					
E-100 ppm	0.0000	0.000	10.0178	25	0.00	0.000000
	0.0000					
Average	0.0000					
	0.0000					
E-300	0.0010	0.000	9.9834	25	0.00	0.000011
	0.0010					
Average	0.0010					
	0.0000					
E-500 ppm	0.0000	0.000	10.0006	25	0.00	0.000000
	0.0000					
Average	0.0000					

Table 1 shows the results of laboratory test of the amount of chromium ion (Cr) release in the treatment group of salak seed extract in each concentration by immersing stainless steel orthodontic wire in artificial saliva with pH 6.8 at 37 ° C for 1 x 24 h. The release of the amount of chromium ion (Cr) varies for each sample. Data measurement for chromium ion (Cr) release in the treatment group extract of 300 ppm shows 0.004 mg/l, whereas at concentrations of 100 ppm and 500 ppm and in the control group without treatment showing the same result, wherein there is no chromium (Cr) ion content dissolved in the saliva expressed in a yield of 0.00000 mg/l. So it can be concluded that there is no effect of the extract of salak seeds in inhibiting the release of chromium ions (Cr).

Table 2: Differences in the release of Ni ions that occur after immersion

Sample code	Absorbance	[Ni] (mg/l)	Weight of sample (G)	Vol samples (ml)	[Ni] mg/kg	[Ni] (%)
	0.0050					
Saliva	0.0030	0.070	10.0282	25	0.17	0.000017
	0.0040					
Average	0.0040					
	0.0070					
E-100 ppm	0.0080	0.169	10.0178	25	0.42	0.000042
	0.0050					
Average	0.0067					
	0.0030					
E-300	0.0040	0.049	9.9834	25	0.12	0.00001
	0.0030					
Average	0.0033					
	0.0050					
E-500 ppm	0.0090	0.285	10.0006	25	0.46	0.000046
	0.0070					
Average	0.0070					

Table 2 shows the results of laboratory test measurements of the amount of Ni ion release in the treatment group of salak seed extract in each concentration by immersing the stainless steel orthodontic wire in artificial saliva with pH 6.8 at 37 ° C for 1 x 24 h. The release of the number of nickel ions (Ni) varies for each sample. The visible measurement data for ion nickel (Ni) varied for each sample, where an increase in the release of nickel ions (Ni) is in group treatment seed extract bark at a concentration of 500 ppm which indicates the value of the release of nickel ions (Ni) of 0.185 mg/l, the concentration 100 ppm also increased the release of nickel ions (Ni) with a value of 0.169 mg/l. While the different results obtained in the measurement of ion release of nickel (Ni) in group treatment bark seed extract concentration of 300 ppm showed a decrease in the release of nickel ions (Ni) with a value of 0.049 mg/l. At a concentration of 300 ppm showed a smaller value compared with the measurement results in an artificial saliva control group without treatment indicates the value of the measurement results of 0.070 mg/l.

The general public has little knowledge and is often unaware of the risks of using orthodontic appliances; therefore, one should be careful while running the treatment [9, 10]. One of the effects of orthodontic treatment is the occurrence of corrosion processes in the oral cavity [6].

Iron, a complex chemical reaction in which iron combines with oxygen in the air and water to form hydrated iron oxide ($Fe_2O_3 \cdot H_2O$). The oxide is solid shaft and thicker, weaker, and more brittle than on its original metal [11].

In the process of corrosion of stainless steel orthodontic wire in the oral cavity, there is the release of metal ions that can enter the body and produce carcinogenic, allergenic, mutagenic and cytotoxic effects [6]. Ghom states that saliva contains inorganic ions (N^+, K^+, $Cl^-$and HCO_3^-). The inorganic components inside the saliva act as electrolyte mediums that can trigger electrochemical reactions. An electrochemical reaction is a reaction occurring at the anode (oxidized) and the cathode (reducing), wherein the metal ion as anode and H^+ion from the electrolyte medium as the cathode. As a result of this electrochemical reaction, the release of chromium (Cr) and nickel (Ni) ions from stainless steel orthodontic wire are a sign of corrosion [2, 4]. Therefore, the introduction of metal ions into the human body is a risk to public health [12].

In general, an inhibitor is a chemical that can inhibit and slow down a chemical reaction. A corrosion inhibitor is a chemical which, when added into an environment, can decrease the rate of attack of the corrosion of the environment against a metal, so that the inhibitor material is said to be helpful in inhibiting the corrosion process [13]. In accordance with the research conducted by leh aji and kurniawan, cellulose extract from salak seed powder can be utilized in the process of purifying water to remove heavy metals. Their research concluded that there is an effect of the extract of salak seed in inhibiting the release of nickel (Ni) ions from the wire orthodontic stainless steels that are soluble in saliva.

This study showed that salak seed extract can inhibit nickel (Ni) ion release at a concentration of 300 ppm. The treatment group, with a concentration of 300 ppm showed a lower release of Ni ions than the control group without treatment. While the group treated with a concentration of 100 ppm and 500 ppm were not found to effect the inhibiting of the corrosion process, where the second concentration increased the release of Ni ion compared to the untreated control group.

Alloys of nickel-chromium stainless steel have special mechanical features that have made it the most common material used for the orthodontic arch wire fabrication. However, the characteristics of stainless steel orthodontic wire that can cause cytotoxic or allergic effects on the main components of nickel (Ni) and chromium (Cr) [12, 14].

Potential metals may cause allergic reactions associated with patterns and corrosion modes followed by the release of metal ions into the oral cavity, where electrochemical reactions on metal surfaces that deteriorate through ion releases are called corrosion. Internal corrosion factor is determined by the metal composition and its structure while in an external factor that depends on biological environments such as media composition, pH, temperature, and lighting strain. The oral environment is conducive to biodegradation; the main process of biodegradation is corrosion caused by constant chemical, mechanical, thermal, microbiological and enzymatic changes [12, 14]. These conditions can cause potential damaging to the surface of the wire arch of orthodontic because of its prolonged existence in the mouth. The corrosion process itself takes place through the loss of metal ions in solution or gradual dissolution on the surface, depending on the chemical solvent in which the metal will be submerged [15, 16].

The administration of inhibitor materials is expected to reduce the release of metal ions by utilizing the antioxidant inhibitor compound that is electron-giving. Salak seed extract has antioxidants; the results of phytochemical tests show that salak seeds contain flavonoid and tannin compounds as well as a little alkaloid. The ethanol extract of bark beans has antioxidant activity with an IC_{50} value of 229.27±6.35 mg/ml [7, 8]. Antioxidants work by donating their electrons to oxidant compounds, causing inhibition of activity from the oxidant compound [13].

The process of inhibition of a corrosion inhibitor is reversible so a s to keep the protective coating present on the metal surface; there can always be a minimum concentration must always be in a metal environment. The results of the study by Novi (2016) says that the mechanism of organic inhibitors occurs anodic and cathodic functions, which in the active position is said to identify that inhibitory substances do not have a significant effect on the environment, thus not proving the mechanism of cathodic inhibitors of cathodic reaction inhibition. It can also be seen in the research conducted by Hussein and Kassim that the addition of the right concentration of inhibitor substances will be more effective in inhibiting corrosion, but if the concentration of corrosion inhibitor added is too big it will affect the inhibition power that precisely will decrease. This is due to the addition of inhibitors with too large concentrations will cause the re-interested molecule inhibitor on the metal surface into the environment of the solution. Weakening of metal interactions and inhibitors will cause the inhibitor molecules on the metal surface to be replaced by water molecules or other ions from the environment which will decrease the protective effect of corrosion inhibitors [17, 18].

CONCLUSION

The results obtained on the measurement of nickel ions (Ni) release showed an effect at the concentration of 300 ppm. The nickel (Ni) nickel content was lower at 300 ppm than the other groups. This shows that the utilization of inhibitor materials inhibiting the release of effective Ni ions at a concentration of 300 ppm.

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AUTHORS CONTRIBUTIONS

Eka Erwansyah, Susilowati, and Citra Pratiwi conceived the study and wrote the manuscript. Citra Pratiwi performed the experiment, while Susilowati analyzed and interpreted the data under Eka Erwansyah supervision. All authors read and approved the final manuscript.

CONFLICT OF INTERESTS

The authors declare no conflict of interest

REFERENCES

1. Dika DD, Hamid T, Sylvia M. User index of orthodontic treatment need (IOTN) as evaluation of treatment results with removable devices; 2011;2:45-8.
2. Jura CO, Tendean LEN, Anindita PS. Number of chromium ions (Cr) and nickel (Ni) orthodontic stainless steel wire discharged in saliva immersion. J E-Tooth; 2015. p. 3.
3. Lombok CG, Anindita PS, Juliatri. Test the release of nickel and chromium ions on some stainless steel brackets immersed in seawater. E-Dent J 2016;4:28-32.
4. Neamah ZT. Nickel and chromium levels in saliva of patients with fixed orthodontic appliances. Med J Babylon 2014;11:557-66.
5. Abdelkarim A, Jerrold L. Risk management strategies in orthodontics. Am J Orthodont Dentofac Orthoped 2015;148:511-4.
6. Minanga MA, Anindita PS, Juliatri. The release of nickel ions and chromium orthodontic stainless steel brackets are immersed in mouthwash. Pharm Sci J 2016;5:135-41.
7. Fitri A, Andriani M, Sudarman A, Toharmat T, Yonekura L. Screening of antioxidant activities and their bioavailability of tropical fruit byproducts from Indonesia. Int J Pharm Pharm Sci 2016;8:95-100.
8. Karta IW, Susila LANKE, Mastra IN, Dikta PGA. Nutritional content of salak seed coffee (salacca zalacca) production of farmer group abian salak sibetan village which has potential as local food product berantioksidan and competitive. Virigin J 2015;1:123-33.
9. Mantiri SC, Wowor VNS, Anindita PS. The status of oral hygiene and dental caries status of student students of the fixed orthodontic appliance; 2013. p. 1-7.
10. Galag CJR, Anandita PSA, Waworuntu O. Oral hygiene status on fixed orthodontic appliance users based on oral hygiene index simplified at SMAN 1 Manado. E-Dent J 2015;3:298-301.
11. Hussain S. Textbook of dental material. 1th ed. New Delhi: Jaypee Brothers Medical Publishers; 2004. p. 298-9.
12. Thamer MR, Al-Joubri SK. The effect of acidity levels on the orthodontics appliances at different time intervals (an *in vitro* study). J Bagh Coll Dentist 2015;27:168-74.

13. Indrayani NL. Study the effect of water hyacinth as a corrosion inhibitor for SS400 steel pipes in the water environment. Sci J Teknik Mesin 2016;4:47-56.
14. Castro SM, Ponces MJ, JD Lopes, Vasconcelos M, Pollman MCF. Orthodontics wire and its corrosio-the spesific case of stainless steel and beta-titanium. J Dent Sci 2015;10:1-7.
15. Arab S, Cham MH, Morsaghian M, Ghamari M, Mortezai O. Evaluation of nickel and chromium release from stainless steel, hant and niti archwire in two 28-day time spans. Iran J Ortho 2015;10:1-4.
16. Navarro ECG, Alexis DM, Ulises C, Carlos GJ. Effect of different salivary pH on the surface and roughness of different orthodontic wire. J Res Dentist 2014;2:528-36.
17. Machfudzah PA, Amin MN, Princess of LSD. Effectivity of belimbing wuluh leaves extract as a corrosion inhibitor material on nickelite-based orthodontic wire. Scient Article Student Res Results; 2014.
18. Leonarto MN, Habar EH. The impact of mouth-rinsing using chlorhexidine gluconate 0.2% to the amount of plaque-causing bacteria colonies in fixed orthodontic users. J Dentomaxillofac Sci 2017;2:91-4.