The effectiveness of jackfruit seed paste (*Artocarpus heterophyllus Lamk*) as an alternative to enamel remineralization (in vitro)

Efektivitas pasta biji nangka (*Artocarpus heterophyllus Lamk*) sebagai bahan alternatif untuk remineralisasi email (*in vitro*)

Juni Jekti Nugroho
Department of Conservative
Faculty of Dentistry, Hasanuddin University
Makassar, Indonesia
Corresponding author: **Juni Jekti Nugroho**, e-mail: **jektijuni@yahoo.co.id**

ABSTRACT

Background: Enamel as the hardest layer of teeth is susceptible to acid attack which can cause demineralization. This triggers a chemical reaction to release calcium ions from the tooth enamel which causes a decrease in the hardness of the enamel surface. Calcium and phosphate ions are minerals that can inhibit demineralization and increase remineralization. The 5% calcium and 20% phosphate content in jackfruit seeds has the potential to be used as a tooth remineralization material. **Objective**: To determine the effectiveness of the application of jackfruit seed paste (*Artocarpus heterophyllus Lamk*) as an alternative remineralization agent to increase enamel surface hardness. **Method**: This experimental laboratory study was conducted using 32 maxillary first premolar teeth. All samples were immersed in cola carbonated drink (2 minutes). Samples in each group were treated (30 minutes) with the application of jackfruit seed paste (group I) and CPP-ACP paste (group II). The Vickers Hardness Number (VHN) test was performed on the surface of the initial tooth enamel, after soaking in cola carbonated drinks and after treatment. **Results**: The enamel surface hardness significantly increased after treatment in groups I and II. **Conclusion**: The application of jackfruit seed paste was effective in increasing enamel surface hardness.
Keywords: enamel surface hardness, cola carbonated drinks, jackfruit seed paste, CPP-ACP paste

ABSTRAK

Latar belakang: Email sebagai lapisan terkeras pada gigi rentan terhadap serangan asam yang dapat menyebabkan demineralisasi. Hal ini memicu reaksi kimia pelepasan ion kalsium dari email gigi yang menyebabkan penurunan kekerasan permukaan email. Ion kalsium dan fosfat merupakan mineral yang dapat menghambat demineralisasi dan meningkatkan remineralisasi. Kandungan kalsium 5% dan fosfat 20% pada biji nangka berpotensi digunakan sebagai bahan remineralisasi gigi. **Tujuan**: Mengetahui efektivitas aplikasi pasta biji nangka (*Artocarpus heterophyllus Lamk*) sebagai bahan alternatif remineralisasi terhadap peningkatan kekerasan permukaan email. **Metode**: Penelitian eksperimen laboratorium dilakukan pada 32 gigi premolar pertama rahang atas. Seluruh sampel direndam dalam minuman berkarbonasi cola (2 menit). Sampel pada setiap kelompok diberi perlakuan (30 menit) dengan aplikasi pasta biji nangka (kelompok I), dan pasta CPP-ACP (kelompok II). Dilakukan uji *Vickers Hardness Number* (VHN) pada permukaan email gigi awal, setelah direndam minuman karbonasi cola dan setelah perlakuan. **Hasil**: Kekerasan permukaan email signifikan meningkat setelah perlakuan pada kelompok I dan II. **Simpulan**: Aplikasi pasta biji nangka dan pasta CPP-ACP efektif meningkatkan kekerasan permukaan email.
Kata kunci: kekerasan permukaan email, minuman berkarbonasi cola, pasta biji nangka, pasta CPP-ACP
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INTRODUCTION

Tooth enamel is a tissue that undergoes a very high mineralization process and is susceptible to acid attack, either directly from food or as a result of bacterial metabolism which ferments carbohydrates into acids. The composition of foods or drinks that contain lots of acid will accelerate the damage to the surface of the tooth enamel.[1,2] In vitro it has been shown that damage due to acids on the tooth surface can chemically cause tooth erosion. Acid ions can penetrate into the prism in the enamel so that it becomes porous. This condition is the beginning of demineralization.[1]

Demineralization is characterized by an increase in surface roughness and a decrease in the microhardness of the enamel surface.[3,4] Decreasing the hardness of the enamel can increase the risk of losing some of the enamel elements so that the dentinal tubules are exposed, which has an impact on dentin sensitivity, reduced vertical tooth height and aesthetic problems.[1,5,6] So that it becomes a reason for preventive action.[7]

The material for remineralization that is receiving the most attention at present is *casein phosphopeptide protein amorphous calcium phosphate* (CPP-ACP).[8,9] The use of CPP-ACP topically is easier to apply to inhibit demineralization and increase remineralization.[10] However, the use of CPP-ACP has limitations, namely that it cannot be applied to individuals who are non-immunocomprized to milk protein.[11] So, it requires natural ingredients that can be used as alternatives a safe remineralizer for everyone.

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One of the natural ingredients that has the potential to be used as a remineralization agent is the jackfruit plant (*Artocarpus heterophyllus Lamk*). The part of the jackfruit plant that is often wasted are the seeds. Even though the high calcium (50 mg) and phosphorus (200 mg) content in jackfruit seeds can be used as an alternative material for remineralization of demineralized teeth.[12] In a study conducted by Ayub *et al*[13] proved that bones given jackfruit seed extract has a higher density of collagen fibers than bones without jackfruit seed extract.[13] So, the authors wanted to know the effectiveness of jackfruit seed paste as an alternative material to enamel remineralization.

METHODS

This research is a laboratory experimental study with a pre-test post-test control group design. Extract preparation begins by drying the jackfruit seeds as much as 1.5 kg and mashed using a blender. After being smooth, it is put into a beaker and 96% ethanol solvent is added. The maceration process is carried out for 24 hours. The residue obtained was re-macerated for 24 hours until the filtrate became clear. Ethanol is then evaporated from the extract solution using a rotary evaporator to obtain a thick extract, then proceed with making a paste by adding nipagin and 0.2 g of NaCMC and menthol then stirring until homogeneous using a magnetic stirrer.

This study used 32 samples of maxillary first premolar without caries, fractures, and shape and structure anomalies. Premolar crowns were cut using a carborundum disc ± 2 mm from the CEJ then implanted in a plaster cast with the buccal surface facing upwards and divided into 2 groups with 16 samples each. The enamel surface hardness was measured three times, namely: initial hardness, after demineralization, and final hardness measurement using a Vickers hardness tester. The data obtained were analyzed with the one-way Anova test followed by paired T-test.

RESULTS

Table 1 shows the mean values of the initial enamel surface hardness, after demineralization for 2 minutes with carbonated drinks and the final enamel surface hardness after experiencing different treatments from each group for 30 minutes. Based on the one-way Anova statistical test, it was obtained p-value 0.015 (less than 0.05) in group I, which means that there was a significant change in initial violence, after demineralization and final violence. The results of the one-way Anova statistical test also showed p-value 0.000 (less than 0.05; significant), which means that there was a significant change between the initial enamel surface hardness, after demineralization and the final hardness in the group.

Based on the independent sample t-test statistical test shows the difference data from changes in the

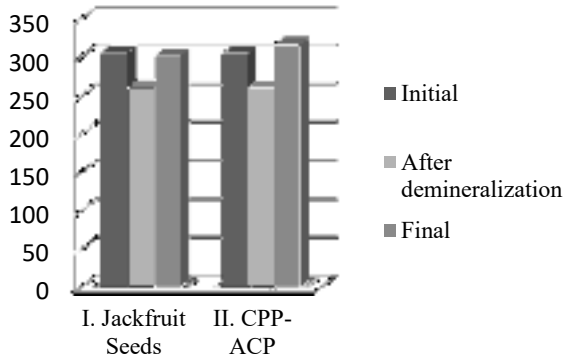

Figure 1 Bar chart of mean baseline, after demineralization, and final enamel surface hardness values

Table 1 Changes in enamel surface hardness values before and after demineralization and treatment (VHN)

Group	N		Initial	After Remineralization	Final	P-Value
Jackfruit Seed Paste	16	Mean	305.78	261.03	302.13	0.015*
		SD	51.2[a]	47.35[a]	44.88[a]	
CPP- ACP Paste	16	Mean	304.05	260.55	316.24	0.000*
		SD	44.04[a]	45.19[a]	43.93[a]	

[a]Shapiro Wilk test> 0.05, data were normally distributed
*One-way Anova test

Table 2 Average decrease and increase in violence

Group		Differences	
		Initial Demineralization	Final Demineralization
Jackfruit Seeds	Mean	-44.76	41.10
	SD	7.74	5.81
CPP- ACP	Mean	-43.50	55.69
	SD	5.04	6.49
p-Value		0.590*	0.000*

*Independent sample t test <0.05, significant

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initial hardness of enamel and after demineralization in the two groups obtained p-value = 0.590 (less than 0.05; not significant), which means there is no difference in decreasing the value of hardness in the two groups. The results of the independent sample t-test statistical test from changes in hardness after demineralization to final hardness obtained p-value = 0.000 (less than 0.05; significant), which means that there is a significant difference in the increase in enamel surface hardness between each treatment in the two groups.

DISCUSSION

The enamel can be demineralized when it comes into contact with acids so that the dissolved enamel minerals will reduce the hardness of the tooth surface. In critical pH conditions, the surface of the enamel will undergo demineralization.[14,15] The process of demineralization of enamel in the mouth does not occur continuously but will always be followed by a natural remineralization process by saliva. This demineralization process depends on the consumption of fermented and acid-producing carbohydrates until the pH of the mouth drops below a critical pH.[16,17]

The demineralization process in this study used an acidic cola type carbonated drink with a pH of 2.4. According to Barac[18] and Zainy[19] of these drinks have the lowest pH and greater erosive effects than other types of soft drinks.[18-21] This research is also supporting research by Abdullah *et al* which describes cola drinks affect the solubility of calcium and magnesium in hydroxyapatite crystals which is the beginning of enamel demineralization.[22]

In this study, all samples were immersed in a cola type carbonated drink for 2 minutes. Soaking time is determined based on the results of preliminary research conducted by the author and the result of researches conducted by Wagehaupt *et al* and Nugroho *et al*.[20,23] This is due to the demineralization process which causes the loss of some of the enamel prisms and forms porosity so that the hardness of the enamel surface is reduced.[24,25]

In table 1 the application of jackfruit seed paste and CPP-ACP paste for 30 minutes showed significant results in increasing the enamel surface hardness value. In line with the results of research by Wiryani *et al* [26] that application of CPP-ACP paste for 30 minutes after immersing in lactic acid solution can increase the maximum hardness on the surface of tooth enamel. This time is in accordance with the manufacturer's instructions, to maintain contact between the CPP-ACP material and the tooth enamel so that the optimal diffusion of calcium and phosphate ions to the enamel structure occurs.[26] The results of the study in the treatment group can be seen changes in the enamel surface hardness value which is almost the same as the baseline hardness and in the positive control group, there is a change in enamel surface hardness that exceeds the baseline hardness. However, both groups showed a statistically significant increase in violence.

The increase in enamel hardness was due to the high content of calcium and phosphate ions in the jackfruit seed extract and CPP-ACP paste. The remineralization process begins with the diffusion of calcium and phosphate ions in the jackfruit seed paste and will be deposited on the surface layer of the microporosity. The incoming minerals can diffuse in all directions between the enamel crystals and then absorbed by hypomineralized enamel, which is enamel that was previously demineralized.[27] Calcium and phosphate ions will inhibit the process of decomposing hydroxyapatite and cause rebuilding or the formation of some of the hydroxyapatite crystals that have dissolved.[28,29] These ions will bind back to the enamel apatite structure to form hydroxyapatite. The higher the concentration of calcium and phosphate ions in the environment around the enamel will affect the degree of hydroxyapatite saturation so that the faster the enamel microporosity closure.[28,30]

Based on the independent t-test in Table 2, it shows that there is a significant difference in the increase in enamel surface hardness in the two groups. Based on the statistical test, it was seen that the increase in enamel surface hardness was more effective in the positive control group which increased to 55.69 VHN, while the treatment group saw an increase of 41.10 VHN. This happens because the CPP-ACP paste contains about 18% calcium and 30% phosphate and contains casein which has the ability to stabilize calcium and phosphate ions, while research by Swami *et al*[12] in 100 g of jackfruit seeds contains 50 mg of calcium equivalent to 5% calcium and 20 mg of phosphate equivalent to 20% phosphate, which during the remineralization process, these ions will diffuse to the enamel rods and form apatite crystals so that an increase in enamel surface hardness can occur.[31,32]

Based on this research, it is concluded that the application of jackfruit seed paste (*Artocarpus heterophyllus Lamk*) is effective in increasing surface hardness of enamel, which is an indicator of tooth remineralization.

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