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The Differences Between Effects Of Using Bagasse Ash Bioactive Glass Nano Silica Paste And Novamin Toothpaste On Tooth Enamel Surface Hardness (In Vitro)

Ameta Primasari[1] , Ika Astrina[2] , Siti Khumairah Azzahra[3]

[1]Department of Oral Biology, Faculty of Dentistry, University of Sumatera Utara, Medan-Indonesia

[2]Department of Oral Biology, Faculty of Dentistry, University of Sumatera Utara, Medan-Indonesia

[3]Faculty of Dentistry, University of Sumatera Utara, Medan-Indonesia

Abstract

Bagasse ash has silica content which can be used as a catalyst in the main raw material for making bioactive glass. Bioactive glass has many benefits in the field of dentistry, one of which is as a remineralization agent. The purpose of this study is to see the differences between the effects of bagasse ash toothpaste and novamin commercial toothpaste on enamel surface hardness. This research was a laboratory experimental study with a one group pretest postest design. In this study, 27 maxillary premolars were divided into 3 groups randomly. Group 1 was the control group, group 2 was the bagasse ash toothpaste application group, and group 3 was the novamin toothpaste application group. The results of the oneway anova test showed a significant difference on enamel surface hardness among the test groups with p=0.024. Group 1 experienced an increase in the mean hardness of 59.47. Group 2 increased of 144.3 and group 3 increased of 92.62. The conclusion of this study was a mixture application of toothpaste of bagasse ash bioactive glass gave the best effect on the increase in enamel surface hardness on teeth.

Key words: bagasse ash, bioactive glass, novamin, enamel surface hardness

INTRODUCTION

The prevalence of oral and dental problems in Indonesia is still very high. Dental caries is the most common oral and dental disease. According to Riskesdas, the increase in the prevalence of active caries in the Indonesian population increased from 53.2% in 2013 to 88.8% in 2018. Dental caries is a disease that attacks the hard tissues of teeth such as enamel, dentin, and cementum which are complex in nature.[1] Enamel surface hardness is influenced by the demineralization and remineralization processes. Demineralization is the first step in the tooth decay process, while remineralization controls and repairs the damage caused by

demineralization.[2] The enamel surface hardness can be increased if remineralization occurs. Naturally, the remineralization process can occur because of the help of saliva.[3,4]

Remineralization materials are needed to help speed up the process, some remineralization materials, such as Fluoride, Casein Phospopeptide Amorphous Calcium Phosphate (CPP-ACP), Tri-calcium phosphate (TCP) and Bioactive Glass.[5] Along with the science development of bioactive glass material, it is starting to be widely used in the field of dentistry because it has properties that are more biocompatible on the body and has a structure that is very similar to bone hydroxyapatite. Research by Narayana et al stated that the results of the analysis using the Scanning Electron

Microscope showed statistically significant results on the increase in calcium in the bioactive glass material group.[5] Another study conducted by Mehta et al showed that the enamel surface hardness in samples that was administered the test material in the form of bioactive glass showed better results for the increase in enamel hardness than samples that was administered the test material in the form of CCP-ACP using the Microvickers Hardness Tester.[7]

This is an encouragement for natural materials to be widely researched which are expected to be used as alternatives to remineralization materials. Bagasse ash which is the sugar production waste from sugarcane plants, the high content of silica in bagasse ash can be used as a catalyst for the main material of making bioactive glass.[8]

RESEARCH METHOD

This research was a type of laboratory experimental research with one group pretest posttest design. This research was approved by the Health Research Ethics Commission (KEPK) Faculty of Medicine, University of North Sumatra / RSUP H. Adam Malik Medan through Ethical Clearance Letter No: 851 / KEP / USU / 2020.

The research was conducted in the laboratory of Approved Training Body, Medan State Polytechnic. The samples used were 27 maxillary permanent premolars with caries-free criteria and no structural abnormalities. The sample was divided into 3 groups.

This research began with the making of bioactive glass nano silica from bagasse ash. The bagasse was dried in the sun and then was burned in a furnace to produce bagasse ash and then washed using HCl solution to get the silica contained in the ash. The silica obtained was then mixed with NaOH solution to obtain sodium silicate, the solution was stirred using a magnetic stirrer to form a gel then dried in a furnace at 110ºC for 2 hours.

The sodium silicate that has been successfully made was then crushed and mixed with distilled water, ethanol, HNO_3, P_2O_5, and $Ca(NO_3)_2.4H_2O$ then stirred with a magnetic stirer to form a gel. The gel that was formed was then left to stand for 5 days at room temperature

and then dried in a furnace at 1000ºC for 2 hours. The dried bioactive result was then crushed and sieved with a 300 mesh sieve.[8]

The bioactive glass powder that has been formed was then used as an active material for the making of toothpaste. A total of 4 grams of CMC-Na along with 0.45 grams of carbomer

were dissolved with distilled water then crushed and added with 24 grams of glycerin, 5 grams of bagasse ash bioactive glass nano silica active material, and 52 grams of calcium carbonate. All materials were mixed and crushed using a mortar until homogeneous and added with distilled water until the toothpaste mass reached 100 grams.

The tooth sample was cut at the root part and then implanted in a pipe mold containing a 1 cm x 1 cm cast with the position of the buccal part of the tooth facing upwards. The initial hardness test was carried out by soaking the sample first in a 0.1 M HCl solution of pH 5 for 30 minutes. The initial hardness measurement was carried out 3 times using the Mickrovickers Hardness Tester.

Then the sample was applied to the test material. Group 1 was soaked in artificial saliva which was used as the control group, group 2 samples were applied with bagasse ash bioactive glass nano silica toothpaste, and group 3 samples were applied with commercial toothpaste made from novamin. The samples were applied the test material and soaked in artificial saliva as well as stored at room temperature for 7 consecutive days.

After the application of the test material for 7 consecutive days the samples were carried out to a final surface hardness test to see the effect of

test material administration. Measurement of the hardness of each sample was carried out 3 times then the mean was taken which was enamel surface hardness of the sample.

RESEARCH RESULT

The measurement of enamel surface hardness was carried out using the Mickrovickers Hardness Tester. The mean results of enamel surface hardness were statistically analyzed using t-paired test to see the difference in the mean of enamel surface hardness in each group. The results of the t-paired test can be seen in table 1.

Table 1. The results of t-paired statistical test comparisons of enamel surface hardness after soaking in 0.1 M HCL solution and after the administering the test material to each group.

No	Variable	N	Mean ± SD	p-value
	Before soaking in Artificial	9	252.15	

1	Saliva (control)		± 42.03	0.006
	After soaking in Artificial Saliva (control)	9	311.63 ± 52.34	
2	Before Application of Bagasse Ash Toothpaste	9	252.12 ± 50.18	0.007
	After Application of Bagasse Ash Toothpaste	9	396.42 ± 106.54	
3	Before Application of Novamin Toothpaste	9	233.46 ± 56.91	0.007
	After Application of Novamin Toothpaste	9	326.08 ± 101.89	

The data result in research were analyzed with a significance level of $p<0.05$. The t-paired test results showed a significant difference and an increase in the enamel surface hardness value in each study group. In group 1, the enamel surface hardness value increased from 252.15 VHN to 311.63 VHN with a p value of 0.006. Group 2, the enamel surface hardness value increased from 252.12 VHN to 396.42 VHN with a p value of 0.007. Meanwhile, group 3 also showed an increase in the enamel surface hardness value from 233.46 VHN to 326.08 VHN with a p value of 0.007.

The results of this study were continued by performing the Oneway Anova statistical analysis to compare the increase in enamel surface hardness among groups after application of the test material.

Table 2. The results of the Oneway Anova test comparison of the increase in tooth enamel surface hardness among groups after the administration of test material.

Group	**N**	**Mean ± SD**	**p.value**
Control	9	59.47 ± 48.12	
Bagasse Ash Toothpaste	9	144.30 ± 121.85	0.024
Novamin Toothpaste	9	92.62 ± 76.96	

From the results of the one way ANOVA test, it is known that the three sample groups experienced a significant increase with a significance level of $p<0.05$. The group that used the bagasse ash bioactive glass nano silica toothpaste test material showed a higher increase in surface hardness value of 144.30 ± 121.85 than the control group and the group with the novam in toothpaste test material with p value = 0.024.

DISCUSSION

The use of bagasse ash in this study was as a catalyst in the making of bioactive glass material by utilizing the silica content in it. Silica is the main ingredient in bioactive glass, which can be used as a remineralizing agent.[9]

The Microvickers Hardness Tester tool was chosen to test the surface hardness in this study because this tool produces a very small indentation with a simple method so that it does not damage the test material and the sample can be reused. Microvickers Hardness Tester provides information about changes in mineral content in enamel by looking at changes in surface hardness, this indirectly indicated the remineralization process that occured in the research sample.[10]

The first hardness test was carried out after the sample was soaked in HCl solution with 0.1 M concentration of pH 5 which aims to demineralize the sample first. The HCL solution used was the HCL solution with a molarity level or concentration of 0.1 M with a pH 5. The HCl solution to be used was made by mixing 2.09 ml of concentrated HCl solution mixed with distilled water up to 250 ml and measured using a pH meter until it reached pH 5.[11]

Samples was soaked in HCl solution with 0.1 M of pH 5 for 30 minutes was carried out on the grounds that the acid solution could dissolve the mineral structure so that the demineralization process could occur in the oral cavity environment at pH 5 for 30 minutes.[11]

This process caused the enamel surface hardness of the teeth to decrease. To prevent further damage, active materials were needed that can increase the enamel surface hardness to restore dissolved minerals, one of which was using bioactive glass.[12]

This study conducted statistical tests with t-paired test to see the mean difference in each group. The results of the t-paired test showed significant results in the three test groups with a significance value of $p<0.05$. This means that the three sample groups after applying the test material showed an increase in enamel surface hardness.

In this study, the process of application of toothpaste for 7 consecutive days. Based on previous research, the remineralization process can occur on day 7 with the formation of a new material from the enamel structure of nanocrystalline at 50 nm.[13]

Group 1 the remineralization process occurred because of saliva without of other active ingredients. Artificial saliva has hydroxyapatite-forming minerals which have the ability to deliver calcium and phosphate ions in the remineralization process because these ions can diffuse into the tissue that has undergone mineral dissolution.[14]

Group 2 and 3 the remineralization process occurred because of saliva and active ingredient, that is bioactive glass. Bioactive glass has been shown to form apatite hydrocycarbonate when it comes into contact with body fluids. The remineralization process in this study occurs because calcium and sodium ions bind to hydrogen ions contained in saliva which results in an increase in local pH and the formation of silanol bond groups. Then these bonds will be

condensed and polymerized to form silica gel, calcium ions, and phosphate which will then exit through the silica gel to form a new apatite hydroxycarbonate layer.[15] The results of research conducted by Mehta et al also showed that there was an increase in the hardness of the enamel surface in the samples given the bioactive glass test material.[7]

Research by Abbasoglu et al which proved that bioactive glass toothpaste can be used as a remineralization agent to increase the surface hardness of the enamel.[2]

This study was added with the one way anova test to see the mean increase in enamel surface hardness among groups. From the one way anova test results obtained p = 0.024, which indicated that there was a significant difference among the three test groups. Samples using material test of bagasse ash bioactive glass nano silica toothpaste showed a higher enamel surface hardness value than the control group sample and sample with novamin toothpaste test material of 144.30 ± 121.85.

In this study, the enamel surface hardness value in all groups increased. Group 2, namely the group with the test material of bagasse ash bioactive glass nano silica toothpaste, had a higher mean increase than group 1 and group 3, this is because the bagasse ash bioactive glass nano silica toothpaste made, had a higher particle size. small so that they had greater attachment power compared to groups 1 and 3.

Bioactive glass bagasse ash in group 2 was made in the form of nano particle sizes of 0.02-0.08 µm or 20-80 nm, while the size of bioactive glass particles in group 3 was 18 µm or 18000

nm. Bioactive glass with nanoparticles will be faster in forming apatite hydroxycarbonate because more and more particles will come into contact with the liquid which will then mineralize to form hydroxyapatite.[16]

Bioactive glass nanoparticles are able to fill gaps in the tooth structure properly so as to produce maximum density, besides that nanoparticles have a high binding strength resulting in good adaptation and attachment to the tooth structure so that it is faster to form apatite hydroxycarbonate due to the more particles that will contact with body fluids will then mineralize to become hydroxyapatite.[14,15]

In this study, it is recommended to carry out further study is to do qualitative and quantitative tests using SEM-EDX to find out the mineral content of tooth enamel and cytotoxicity test to find out the biocompatibility of the material on body tissues.

CONCLUSION

Based on the results of the study, bagasse ash bioactive glass nano silica toothpaste and toothpaste made from novam in can increase the value of tooth enamel surface hardness. The use of bagasse ash bioactive glass nano silica toothpaste showed a higher increase in the

increase in tooth enamel surface hardness of 144.3 VHN with p value = 0.007 ($p<0.05$). Bagasse ash bioactive glass nano silica toothpaste and novamin toothpaste significantly of $p = 0.024$ ($p<0.05$) increased the tooth enamel surface hardness.

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