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COMPARISON OF SHRIMP (LITOPENAEUS VANNAMEI) SHELL PASTE AND CASEIN PHOSPHOPEPTIDE-AMORPHOUS CALCIUM PHOSPHATE (CPP-ACP) PASTE AS TEETH REMINERALIZATION MATERIAL

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ABSTRACT

Objective: To determine the comparison of shrimp shell and casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) as tooth remineralization material.

Methods: This study was an experimental laboratory with a cross-sectional design. Study sample was 10 maxillary central incisors that were applied with 35% hydrogen peroxide for 2 h, then assessed with energy dispersive spectroscopy (EDS). Samples were divided into 2 groups: 5 samples were applied using CPP-ACP paste and 5 samples using shrimp shell paste every 8 h for 14 consecutive days then checked with EDS. Data analysis using SPSS test independent t-test to compare shrimp shell paste and CPP-ACP paste as tooth remineralization material.

Results: The result of this study showed p>0.05, meaning there was no significant difference between CPP-ACP and shrimp shell paste mineral composition.

Conclusion: Shrimp shell paste has an effective value to be used as a tooth remineralization material.

Keywords: CPP-ACP paste, Shrimp shell paste, Tooth remineralization

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INTRODUCTION

Indonesia is a country that has a wider water territorial than the mainland, so the production of marine products in Indonesia is very abundant, one of which is shrimp (Litopenaeus Vannamei). Each year approximately 500,000 tons of shrimp is produced and processed, and 75% of the total weight of shrimp is comprised of the shell and head of shrimp. These portions of the shrimp are deemed as waste and not utilized optimally [1, 2].

The use of natural products in the field of dentistry is growing rapidly. One of the materials that can be used is shrimp shell because shrimp shells contain chitosan that is very useful. Chitosan is one of the latest biomaterials to be developed because it has various medical benefits and has been proven safe for humans. Chitosan has some special properties, including excellent biocompatibility, biodegradable, mucoadhesion, non-toxic, does not cause immunological reactions, and does not cause cancer. Therefore, chitosan is often used in biomedical applications [3].

Calcium carbonate is also very useful for health. There is about 45-50% calcium carbonate in a shrimp shell that can become a potential ingredient of tooth remineralization materials. Shrimp shells could be used as an alternative in dentistry using an easy application on teeth in the form of shrimp shell paste [4].

Calcium in shrimp shells can also be processed into nano-calcium so that shrimp shell elements can be absorbed more quickly by organ or tooth enamel so that calcium needs can be met [5]. According to Nather at al., shrimp shell (Litopenaeus vannamei) has many ingredients that can be utilized for example chitin that becomes chitosan, in the field of health can become bone and tooth replacement material because it is biocompatible, biodegradable, bioresorbable, and non-toxic. It can also improve wound healing as an antimicrobial and anti-cholesterol [6].

There are many substances that have been produced to improve enamel remineralization other than fluor, such as casein phosphopeptide that stabilizes amorphous calcium phosphate (CPP-ACP), unstabilized amorphous calcium phosphate and bioactive glass containing calcium sodium phosphosilicate. All three ingredients have high calcium and phosphate composition that serves to strengthen the main teeth enamel [7]. That is the reason why the authors are interested to examine the comparison of CCP-ACP paste with shrimp shell paste.

MATERIALS AND METHODS

Material

Preparation of shrimp shell paste

Shrimp shell waste (10 g) was cleaned under running water and dried at room temperature. Then shrimp shells were then sifted and crushed until smooth.

The aquades was heated before adding Nipagin 0.2 gr and NaCMC (0.2 gr). The crushed shrimp skin (10 g) was then added and moistened with glycerol (1 g). A menthol solution was prepared by mixing 0.05 g with alcohol until dissolved. The ethanol solution 0.05 gr was added to the shrimp skin mixture to form a homogeneous paste.

Methods

The ethical clearance has been approved by the ethics committee with number: 781/H4.8.45.31/PP36-KOMETIK/2017. This study was an experimental laboratory with cross-sectional study design with data analysis using SPSS independent test t-test to compare shrimp (Litopenaeus Vannamei) shell paste and Casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) effectivity as tooth remineralization materials. Samples from this study were 10 maxillary central incisors post-extraction. The sample was applied with 35% hydrogen peroxide (H_2O_2) as a demineralization agent for 2 h. The sample was then cleaned with aquades and dried. The samples were examined with energy dispersive spectroscopy (EDS) to see changes in enamel structure due to the demineralization process.

The ten samples were then divided into two groups, the first group of 5 samples was treated using shrimp shell paste and the second group of 5 samples was treated using casein phosphopeptides-amorphous calcium phosphatase (CPP-ACP) as control. The pastes were applied for 8 h each day for 14 consecutive days before checking the sample using EDS.

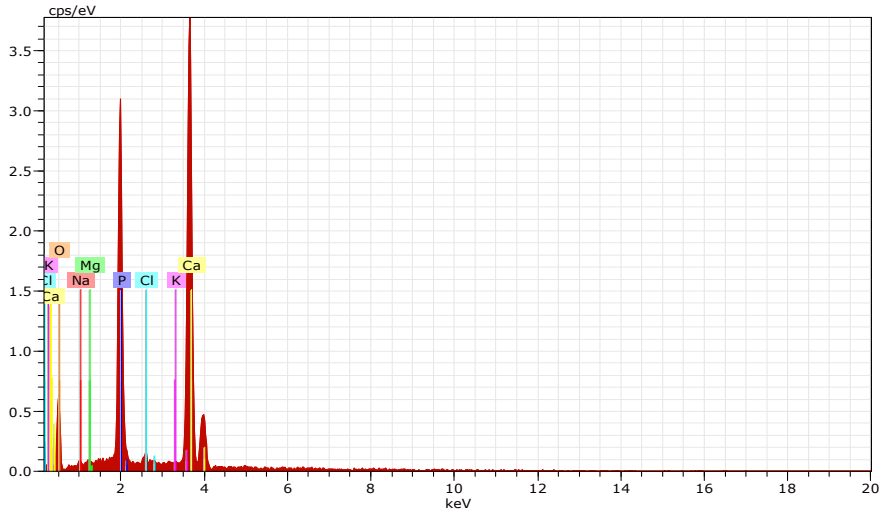

Fig. 1: X-ray diffraction pattern of dental enamel after the application of hydrogen peroxide (H_2O_2) 35%

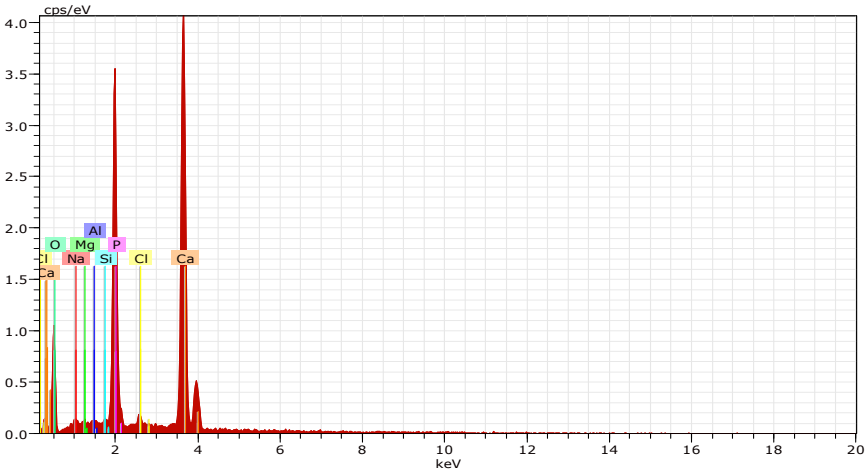

Fig. 2: X-ray diffraction pattern of dental enamel after the application of casein phosphopeptides-amorphous calcium phosphatase (CPP-ACP)

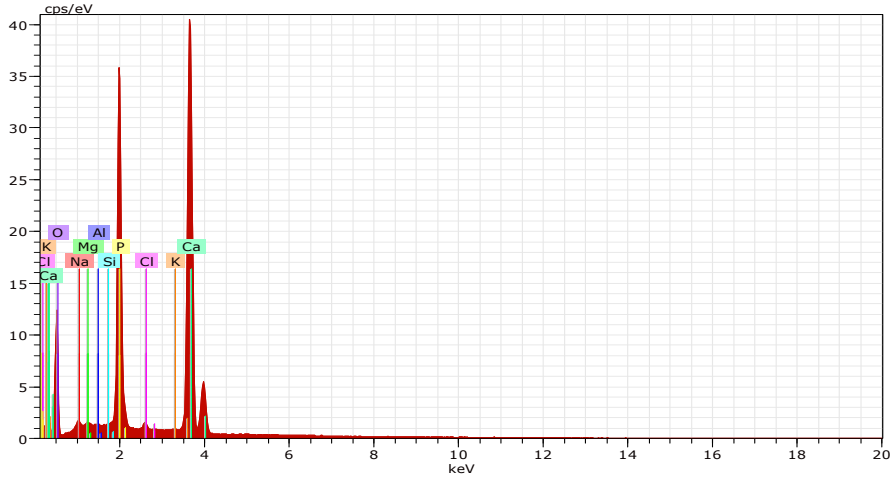

Fig. 3: X-ray diffraction pattern of dental enamel after the application of shrimp shell paste

RESULTS AND DISCUSSION

EDS examination showed the amount of mineral composition in the sample after H_2O_2 application fig. 1, after the sample was applied with CPP-ACP paste fig. 2, and after the sample was applied with shrimp shell paste fig. 3. As shown in the table, the tooth enamel composition consists of calcium, phosphorus, sodium, magnesium, aluminum, chlorine, and potassium.

Table 1 shows the comparison of shrimp shell paste and CPP-ACP paste as tooth remineralization material based on independent t-test. It can be seen that the average calcium content in samples that have been applied with CPP-ACP and shrimp shell paste is greater in CPP-ACP application but vice versa phosphorus, sodium, magnesium, aluminum, potassium have larger content in shrimp shell paste samples.

Table 1: Mineral composition of teeth enamel after CPP-ACP and shrimp shell paste application

Mineral	Group	N	mean±SD	*P value*
Calcium	CPP-ACP I	5	39.39±0.60	0.055
	Shrimp shell	5	38.18±1.04	
Phosphorus	CPP-ACP I	5	18.29±0.19	0.802
	Shrimp shell	5	18.33±0.21	
Sodium	CPP-ACP I	4	0.92±0.18	0.296
	Shrimp shell	5	1.09±0.28	
Magnesium	CPP-ACP I	3	0.24±0.08	0.019
	Shrimp shell	5	0.43±0.11	
Aluminum	CPP-ACP I	5	0.16±0.10	0.533
	Shrimp shell	4	0.20±0.08	
Chlorine	CPP-ACP I	5	0.57±0.11	0.519
	Shrimp shell	5	0.53±0.11	
Potassium	CPP-ACP I	2	0.87±0.03	0.957
	Shrimp shell	5	0.88±0.07	

The statistical test results obtained *p>0.05 which means there was no significant difference between CPP-ACP and shrimp shell paste mineral composition which means that shrimp shell paste has effective value as a tooth remineralization material.

Enamel is the hardest substance in the body and has high calcification. Enamel consists of mainly inorganic materials and a little organic matter. Inorganic enamel content consists of 90-92% calcium hydroxyapatite and as much as 3-5% of other minerals [8, 9].

Demineralization is the destruction of enamel hydroxyapatite due to an increased concentration of hydrogen ions caused by the pH of the solution around the enamel surface being lower than 5.5. Demineralization occurs by diffusion, ie the process of transfer of water-soluble molecules or ions to or from the enamel to the saliva because there is a difference in the concentration of acidity on the surface within the enamel. Continuous demineralization will form small pores or porosity on the enamel surface of the tooth so that it can cause the dissolution of calcium minerals [10]. Calcium is one of the nutrients that is needed for various functions of the body to support the development of more optimal organ function. Lack of calcium in the body results in a variety of major complaints on bone, teeth, blood, nerves, and metabolism [11].

The occurrence of the demineralization process can have negative effects, such as toothache and increased risk of dental caries to fracture, for which applications are needed that can stimulate tooth remineralization, which contains calcium, phosphate, and fluorine.

The main composition of the shrimp shell is calcium. Several studies have reported that calcium bioavailability is used for chemical and physiological processes that affect the absorption of calcium in the body so that the minerals can be used by the body to perform its functions [12].

Pipih et. al conducted a study on the characterization and bioavailability of calcium from shrimp vannaimai shell that suggested that shrimp shell immersion for 48 h produced calcium levels of 85.49%. The main constituent mineral of nano-calcium is calcium, but nano-calcium also contains other mineral components such as magnesium, potassium, sodium, phosphorus, iron, zinc, and manganese [13].

Remineralization is a process in which calcium and phosphate mineral ions reform hydroxyapatite crystals in enamel. The remineralization process is an important process that has a significant effect on tooth hardness and strength. The presence of materials containing calcium and phosphorus is expected to produce remineralization on teeth. This study suggested that shrimp shells have a similar composition to CPP-ACP so it is expected that the development of the utilization of natural materials, especially shrimp shells, can be used as a remineralization material [14].

The statistical test results obtained *p>0.05 also proved that there was no significant difference between the mineral composition of CPP-ACP and shrimp shell paste which means that shrimp shell paste has the effectivity to be used in tooth remineralization.

CONCLUSION

Shrimp shells have a similar composition to CPP-ACP so it is expected that the development of the utilization of natural materials, especially shrimp shells, can be used as a remineralization material.

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AUTHORS CONTRIBUTIONS

All the authors have contributed equally.

CONFLICT OF INTERESTS

There are no conflict of interest in this study

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