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ORIGINAL RESEARCH

THE EFFECT OF IMMERSION IN 0.1% CHLORHEXIDINE GLUCONATE MOUTHWASH ON COLOR CHANGE OF COMPOSITE RESIN CONTAINING BOVINE BONE HYDROXYAPATITE FILLER

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ABSTRACT

Introduction *:Synthetic composites provide color stability, but over time, synthetic materials have been replaced by natural materials to be more environmentally friendly. In addition to synthetic materials, hydroxyapatite (HA) can also be obtained from natural materials (natural hydroxyapatite) to replace the most commonly used filler materials. One of the physical properties of composite resin is color stability. The composition of mouthwash that can affect color change is the sodium fluoride content and pH.* ***Aim****: To determine the effect of immersing composite resin with bovine bone hydroxyapatite filler in a 0.1% chlorhexidine gluconate mouthwash solution on color change.* ***Methods****: This study was a true experimental study with a pretest-posttest group design. A total of 16 composite resin specimens containing bovine bone hydroxyapatite filler were used, each measuring 4 mm in diameter and 6 mm in height.* ***Results****: The mean color change value increased from 0.5939 ± 0.001360 before immersion to 0.5964 ± 0.001360 after immersion. The Wilcoxon Signed-Rank Test showed a statistically significant difference between the pre- and post-immersion measurements ($Z = -3.448$, $p = 0.001$).* ***Conclusion****: There was a significant difference between the group before immersion in 0.1% chlorhexidine gluconate mouthwash and after immersion in 0.1% chlorhexidine gluconate.*

Keywords: *Color stability, composite resin, non-alcoholic mouthwash, non-synthetic filler.*

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INTRODUCTION

Oral health cannot be separated from overall bodily health, as it directly impacts general health status. The most prevalent oral and dental disease in Indonesia is dental caries. Dental caries is an infectious disease that damages the hard structures of the tooth, causing demineralization of calcified tissues along with degradation of organic components, resulting from the activity of microorganisms and fermentable carbohydrates. One method of preventing dental caries is restoring the affected tooth using dental restorative materials. Materials commonly used for this purpose include amalgam, glass ionomer cement, and composite resin. Each of these restorative materials has distinct advantages and disadvantages according to their composition and specific properties.[1,2]

Composite resin is a tooth-colored restorative material composed primarily of a resin matrix and inorganic filler particles bonded together by a coupling agent through a polymerization process. Fillers are inorganic components that influence the mechanical properties of the composite resin and also contribute to reducing polymerization shrinkage.[3]

One approach to developing composite resins with high biocompatibility is replacing conventional fillers with hydroxyapatite (HA). Hydroxyapatite can be produced through chemical synthesis or extracted from natural sources such as the bones of vertebrate animals, as it is the main constituent of hard tissues in these organisms.[7] Its structural similarity to human bone ensures good biocompatibility with human bone and tooth tissues. Bone mineral consists of inorganic salts including calcium phosphate (58.3%), calcium carbonate (1%), magnesium phosphate (2.1%), calcium chloride (1.5%), and organic components (30.6% protein.[4,5]

Matching the color of composite resin to the natural tooth is essential for achieving satisfactory esthetic outcomes. Composite resin may undergo color changes caused by intrinsic or extrinsic factors. Intrinsic factors include oxidation of amine accelerators, the structure of the polymer matrix, unpolymerized methacrylate groups, or incomplete polymerization reactions. Extrinsic factors leading to discoloration include water absorption, dietary habits, tobacco use, and poor oral hygiene.[6]

Chlorhexidine gluconate mouthwash is widely used as an antimicrobial agent to use of this mouthwash may cause adverse oral effects, including staining of the oral mucosa, teeth, and the dorsal surface of the tongue.[7] Chlorhexidine has been documented to produce several local side effects when used orally.[8]

1. Brown discoloration of teeth, certain restorative materials, and the dorsal tongue (dose-dependent).
2. Alteration of taste perception (concentration-dependent).
3. Erosion of the oral mucosa.

This effect may result from precipitation of salivary proteins on the tooth surface, leading to a thicker acquired pellicle layer and/or deposition of inorganic salts within this layer. As the influence of chlorhexidine gluconate mouthwash on the color stability of composite resins containing non-synthetic fillers remains insufficiently studied, this research aims to investigate whether immersion in 0.1% chlorhexidine gluconate mouthwash affects the color of composite resin reinforced with bovine bone hydroxyapatite filler.

METHODS

This study employed a true experimental method with a pretest-posttest group design to evaluate the effect of immersion in 0.1% chlorhexidine gluconate mouthwash on the color change of composite resin containing bovine bone hydroxyapatite filler. A total of 16 composite resin specimens containing bovine bone hydroxyapatite filler were used. Color measurements were performed before and after immersion using a UV-Vis spectrophotometer. Data were analyzed using a non-parametric Wilcoxon test.

RESULTS

The mean color change value increased from 0.594 ± 0.001 before immersion to 0.596 ± 0.001 after immersion. Of the 16 specimens, 15 showed higher post-immersion values, while one specimen showed no change. The Wilcoxon Signed-Rank Test showed a statistically significant difference between the pre- and post-immersion measurements ($Z = -3.448$, $p = 0.001$).

Table 1. Distribution of color change in composite resin with bovine bone hydroxyapatite filler before and after immersion

No.	Pre	Post
1	0,595	0,597
2	0,593	0,594
3	0,595	0,596
4	0,595	0,598
5	0,592	0,595
6	0,595	0,597
7	0,593	0,595
8	0,595	0,597
9	0,593	0,596
10	0,592	0,597
11	0,595	0,595
12	0,593	0,596
13	0,592	0,595
14	0,593	0,598
15	0,595	0,597
16	0,596	0,599
Mean	0.5939	0.5964
Standard Deviation	.001360	.001360

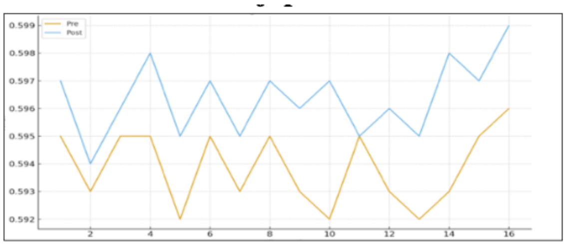

Figure 1. Color change test results

Table 2. Wilcoxon tes results for color change in composite resin with bovine bone filler

	Mean ± SD	Z	P- value
Pre test	.00 ± .001360	-3.448	0.001
Post test	8.00 ± .001360		

Note: Wilcoxon Signed-Rank Test; statistical significance was set at $p < 0.05$.

Based on the Wilcoxon Signed Ranks Test results, 15 samples showed higher post-test values compared to pre-test values, no samples showed lower post-test values, and 1 sample showed identical values before and after treatment. This indicates a consistent increase in measured values following immersion. The mean rank for positive ranks was 8.00, with a sum of ranks equal to 120.00, reflecting a consistent rise in values across most specimens. Statistical analysis yielded a Z value of -3.448 and a significance value of $p = 0.001$ (< 0.05), confirming a statistically significant difference between pre-immersion and post-immersion measurements. It can therefore be concluded that immersion in the test solution produced a significant increase in the measured parameter.

DISCUSSION

The results demonstrate that immersion in the mouthwash solution caused measurable changes in the specimens. In this study, color change was quantified using absorbance values obtained via UV-Vis spectrophotometry; higher absorbance values correspond to darker discoloration of the composite resin. Color change may be influenced by both extrinsic and intrinsic factors. Extrinsic factors include exposure to various liquids present in the oral environment. Intrinsic factors include the ratio of resin matrix to filler, the hydrophilicity of the matrix, the inherent tendency of the material to absorb water, and the completeness of the polymerization process.[6]

The type of composite resin also affects liquid absorption, largely determined by the size and characteristics of its filler particles.

Composite resins with larger filler particles generally exhibit lower water absorption rates compared to those with smaller particles.[9]

The composite resin used in this study contained bovine bone hydroxyapatite classified as macrofiller. While larger filler particles can improve certain mechanical properties, they also make the composite more susceptible to color alteration. The quantity of filler further influences physical, chemical, and mechanical properties including water absorption, color stability, and wear resistance. As shown in research by Permatasari et al., the type, size, shape, and proportion of filler directly determine the long-term color stability of composite resin.[10]

The use of triethylene glycol dimethacrylate (TEGDMA) and urethane dimethacrylate (UDMA) as matrix components may also contribute to increased discoloratio. These monomers are hydrophilic due to their ether and urethane linkages, which are weaker in aqueous environments compared to the hydrogen-bonded hydroxyl groups found in bisphenol A-glycidyl methacrylate (Bis-GMA). The addition of TEGDMA specifically increases water absorption, reduces mechanical strength, and lowers color stability. Furthermore, the quality of bonding between the resin matrix and filler particles affects water uptake; excessive water absorption can soften the material through hydrolysis and create microcracks. Consequently, these microcracks or gaps at the matrix-filler interface allow penetration of staining agents, leading to visible discoloration.[10-12]

The significant color change observed in this study is consistent with known effects of long-term chlorhexidine use. As reported by Armiati, side effects include altered taste perception, a burning sensation, and tooth discoloration.[13]

Chlorhexidine gluconate 0.1% penetrates the composite resin and degrades siloxane bonds through hydrolysis, weakening the adhesion between filler and matrix. This facilitates greater water absorption, which in turn accelerates discoloration. According to Anas et al., alcohol-free mouthwashes can promote degradation of composite resins because the polymer-based matrix is inherently hydrophilic, allowing diffusion of hydrogen and hydroxide ions into the material. This triggers hydrolysis reactions at the interface between filler and resin.[13],[14]

In this research, immersion was carried out for 12 hours, a duration selected to simulate one year of regular mouthwash use: twice daily rinsing for 60 seconds over 365 days totals 43,800 seconds, or 12 hours. This prolonged exposure simulates cumulative effects over time, explaining the measurable color change. This finding aligns with Hermanegara's study, which noted that regular use of 0.1% chlorhexidine for one month—equivalent to one hour of immersion—already produces visible discoloration.[15]

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