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COMPARATIVE EVALUATION OF EFFECT OF HERBAL EXTRACTS ON SURFACE PROPERTIES OF NANOHYBRID COMPOSITES AFTER BLEACHING- AN INVITRO STUDY

Dental Science

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ABSTRACT

Introduction: Dental bleaching is a procedure aimed at enhancing tooth color. While effective in improving smiles, concerns have arisen about the impact of bleaching on existing dental restorations. Additionally, consuming acidic beverages can cause significant surface alterations in dental composites. Herbal extracts like Tulsi and lemon may also influence these restorations' color, hardness, and roughness. This study aimed to evaluate the effects of commonly consumed beverages, specifically Tulsi and lemon extracts, on the surface properties of Filtek Z350 and Omnichroma composites following in-office vital bleaching. **Methods:** A total of 54 composite discs were divided into three groups. Each group underwent three rounds of bleaching, followed by treatment with the two extracts. The discs were then assessed for surface roughness, color stability, and microhardness, with subsequent statistical analysis performed. **Results:** The Filtek bleach group exhibited the highest surface roughness, while Tulsi and lemon extracts resulted in a moderate increase in roughness. Omnichroma demonstrated improved hardness after treatment with the extracts. In terms of color change, Omnichroma showed no significant differences among the bleach, Tulsi, and lemon groups, indicating stable color retention post-treatment. **Conclusion:** The application of Tulsi and lemon extracts after bleaching can enhance the surface properties of bleached composites.

KEYWORDS

Nanohybrid, Tulsi, Lemon, Vital-Bleaching

INTRODUCTION

Teeth play a crucial role in shaping overall facial aesthetics, with various factors such as color, shape, position, and the quality of dental restorations significantly affecting their appearance and influencing individual satisfaction. [1] Dental bleaching is a popular procedure to improve tooth color, utilising chemicals or natural agents to eliminate extrinsic stains from enamel and dentin. The most commonly used bleaching agents are hydrogen peroxide and carbamide peroxide, which are available for at-home and in-office treatments. While these methods effectively enhance smiles, concerns have emerged regarding their potential effects on existing dental restorations.

Additionally, the growing focus on aesthetics has increased the use of direct restorative materials, especially Dental Composites. The clinical performance of these materials is largely determined by the characteristics of the resin matrix and fillers, playing a significant role in influencing the properties of the composite.

Despite significant advancements in composite resins, fluctuating pH levels and temperature changes still challenge their effectiveness in the oral environment. The consumption of acidic beverages, such as drinks, medicines, or mouthwashes, can lead to notable surface changes in dental composites. For these materials to be effective, they must be tough and highly wear-resistant, as they are constantly exposed to various chemicals in saliva and food which can weaken the resin matrix and erode filler particles.

Filtek™ Z350 XT is a versatile nano-filled composite containing nanosized silica and zirconia particles present with superior polishing and aesthetics. [2] At the same time, Omnichroma is a universal composite designed with Smart Chromatic Technology that adapts to any tooth color, streamlining shade selection for dental professionals. [3]

Herbal extracts such as Tulsi and lemon are recognised for their antimicrobial properties and acidic pH, which can significantly affect dental restorations' color, hardness, and roughness. Tulsi aids in preserving the integrity of restorations by inhibiting bacterial growth. [4] On the other hand, lemon is effective for stain removal, it can erode surfaces, leading to decreased hardness and increased roughness. [5] Nevertheless, when used in moderation and under professional supervision, lemon can offer temporary whitening benefits. [6]

The impact of acidic agents on the surfaces of enamel and various composites has been reported in several studies. [7,8] However, there is insufficient evidence regarding the changes induced by acidic agents on the surfaces of bleached composites. Therefore, this study aimed to assess the effects of commonly consumed beverages, specifically Tulsi and Lemon extracts, on the surface properties of Filtek Z350 and Omnichroma following in-office vital bleaching. The null hypothesis was that different beverages would not alter the surface properties of two composites after bleaching.

MATERIALS AND METHODS

The sample size was determined using G power software V.3.1.9.2. Considering the power at 80% and α error at 5%, the total sample needed was 54 (including positive and negative control groups).

Preparation Of Resin Discs

54 Composite discs (8x2mm) were prepared using a thick acrylic mould, using a mylar matrix band press over the composite for a smooth surface and to prevent an Oxygen inhibition layer. The composite resin was light-cured for 20 seconds with a 1000 mW/cm² LED unit, polished, rinsed, and cleaned ultrasonically, then stored in distilled water at 37°C for 24 hours to ensure 100% polymerization. [8]

Samples were divided into

- **Group A:** Filtek Z350XT (3M, ESPE, St. Paul, USA)
- **Group B:** Omnichroma (Tokuyama Dental)
- **Control Group:** Composite not exposed to any bleaching agents.

Preparation Of Extract

To prepare 15ml of 100% Tulsi (Ocimum sanctum) extract, fresh leaves were rinsed thoroughly to remove impurities and blended with water to form a smooth paste. The paste was subsequently filtered to obtain the liquid extract. 15ml of 100% Lemon extract was prepared by filtering the extracted juice from fresh lemons. [4] The pH of Tulsi extract was slightly acidic, ranging from 5.0 to 6.0, whereas the pH of lemon extract was highly acidic, ranging from 2.0 to 3.0. [9]

Bleaching Procedure

Each group underwent the three-round bleaching procedure using 32% hydrogen peroxide (HP) (Polaoffice) every 15 minutes by dipping it in that solution followed by a thorough rinse with distilled water. After bleaching, the discs were treated with two extracts: Lemon and Tulsi, each applied for 15 minutes. [8] Once the extract treatments were completed, all samples were stored in distilled water until analysis.

Evaluation Of Surface Roughness, Color Stability And Microhardness

Surface roughness was assessed using a profilometer (Mitutoyo Surftest SJ-210). Samples were measured before and after bleaching, with three readings taken from different locations. Mean roughness values were calculated.

Color changes were evaluated using a spectrophotometer (X-rite RM200QC). Samples were measured before and after bleaching, with three readings collected from the centre of each sample. The average values were recorded.

Microhardness was measured using a Vickers hardness testing machine (MICRO MACH TECHNOLOGIES MODEL-S1300). A load of 100 g was applied for 15 seconds, and the indentation diagonal was measured to calculate the area. Specimens were mounted on the device platform, with a 14mm spacer and a square-based pyramid diamond indenter.

Statistical Analysis

The following non-parametric tests were used: Friedman's ANOVA, the Wilcoxon post-hoc test, and the Mann-Whitney test. Each test was performed using SPSS VERSION 17 with a 5% level of statistical significance.

RESULTS

Surface Roughness

Table 1- Group-wise Comparison Of Surface Roughness

	Mean	Std. Deviation	Mean Rank	p-value
FILTEX CONTROL	.07925	.109389	1.25	**<0.001***
FILTEK BLEACH	.21425	.001581	2.88	
FILTEK TULSI	.24800	.019508	4.00	
FILTEK LEMON	.21013	.027472	1.88	
OMNICHROMA CONTROL	.07888	.108871	1.75	**0.002***
OMNICHROMA BLEACH	.27025	.005523	4.00	
OMNICHROMA TULSI	.15750	.008992	2.25	
OMNICHROMA LEMON	.15563	.010113	2.00	

p-value by Friedman test
*p<0.05 statistically significant

Table 2- Pairwise comparison

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	p-value
FILTEX CONTROL- FILTEK LEMON	-.625	.645	-.968	.333
FILTEX CONTROL- FILTEK BLEACH	-1.625	.645	-2.517	**.012***
FILTEX CONTROL- FILTEK TULSI	-2.750	.645	-4.260	**<0.001***
FILTEK LEMON- FILTEK BLEACH	1.000	.645	1.549	.121
FILTEK LEMON-FILTEK TULSI	2.125	.645	3.292	**.001***
FILTEK BLEACH-FILTEK TULSI	-1.125	.645	-1.743	.081
OMNICHROMA CONTROL-OMNICHROMA LEMON	-.250	.645	-.387	.699
OMNICHROMA CONTROL-OMNICHROMA TULSI	-.500	.645	-.775	.439
OMNICHROMA CONTROL-OMNICHROMA BLEACH	-2.250	.645	-3.486	**<0.001***
OMNICHROMA LEMON-OMNICHROMA TULSI	.250	.645	.387	.699
OMNICHROMA LEMON-OMNICHROMA BLEACH	2.000	.645	3.098	**.002***
OMNICHROMA TULSI-OMNICHROMA BLEACH	1.750	.645	2.711	**.007***

p-value by Friedman test
*p<0.05 statistically significant

Color

Table 3- Pairwise comparison in Filtek and Omnichroma

Dependent Variable	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	p-value
Filtek	**Bleach**	**Tulsi**	2.047500	.513851	**.002***
	Bleach	**Lemon**	1.516625	.513851	**.020***
	Tulsi	**Lemon**	-.530875	.513851	.565
Omnichroma	**Bleach**	**Tulsi**	.82875	.91105	.640
	Bleach	**Lemon**	1.16000	.91105	.425
	Tulsi	**Lemon**	.33125	.91105	.930

p-value by post hoc Tukey
*p<0.05 statistically significant

Hardness

Table 4- Group Comparison Between Filtek And Omnichroma

Parameter	Group	n	Mean	Std. Deviation	Mean Rank	Z value	p-value
Bleach	**Filtek**	8	47.3938	1.09887	12.50	-3.371	**<0.001***
	Omnichroma	8	44.5638	.90019	4.50		
Tulsi	**Filtek**	8	93.3750	1.20268	12.50	-3.366	**<0.001***
	Omnichroma	8	68.7150	.90162	4.50		
Lemon	**Filtek**	8	64.0238	.77715	4.50	-3.363	**<0.001***
	Omnichroma	8	128.3525	1.02903	12.50		

p-value by Mann Whitney U test
*p<0.05 statistically significant

Table 1

The statistical results showed significant differences in surface roughness among the groups ($p < 0.05$). In the Filtek group, bleaching led to the highest roughness, while Tulsi and Lemon increased roughness moderately compared to the control. Similar results were observed in the Omnichroma group. The p-values for both Filtek (<0.001) and Omnichroma (0.002) indicated that the surface roughness variations across the groups are statistically significant.

Table 2

The pairwise comparison of results showed significant differences in surface roughness between certain groups. In the Filtek group, Tulsi ($p < 0.001$) showed higher surface roughness than bleach ($p = 0.012$) and the control group. However, no significant difference was found between Filtek Control and Lemon ($p = 0.333$). In Omnichroma, the bleach group ($p < 0.001$) showed higher roughness than the control group while Lemon and Tulsi did not differ significantly in surface roughness from each other or the control.

Table 3

The pairwise comparison for color change- in the Filtek group, extracts showed statistically significant color stability compared to the bleach group (Tulsi and Lemon $p = 0.002$ and $p=0.20$). In Omnichroma, no significant differences were found between the bleach, Tulsi, and Lemon groups ($p>0.05$).

Table 4

The group comparison for Hardness, Filtek and Omnichroma composites showed statistically significant differences across all groups. For the bleached groups, both Filtek and Omnichroma showed decreased hardness (p-value < 0.001). In the Tulsi-treated groups, Filtek showed improved hardness than Omnichroma (p-value < 0.001). For the Lemon-treated groups, Omnichroma showed improved hardness than Filtek, showing increased hardness after treatment.

DISCUSSION

As vital teeth bleaching gains popularity, it's crucial to consider how these treatments affect the surface properties and aesthetic appearance of existing dental restorations, complicating the color-matching process and its function. [1] There can be an increase in the caries risk and periodontitis due to an increase in the surface roughness by promoting plaque retention, [2,3] while color, gloss, and staining are also influenced. [4,5]

Bleaching agents may decrease composites' surface hardness and color stability while increasing their roughness. These effects vary depending on the type of agent, exposure time, and substrate. [10,11] This study revealed that in-office bleaching significantly decreased the surface hardness of composites in all groups, leading to the rejection of the null hypothesis. This could be attributed to HP's generation of free radicals during bleaching likely causing polymer chain separation and double bond cleavage, reducing microhardness and microcracks formation at the resin-filler interface. [12] This finding aligns with Kamangar et al, [13] and Mohammadi et al, [14] who observed similar microhardness reductions with higher HP concentrations. The application of Tulsi and lemon extracts has contrasting effects on the microhardness of composites. They have been found to preserve microhardness which could help maintain the composite integrity rather than bleaching alone. This behaviour of extracts might be attributed to the ingredients present in their pure form which can resist the opposing actions of bleaching agents in reducing the

microhardness of the composites.

Color perception in dental materials is subjective and varies based on observer skill and environmental conditions. This study utilized a Spectrophotometer, which is commonly used in dentistry to reduce errors in visual assessments. [15] Comparing Filtek and Omnichroma across treatment groups, Omnichroma showed superior color stability between groups, showing that it is not affected by any surface treatments. In the filtek group, the application of extracts after bleaching has improved the color stability of the composites. These findings emphasize the importance of context in selecting appropriate materials. [3,16]

Surface roughness is vital for assessing the long-term behaviour of composites, as increased porosity and water sorption lead to roughness, color changes, and dimensional alterations. Roughness below 0.2 μm prevents plaque accumulation, while values ≤1 μm are clinically acceptable. [13,14]

This study showed that Control groups exhibited significantly lower surface roughness than those treated with bleaching agents or natural extracts. The addition of Tulsi extract resulted in a moderate increase in roughness compared to controls, but significantly less than bleaching agents alone, while Lemon extract showed intermediate roughness levels, indicating a less pronounced effect on surface degradation. Bleaching agents can weaken the resin matrix and resin-filler interface, increasing susceptibility to chemical erosion,[17] which requires caution in patients with extensive restorations.

To the best of our knowledge, this is the first preliminary study executed to evaluate the effect of natural extracts on bleached composites. Future research should include variations in extract concentrations, pH levels, and temperature for a more comprehensive understanding. Additionally, incorporating Tulsi and Lemon extracts into bleaching agents showed potential for enhancing color stability after bleaching, indicating that these extracts could serve as effective natural stain-resistant additives to composites.

CONCLUSION

This study concluded that applying Tulsi and Lemon extracts after bleaching improves the surface properties of bleached composites relatively. Therefore, they can be used as supplemental steps in the vital-bleaching procedure to extend the survival rate of existing composite restorations.

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