

Effect of herbal antioxidants on the shear bond strength of composite resin to bleached enamel at different time intervals

Sharad Kamat, Nakul Hemantkumar Malgundkar¹, Divya Gupta², Mamata Kamat³

Departments of Conservative Dentistry and Endodontics and ³Oral and Maxillofacial Pathology, Bharati Vidyapeeth (Deemed to be University) Dental College and Hospital, Sangli, ¹White Teeth Advanced Dental Clinic, Mumbai, ²Department of Conservative Dentistry and Endodontics, D. Y. Patil Dental School, Dr. D. Y. Patil Knowledge City, Pune, Maharashtra, India

Abstract

Background: Anterior tooth discolorations can be treated conservatively and noninvasively through bleaching to achieve the desired esthetic outcomes. However, bleaching along with composite resin is advisable for certain clinical cases for optimum results. However, shear bond strength (SBS) of composite resin to the bleached tooth gets significantly lowered. Before placing the composite restoration, the bleached enamel needs to be treated with antioxidant agents to increase its SBS. The study aims to evaluate and compare the effect of herbal antioxidants on SBS of composite resin to bleached enamel at different time intervals.

Materials and Methods: Sixty extracted single-rooted maxillary incisors postdecoration, keeping their labial surfaces up were mounted in cold-cure acrylic resin. The samples were randomly divided into: Group I – unbleached; Group II – 10% pine bark extract for 10 min postbleaching; Group III – 10% pine bark extract for 20 min postbleaching; Group IV – application of 10% rosemary extract for 10 min postbleaching, Group V – application of 10% rosemary extract for 20 min postbleaching; Group VI – no application of antioxidant. 35% hydrogen peroxide was used for bleaching all the samples except those which served as negative control. Later composite cylinder 4 mm in diameter and length were built on prepared enamel. The maximum load at failure was recorded using the universal testing machine.

Statistical Analysis: Data were analyzed using the analysis of variance and Tukey's *t*-test with significance level of $P < 0.05$.

Results: Highest load was exhibited by Group I. Group V showed satisfactory shear strength followed by Groups IV, III, II, and VI.

Conclusion: Both 10% rosemary and 10% pine bark extracts showed better results when applied for 20 min as compared to 10 min application. Increased duration of antioxidant application increases the SBS.

Keywords: Antioxidants; bleaching; composite resin; pine bark extract; rosemary extract

Address for correspondence:

Dr. Divya Gupta,
Department of Conservative Dentistry and Endodontics,
D. Y. Patil Dental School, Dr. D. Y. Patil Knowledge
City, Charholi-Budruk, Via Lohegaon, Pune - 412 105,
Maharashtra, India.
E-mail: divyagupta8989@yahoo.com

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INTRODUCTION

Esthetics plays a crucial role in the appearance and personality of an individual. Effectual treatment is warranted in anterior tooth discoloration as it involves patient's esthetics. In many cases, treatment for discoloration varies from micro abrasions, bleaching to composite resin restorations, and porcelain veneers.^[1] Noninvasiveness,

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conservative nature, and comparative ease of performance are the attributes which makes bleaching the choice of treatment. Prompt reduction in the bonding capacity and wear resistance of enamel along with increased enamel porosity leading to decreased fracture toughness are considered to be the deleterious effects of bleaching.^[2]

For certain cases, bleaching along with composite resin is advisable to achieve the desired esthetics.^[3] Bleaching generates residual oxygen layer, thereby impeding the polymerization reaction and lowering the shear bond strength (SBS) of composite to enamel that has been bleached.^[4,5] The usage of antioxidants is considered a more effective alternative to increase the SBS.^[1,6] Literature revealed that the synthetic antioxidants (sodium ascorbate, ascorbic acid, and sodium salts) require multiple applications posing economic and time concerns and did not totally reversed the compromised bond strength.^[7,8]

Owing to the drawbacks of synthetic antioxidants, the herbal antioxidants can be considered as an effective alternative. When compared to sodium ascorbate, the potency of pine bark extract is 50 times more which is attributed to the presence of naturally occurring antioxidants such as oligomeric proanthocyanidin complexes (OPCs) exerting its scavenging effect.^[3,8] Other natural antioxidants such as rosemary extracts contain principal antioxidative components, i.e. the phenolic diterpenes carnosol and carnosic acid which shows potent antioxidant activity.^[6] The herbal antioxidants have better antioxidative properties than synthetic, are safe to use and more cost-effective.^[8]

The SBS of composite resin to bleached enamel is affected not only by the potency but also the duration of application of the herbal antioxidants. The potency of herbal antioxidants has been documented in the literature. However, there is dearth of research on their effectiveness at different time durations of application in reversing the SBS. Hence, this study was designed to evaluate and compare the effect of pine bark and rosemary extracts at different time durations of application on reversing the SBS.

MATERIALS AND METHODS

Sixty caries-free extracted human single-rooted maxillary incisors were cleaned using ultrasonic scaler and then disinfected with 0.1% thymol. Under copious water coolant, using a diamond disc the teeth crowns were separated at the cement-enamel junction. Keeping labial surfaces upward, the crowns were inserted in self-cure acrylic resin block and central tooth portion was transformed into a flat uniform enamel surface using 600-grit silicon carbide paper. A coat of nail varnish was applied on the crown surface except an area of 5 mm² on which the bleaching was done.

Preparation of the extracts

10% pine bark extract: Distilled water (100 ml) added to pine bark extract (10 g) yielded 10% pine bark extract.

10% rosemary extract: Distilled water (100 ml) added to rosemary extract (10 g) yielded 10% rosemary extract.

Random segregation of samples was done into six groups. Samples were bleached for three cycles of 8 min each with 35% hydrogen peroxide gel (Pola Office Plus).

- Group I ($n = 10$) (negative control): No bleaching was done
- Group II ($n = 10$): 10% pine bark extract application for 10 min followed the bleaching procedure
- Group III ($n = 10$): 10% pine bark extract application for 20 min followed the bleaching procedure
- Group IV ($n = 10$): 10% rosemary extract application for 10 min followed the bleaching procedure
- Group V ($n = 10$): 10% rosemary extract application for 20 min followed the bleaching procedure
- Group VI ($n = 10$) (positive control): Immediate composite resin build up followed the bleaching procedure.

The samples with extracts applied were rinsed with distilled water for 30 s. It was followed by enamel etching with 37% phosphoric acid (Ivoclar N etchant gel) for 15 s, water rinsing for 15 s, air drying for 5 s and dentin bonding agent (Tetric N-Bond Ivoclar Vivadent) application and curing for 10 s. A cylindrical plastic mold with 4 mm diameter and 4 mm length was securely adapted to the prepared enamel surface followed by 2 mm incremental build-up of composite resin (Te-Econom Plus Composite Ivoclar Vivadent) and 40 s curing time. The mold was removed and samples were kept at 37°C in distilled water for 24 h. The samples were mounted on Universal Testing Machine (INSTRON 3369, UK) with a knife edge loading head. The shear stress rate was 1 mm/min. The maximum load at failure was recorded and converted to megapascals [Figure 1].

RESULTS

Analysis of variance and *post hoc* Tukey's *t*-test for multiple comparisons among the groups were applied for the statistical analysis using the Statistical Package for Social Sciences (IBM SPSS Statistic for Window, Version 21.0. Armonk, NY:IBM Corp.). $P < 0.05$ implied statistically significant.

SBS values were obtained in the following descending order [Table 1]:

Unbleached > Rosemary extract for 20 min > Rosemary extract for 10 min > Pine bark extract for 20 min > Pine bark extract for 10 min > bleaching without antioxidant used.

Although SBS of Group V (rosemary extract for 20 min) was less than Group I, it has shown superior results in comparison to other experimental groups.

The study results demonstrated maximum mean difference of SBS between Group I and VI followed by Group V and VI, Group I and II, Group IV and VI, Group I and III, and Group I and IV which were statistically significant [Table 2].

DISCUSSION

Tooth discoloration can be efficaciously treated by bleaching. However, bleaching alone does not suffice for the correction of diastemas, malposed teeth, spacing which necessitates additional esthetic techniques such as composite restorations, veneers, laminates, and lumineers. Teeth restored after bleaching exhibit a more natural translucent appearance as they require lighter composite shades with lowered incorporation of opacifier.^[6,8]

Literature has revealed that bleaching with peroxides significantly reduces enamel bond strength as compared to tooth surface not bleached owing to free residual oxygen layer formed during bleaching that interferes with polymerization.^[3-5] Loss of calcium, decreased microhardness, altered organic substance, loss of prismatic structure, and increased enamel porosity are the deleterious effects seen after carbamide peroxide bleaching.^[9] Majority of the patients require composite restorations following the bleaching procedure for further esthetic correction, and hence, this initial decrease in enamel bond strength becomes an important clinical challenge.^[10] Waiting for 24 h–3 weeks before undertaking composite restoration which helps regain the lost bond strength, might not be acceptable to patients with immediate esthetic demands. Immediate improvement in the SBS to bleached enamel can be achieved by alcohol treatment of enamel postbleaching,

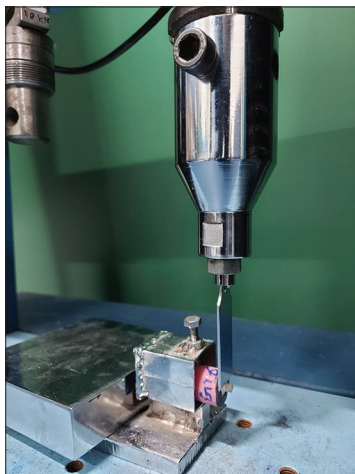


Figure 1: Measurement of shear bond strength on universal testing machine

removing superficial layer of enamel, using organic solvent adhesives, and by using antioxidants.^[2,6]

Synthetic antioxidants such as sodium ascorbate regain the SBS of composite resin to enamel by neutralizing peroxide layer.^[8] Organic solvents such as acetone and ethanol cause water displacement from bleached enamel surface by interacting with residual oxygen and thus increase the bond strength.^[11] However, it was found that sodium ascorbate was mutagenic for mammalian somatic cells, needed multiple applications thereby raising economic and treatment times concerns and was not totally effective in improvising the bond strength.^[7,8] Naturally occurring antioxidants are found to have better antioxidant properties than the synthetic antioxidants and are cost effective too. These natural antioxidant extracts (oligomeric proanthocyanidine, alpha tocopherol, green tea, pomegranate seeds, rosemary, gooseberry, and strawberry) used in various studies revealed effective reversal of SBS of composite to enamel surface postbleaching.^[12-15]

There are lack of sufficient studies reporting comparison between antioxidants pine bark extract and rosemary extract in effective reversal of the SBS after bleaching.

Table 1: Comparison of shear bond strength and maximum load among all the groups

Group	Mean±SD	
	Maximum load	Shear bond strength
I (negative control)	190.8±20.41	10.50±1.26
II (10% pine bark extract for 10 min)	123.3±11.41	7.01±1.36
III (10% pine bark for 20 min)	132.75±1.99	7.09±0.35
IV (rosemary extract for 10 min)	154.3±52.45	8.10±3.28
V (rosemary extract for 20 min)	156.4±17.76	8.70±0.94
VI (bleaching followed by composite resin build up)	119.60±48.84	4.33±1.88
Total	146.19±39.27	7.62±2.55
P	<0.01*	<0.01*

*P<0.05 statistically significant. Test applied-One-way ANOVA. SD: Standard deviation

Table 2: Comparison of mean difference of shear bond strength in between different groups

Groups	Mean difference	P
1 versus 2	3.48	0.001*
1 versus 3	3.40	0.001*
1 versus 4	2.40	0.045*
1 versus 5	1.80	0.23
1 versus 6	6.16	<0.01*
2 versus 3	0.82	1.0
2 versus 4	1.08	0.75
2 versus 5	1.68	0.29
2 versus 6	2.67	0.01*
3 versus 4	1.007	0.80
3 versus 5	1.60	0.35*
3 versus 6	2.75	0.14*
4 versus 5	0.60	0.97
4 versus 6	3.76	<0.01*
5 versus 6	4.36	<0.01*

*P<0.05 statistically significant. Test applied – *post hoc* test

Nevertheless, our literature search has revealed that studies related to usage of pine bark and rosemary extracts at different time intervals are sparse.

This study comparatively evaluated the SBS of composite resin to bleached enamel using herbal antioxidants (pine bark extract and rosemary extract) at different time intervals. OPCs that show antioxidant, anti-viral, anti-bacterial, anti-allergic, and anti-inflammatory properties are highly concentrated in naturally found pine bark extract, grape seed extract, cranberries, lemon tree bark and have been proven to be safe in dietary supplements and clinical usages.^[8]

In the present study, rosemary extract was selected as another natural antioxidant because rosemary contains phenolic diterpenes carnosol and carnosic acid which contribute toward its antioxidant properties.^[16]

The results of this study revealed that Group I (unbleached group) SBS was significantly higher in values than all the other groups (bleached groups). This finding is in correlation with the studies of Shashibhushan *et al.*,^[17] Thapa *et al.*,^[18] and Baidas *et al.*^[12] This could be because of the residual oxygen layer postbleaching interfering with resin penetration into enamel and hindering composite polymerization. Groups II and III in which tooth surfaces were treated with pine bark extract showed significantly higher SBS compared to Group VI. The results of the present study are consistent with other studies Mukka *et al.*^[11] and Subramonian *et al.*^[19] This could be due to the scavenging of superoxide radicals by the multiple donor sites on OPCs increasing the specificity of hydroxyl free radicals. The other reason could be the presence of gallic acid in OPCs leading to increased scavenging ability by esterification of epicatechin for free radicles.^[18] Subramonian *et al.*^[19] in their study compared the effect of 10% pine bark, 10% grape seed, and 10% sodium ascorbate for 10 min each; on SBS of composite resin to bleached enamel and concluded that 10% pine bark extract showed better bond strength among the experimental groups. The present result coincided with the results of studies conducted by Mukka *et al.*^[11] in which 5% pine bark extract for similar time duration (10 min) showed similar results of reversal in bond strength when compared to group with no antioxidant used.^[11]

Group III showed greater SBS compared to Group II which shows that with increase in the time duration of application of pine bark extract over bleached enamel surface; the SBS increased. Groups IV and V in which tooth surfaces were treated with rosemary extract showed significant higher SBS when compared to Group VI. Our results coincided with the study conducted by Suneetha *et al.*^[6] They reported that rosemary extract for 10 min effectively reversed SBS postbleaching and ascribed it to its major antioxidative components-phenolic diterpenes carnosol (C₂₀H₂₈O₄) and carnosic acid (C₂₀H₂₈O₄).^[6]

Group V showed greater bond strength when compared to Group IV which confirmed that increasing the time duration of rosemary extract application on bleached enamel, the SBS values increased. Among all the experimental groups, Groups IV and V showed greater fracture load resistance than Groups II and III revealing that herbal antioxidant rosemary extract has better potency in removal of peroxide layer than pine bark extract at 10 and 20 min, respectively. The reduced SBS in Group VI when compared to Groups II, III, IV, and V may be due to remaining oxygen layer postbleaching thereby interfering with resin infiltration into etched enamel and inhibiting its polymerization and is in accordance with a study conducted by Mukka *et al.*,^[11] Shashibhushan *et al.*,^[17] Subramonian *et al.*,^[19] and Stokes *et al.*^[20]

Overall, the results of the present study revealed that the herbal antioxidants rosemary and pine bark extracts exhibited reversal of SBS of composite to bleached enamel and the potency of reversal increases with their duration of application.

The present study also had some limitations such as only single concentration of antioxidants was used. By increasing the concentration and use of different herbal antioxidants, the SBS could show better reversal. Moreover, this study being an *in vitro* study did not exactly simulate the oral environment. The oral conditions, especially the periodontal status, gingival conditions, and oral hygiene status may also alter the prognosis of the treatment. Therefore, the clinical application requires more *in vitro* studies and further long-term clinical studies to evaluate the effect of herbal antioxidants at different time intervals.

CONCLUSION

Reduction in the SBS postbleaching deleteriously affects the bonding of composite resin to the bleached enamel. It must be reversed by the immediate application of antioxidants. As compared to the synthetic antioxidants, the herbal antioxidants are not only more potent but also easily extracted, cost-effective, and less time-consuming. This study opens new avenues for the use of various types of herbal products as postbleaching antioxidants. More research should be carried out to document the antioxidant activity of the various abundant herbal products available in nature at their different concentration formulations and varying durations of application.

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Conflicts of interest

There are no conflicts of interest.

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