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Anti-Oxidants and Their Role in Prevention of Dental Caries: A Multi Arm Randomised Controlled Trial

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Abstract

Dental erosion and caries are prevalent oral health issues that can have significant consequences. This study aims to evaluate the role of antioxidants (green tea extract, vitamin C, and vitamin E) in reducing dental caries and erosion. A total of 150 participants were divided into one control group and three treatment groups (green tea extract, vitamin C, and vitamin E). The study assessed BEWE (Basic Erosive Wear Examination), DMFT (Decayed, Missing, and Filled Teeth), and baseline demographics. Salivary samples were analyzed for oxidative stress markers and antioxidant levels, and changes in scores were evaluated for participants receiving specific treatments. Statistical significance was determined using a paired t-test. All treatment groups exhibited significant reductions in BEWE and DMFT scores compared to the control group. Specifically, the DMFT for Group A (vitamin C) decreased from 4.2 to 2.8, for Group B (vitamin E) from 4.0 to 2.9, and for Group C (green tea extract) from 4.1 to 3.0. The treatment groups also showed significant decreases in BEWE scores, while the control group exhibited minimal changes. Antioxidants have the potential to serve as effective preventive agents in dental care, significantly reducing dental caries and erosion. Further research is needed to confirm long-term benefits and explore optimal usage.

Keywords: Dental Caries, Dental Erosion, Antioxidants, Vitamin C, Vitamin E, Green Tea Extract, BEWE, DMFT.

INTRODUCTION

Dental caries and erosion are significant global health issues that can lead to serious complications. Various factors contribute to dental caries, including the loss of tooth enamel due to acids produced by the fermentation of carbohydrates by oral bacteria, which can result in cavities if untreated. Dental erosion, on the other hand, refers to the gradual loss of tooth structure caused by the chemical action of non-bacterial acids, such as those found in certain foods or due to gastric reflux. If left untreated, both conditions can lead to severe consequences.

Dental caries is one of the most common chronic diseases worldwide, with the World Health Organization estimating that 2.3 billion adults and 530 million children will experience it at some point in their lives. Although dental erosion is less prevalent, it is increasingly recognized as a serious oral health concern, particularly among young adults and children, due to the rising consumption of acidic foods and beverages. The consequences of caries can include diminished self-esteem, impaired nutritional status, significant financial burdens due to treatment costs, and disruptions in social interactions.

Research has indicated that oxidative stress plays a role in the development of dental issues such as caries and erosion. This oxidative damage results from an imbalance between the production and elimination of reactive oxygen species (ROS). The harmful effects of free radicals can be countered by a range of molecules, including enzymatic antioxidants like catalase and superoxide dismutase, as well as non-enzymatic antioxidants such as vitamins and flavonoids.

Numerous studies have explored the role of antioxidants in preventing dental caries and erosion, highlighting their importance in maintaining the health of dental tissues. For instance, vitamin E helps prevent cell membrane damage, while vitamin C is essential for collagen synthesis, contributing to the health of gums

and periodontal ligaments. Additionally, catechins found in green tea have been shown to improve dental health by reducing the presence of cariogenic bacteria.

While the precise mechanisms behind these benefits remain unclear, various in vitro and animal studies have investigated the use of antioxidants in preventing dental decay and erosion. However, high-quality clinical trials are still needed to assess the safety and efficacy of these antioxidants.

This study aims to evaluate the effectiveness of antioxidants, specifically vitamin C, vitamin E, and green tea extract, in combating dental caries and erosion.

METHODS

This case-control study was conducted over a 12-month period from January 2024 to December 2024. Participants were recruited from dental clinics and college campuses. A total of 150 participants aged 20-45 years were enrolled in the study. Inclusion criteria required participants to have at least 20 natural teeth, be in good general health, and be prescribed vitamin C (ascorbic acid) mouthwash, vitamin E (alpha-tocopherol) gel, green tea extract rinse, or a placebo mouthwash for a minimum of three months. Exclusion criteria included smoking, systemic diseases affecting oral health, and the use of medications that influence salivary flow.

Participants were assigned to four groups based on their prescribed treatment, with each group receiving a different antioxidant treatment:

1. Group A: Vitamin C (ascorbic acid) mouthwash
2. Group B: Vitamin E (alpha-tocopherol) gel
3. Group C: Green tea extract rinse
4. Control Group: Placebo mouthwash

Data Collection Procedure

Baseline dental examinations were conducted, including assessments of dental caries and erosion using standardized indices (DMFT and BEWE). Saliva samples were collected to measure antioxidant levels and oxidative stress markers. Participants were instructed to use their assigned treatment twice daily after brushing their teeth for three months. Follow-up assessments were conducted at 1.5 months, with final evaluations at the end of the study period.

Data Analysis

Primary outcomes included changes in DMFT and BEWE scores, while secondary outcomes involved salivary antioxidant levels and oxidative stress markers. Data were analyzed using SPSS version 23.0, with significance set at $p<0.05$ after applying a paired t-test at baseline and three months post-treatment.

RESULTS

The baseline demographics of the participants included in the study are presented in Table I. A total of 160 participants were distributed uniformly into four groups: Group A, Group B, Group C, and a control group, each comprising 40 individuals. The mean age of participants in Group A was 25.3 years (± 4.2), in Group B was 24.8 years (± 3.9), in Group C was 25.1 years (± 4.1), and in the control group was 24.7 years (± 4.0).

Table I: Baseline demographics of participants included in the study (n=160)

Groups	Mean Age (years)	Gender	
		Male	Female
Group A (n=40)	25.3 ± 4.2	15	25
Group B (n=40)	24.8 ± 3.9	20	20
Group C (n=40)	25.1 ± 4.1	25	15
Control Group (n=40)	24.7 ± 4.0	16	14

Table II displays the changes in BEWE and DMFT scores from baseline to three months for each group. The BEWE scores at baseline were similar across the groups, with Group A at 7.1 (± 1.9), Group B at 7.0 (± 1.8), Group C at 7.2 (± 1.7), and the control group at 7.3 (± 1.8). After three months, significant reductions in BEWE scores were observed in the treatment groups: Group A decreased to 4.6 (± 1.5), Group B to 4.8 (± 1.4), and Group C to 4.7 (± 1.6), all with p-values of <0.001. In contrast, the control group showed a non-significant change from 7.3 (± 1.8) to 7.0 (± 1.6) with a p-value of 0.08.

Table II: Changes in BEWE and DMFT Scores at Baseline and at 3 Months (n=160)

Groups	BEWE (Baseline)	BEWE (3 months)	P-value	DMFT (Baseline)	DMFT (3 months)	P-value
Group A (n=40)	7.1 ± 1.9	4.6 ± 1.5	<0.001	4.2 ± 1.3	2.8 ± 1.1	<0.001
Group B (n=40)	7.0 ± 1.8	4.8 ± 1.4	<0.001	4.0 ± 1.4	2.9 ± 1.2	<0.001
Group C (n=40)	7.2 ± 1.7	4.7 ± 1.6	<0.001	4.1 ± 1.2	3.0 ± 1.0	<0.001
Control Group (n=40)	7.3 ± 1.8	7.0 ± 1.6	0.08	4.3 ± 1.3	4.1 ± 1.2	0.07

The DMFT scores also exhibited significant reductions in the treatment groups over three month period. Group A's DMFT score decreased from 4.2 (± 1.3) to 2.8 (± 1.1), Group B's from 4.0 (± 1.4) to 2.9 (±

1.2), and Group C's from 4.1 (± 1.2) to 3.0 (± 1.0), all with p-values of <0.001. The control group showed a minimal decrease from 4.3 (± 1.3) to 4.1 (± 1.2), which was not statistically significant with a p-value of 0.07.

Figure I illustrate the mean changes in DMFT scores from baseline to three months. The graphical representation shows that Group A's DMFT score decreased from 4.2 at baseline to 2.8 at six months, Group B's decreased from 4.0 to 2.9, and Group C's decreased from 4.1 to 3.0. The Control group's DMFT score showed a negligible change from 4.3 to 4.1.

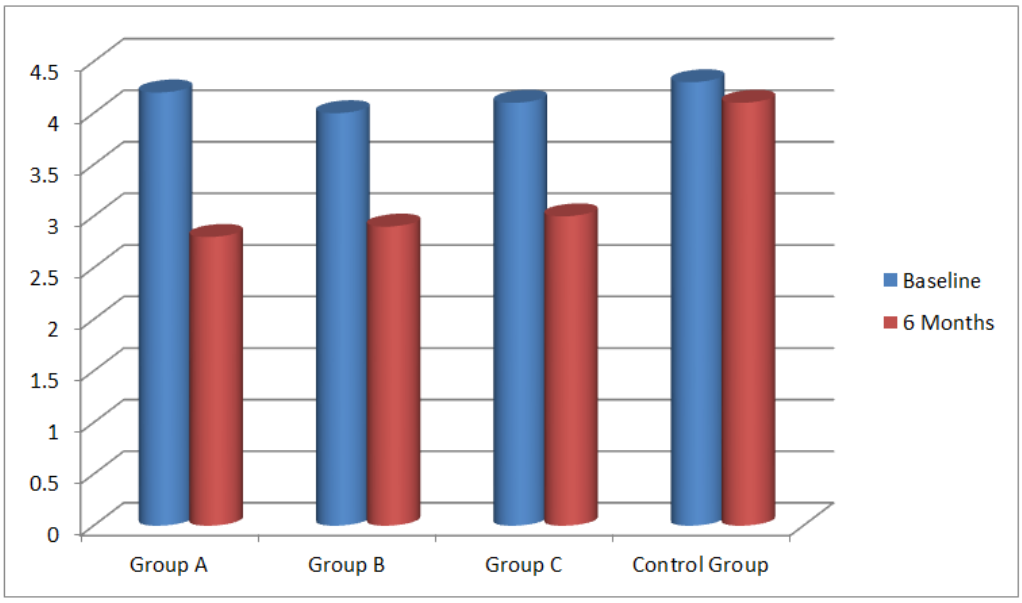

Figure I: Graphical representation of mean change in DMFT Scores (n-160)

Figure II presents the mean changes in BEWE scores from baseline to three months. Group A's BEWE score decreased from 7.1 at baseline to 4.6 at three months, Group B's decreased from 7.0 to 4.8, and Group C's decreased from 7.2 to 4.7. The control group exhibited a minor change from 7.3 at baseline to 7.0 at three months.

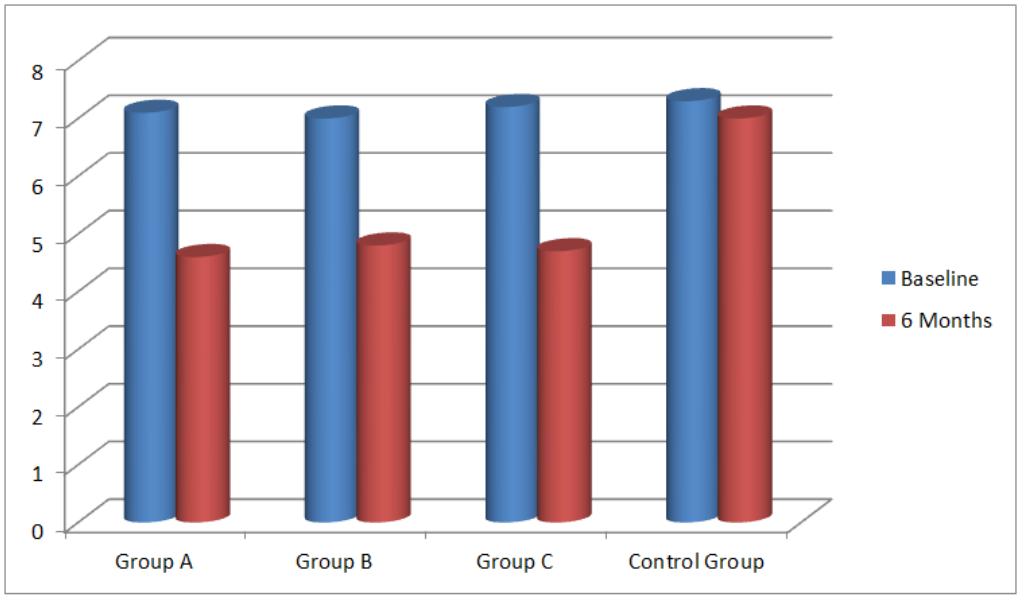

Figure II: Graphical representation of mean change in BEWE Scores (n-160)

DISCUSSION

The results of this study demonstrate that antioxidants, including vitamin C, vitamin E, and green tea extract, significantly reduced dental caries and erosion compared to a placebo mouthwash. This research also underscores the potential role of these antioxidants

in enhancing oral health by reducing oxidative stress through the neutralization of free radicals. These findings are consistent with previous studies that highlight the protective effects of antioxidants against dental erosions and caries. Antioxidants have been shown to mitigate oxidative stress by inhibiting the growth of cariogenic bacteria, thereby promoting better dental health.

Research has confirmed the antimicrobial properties of antioxidants, particularly their effectiveness in inhibiting cariogenic bacteria. For instance, catechins found in green tea exhibit strong antibacterial activity against Streptococcus mutans, a primary pathogen linked to dental caries. Our study supports these findings, as the use of green tea was associated with a significant reduction in DMFT scores, indicating effective prevention of caries.

Similarly, other studies have shown that vitamin C treatment leads to the inhibition of oral bacterial growth and a reduction in plaque formation, which significantly decreases the incidence of caries. Our findings also revealed reductions in DMFT scores with the use of vitamin C mouthwash, reinforcing its antimicrobial role in maintaining oral hygiene.

Antioxidants are known to alleviate oxidative stress by neutralizing free radicals and reactive oxygen species (ROS). Our study found an increase in salivary antioxidant levels along with a decrease in oxidative stress markers, which aligns with other research reporting similar outcomes.

For example, vitamin E, a powerful lipid-soluble antioxidant, has been shown to protect cell membranes from oxidative damage and reduce inflammation in gingival tissues. This is supported by studies indicating that vitamin E supplementation can lower oxidative stress in patients with periodontal disease. The significant reduction in BEWE scores in Group B, which used vitamin E gel, further validates the efficacy of alpha-tocopherol in safeguarding dental tissues from erosion.

When multiple antioxidants are combined, they may exhibit synergistic effects that enhance their protective benefits. A study by Sardari F indicated that the combined use of vitamins C and E provided greater protection than when used individually, resulting in substantial decreases in DMFT and BEWE scores. Although our study did not specifically evaluate combination strategies, this suggests that using multiple antioxidants together may offer additional advantages.

Recent research indicates that there are significant therapeutic benefits associated with substantial reductions in dental cavities and erosion. Incorporating mouthwashes, gels, and rinses containing antioxidants into daily oral hygiene practices could provide enhanced protection by reducing oxidative damage and inhibiting the growth of harmful cariogenic bacteria.

Mouthwashes containing vitamin C may be especially beneficial for individuals with conditions that lead to dry mouth or reduced salivation. Additionally, vitamin E gels may be useful for patients with gastro esophageal reflux disease (GERD), which frequently exposes teeth to acidic environments.

It is crucial to promote antioxidant-rich foods and oral hygiene products to the public, as they can help decrease the prevalence of dental caries and erosion. Public awareness campaigns should focus on the benefits of these products, and discussions about various antioxidant-containing products should be included in community outreach efforts. Foods such as green tea, fruits, and vegetables, which are high in antioxidants, should be encouraged.

This study does have some limitations, including a relatively short duration and a small sample size. Future research should aim to include a more diverse population and implement longer follow-up periods to validate the effects of these products. Additionally, exploring the combined effects of multiple antioxidants may reveal synergistic benefits that could provide even greater protective advantages.

CONCLUSION

It's great that our study highlighted the potential of antioxidants and dietary changes in preventing dental caries and erosion. Various studies have mentioned the importance of diet control in promoting remineralization and preventing further decay also pointed out how the increasing consumption of acidic foods and drinks contributes to enamel erosion. While antioxidants play a crucial role in overall health by combating free radical, further research is essential to solidify their role in preventing dental problems specifically, yet the benefits of antioxidants haven't been fully realized in clinical studies. Therefore, while our study's findings are promising, continued investigation is needed to determine the most effective ways to utilize antioxidants in dental practice and public health policy. Exploring the specific types of antioxidants and dietary recommendations that yield the best results would be particularly beneficial.

Both the authors have read and agreed to the published version of the manuscript.

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