ORIGINAL RESEARCH

Comparative Evaluation of the Remineralization Potential of Fluoride-containing Toothpaste, Honey Ginger Paste and Ozone. An *In Vitro* Study

Kimaya K Kade[1], Shweta Chaudhary[2], Rohan Shah[3], Smita Patil[4], Alok Patel[5], Amol Kamble[6]

Abstract

Introduction: A drop in pH of the oral cavity results in demineralization, which, if continued, leads to loss of minerals from tooth structure, resulting in dental caries. A goal of modern dentistry is to manage noncavitated caries lesions noninvasively through remineralization in an attempt to prevent disease progression.

Materials and methods: A total of 40 extracted premolar teeth were selected for the study. The specimens were divided into four groups, group I, the control group; group II, remineralizing agent as fluoride toothpaste; group III, the treatment material as ginger and honey paste; and group IV, the treatment material as ozone oil. An initial reading of surface roughness and hardness was recorded for the group (control group). Repeated treatment has continued lasting 21 days. This saliva was changed each day. Following the lesion formation procedure, the surface microhardness was measured for all specimens. The parameters were 200 gm force for 15 seconds with a Vickers indenter and the roughness of the demineralized area of each specimen was obtained by using the surface roughness tester.

Results: Surface roughness was checked by using a surface roughness tester. Before starting the pH cycle, the baseline value for the control group was calculated. The baseline value for the control group was calculated. The surface roughness average value for 10 samples is 0.555 µm and the average surface microhardness is 304 HV; the average surface roughness value for fluoride is 0.244 µm and the microhardness is 256 HV, 0.241 µm, and 271 HV value for honey-ginger paste. For ozone surface roughness average value is 0.238 µm and the surface microhardness average mean value is 253 HV.

Conclusion: The future of dentistry will rely on the regeneration of tooth structure. There is no significant difference seen between each treatment group. Considering the adverse effect of fluoride, we can consider honey-ginger and ozone as good remineralizing agents for fluoride.

Keywords: Ginger, Honey, Ozone oil, Preventive, Remineralization, Surface roughness.

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Introduction

Worldwide dental caries is the most prevalent chronic disease. Remineralization and demineralization are routine processes that dental hard tissues undergo. The presence of cariogenic dental plaque, imbalance of remineralization and demineralization, and fermentable carbohydrates in the host give rise to dental caries.[1,2]

For most of the 20th century, the approach to the treatment of caries was purely surgical. Only the complete removal of demineralized tissues was thought to be an effective method for treating dental caries.[3]

Demineralization is a result of a drop in pH, which leads to mineral loss from the tooth structure resulting in dental caries. Dirks, in 1966 realized the importance of remineralization when he found that the white spot lesions in nearly half the individuals remineralized.[2]

Modern dentistry aims to prevent disease progression through noninvasive remineralization techniques for noncavitated lesions. Fluoride plays a significant role in the inhibition of this process through mineral deposition. It induces an anticariogenic activity. Ozone has multiple applications in the field of preventive dentistry.[1]

Information about foods that protect against caries should be included in the dietary advice given to patients.[4]

The use of herbal ingredients is preferred over chemical substances. India, being the hub of Ayurveda medicine, has no dearth of herbal substances and in-depth knowledge of the same. Herbs and spices are generally considered to be safe and have proved very effective against most microorganisms.

The use of ginger in Ayurveda is well documented. In dentistry, ginger is used as a paste. Which is made by blending ginger and honey and can be used as a mouthwash for the treatment of mouth sore and dental caries.[5]

Remineralization of incipient carious lesions is an important aspect of preventive dentistry. Dental caries, considered the most common infectious disease, the focus on preventing caries formation rather than treating the lesions, would be beneficial in a

[1–6]Department of Pediatric and Preventive Dentistry, Bharati Vidyapeeth Dental College and Hospital (Deemed to be University), Pune, Maharashtra, India

Corresponding Author: Kimaya K Kade, Department of Pediatric and Preventive Dentistry, Bharati Vidyapeeth Dental College and Hospital (Deemed to be University), Pune, Maharashtra, India, Phone: +91 9404485066, e-mail: kimaya2054@gmail.com

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country like ours where parents, due to economic reasons or lack of awareness, do not seek dental treatment. In such cases, widespread provision of endogenously available remineralizing agents could change the dynamics of caries in a developing nation like India.

Materials and Methods

Materials

The following materials were used for the study:

- Fluoride-containing toothpaste (Cheerio gel containing available 458 ppm fluoride).
- Honey-ginger paste (Manakarnika, Pune).
- Ozone oil (Ozone, Mumbai).
- Artificial saliva (Mp Sai Enterprise, Mumbai).
- Extracted premolar teeth.
- Demineralizing solution (Stratum company, Himachal Pradesh).
- Diamond disk (0.2 mm, DFS Germany).
- Straight handpiece (NSK, 30,000 rpm).
- Acrylic resin (DPI Rr cold cure).
- Applicator tip (CSTISEN, 1.5 mm).

Armamentarium

- Vickers indenter (Reichert Austria Make, Sr. No. 363798, Indentor: Diamond, 136° angle).
- Surface roughness tester (Mitutoyo, Japan. Model: SJ 210 stylus speed: 0.5 mm/second, cut-off length: 0.4 mm).

Specimen Preparation

- A total of 40 extracted premolar teeth were selected for the study.
- Immediately after extractions, teeth were stored in 0.10% thymol and maintained in the solution.
- The enamel core is prepared by using a diamond disk. The buccal surface was chosen for the preparation of enamel cores.
- These enamel cores were mounted on acrylic.
- Four groups were prepared, with 10 specimens in each group.
- An initial reading of surface roughness and hardness was recorded for group I (control group).

The Specimens were Divided into Four Groups

- Group I: Control group.
- Group II: Remineralizing agent as fluoride toothpaste.
- Group III: Treatment material as ginger and honey paste.
- Group IV: Treatment material as ozone oil.

Preparation of Demineralization Solutions

Artificial subsurface carious lesions were formed on each enamel specimen by placing the specimen individually for 72 hours at 37°C in a demineralizing solution containing lactic acid as 0.1 M amount, Carbopol as 0.2–50% hydroxyapatite (HAp) saturated in volumes and adjusted to pH 5.0 using sodium hydroxide (NaOH) to create lesions.

To prepare a 0.1 M lactic acid solution, we need to consider the Ka value as A 0.10 M lactic acid solution ($Ka = 1.4 \times 10^{-4}$) has a pH of 2.43–3.7% ionization of the acid. Carbopol is a well-known rheology modifier and has inert characteristics to impact the ultimate formulation with respect to pH and significance/efficacy. In the present study, Carbopol of 940 grade has been used. HAp is mixed with water with constant stirring. Lactic acid is prepared with 0.1 M, which increases the pH value of the product. Carbopol, when added, helped the mixture to increase its rheology properties, and then finally, by adding NaOH.

Stability Testing of the Demineralizing Solutions

In the remineralizing solution accelerated stability tests, a product is stored at elevated stress conditions (such as temperature, humidity, and pH). Degradation at the recommended storage conditions can be predicted using known relationships between the acceleration factor and the degradation rate.

Demineralization–remineralization Cycle

The artificial saliva is used to store samples. The procedure was continued for 21 days. This saliva was changed each day. Following the lesion formation procedure, the surface microhardness was measured for all specimens. Vickers indenter was used and the set parameter was 200 gm force for 15 seconds (Figs 1 to 3). This value provided a baseline surface hardness value. Surface roughness tester was used to assess the mineral content and roughness of the demineralized area before and after each test period (Figs 4 and 5 and Table 1).

Statistical Analysis

The Sample Size Formula n

$n = N \times X/(X + N-1)$. By using this formula, we calculated the sample size as 40.

Results

- Surface roughness is checked by using a surface roughness tester. Stylus speed: 0.5 mm/second, cut-off length: 0.4 mm. Before starting the pH cycle, the baseline value for the control group was calculated.
- The baseline value for the control group was calculated. The surface roughness average value for 10 samples is 0.555 μ. The surface microhardness average mean value is 304 HV.
- The baseline value for the fluoride group was calculated. The surface roughness average value for 10 samples is 0.244 μ. The surface hardness average mean value is 256 HV.
- Surface roughness tester used for honey-ginger paste. The average roughness value is 0.241 μm. The average mean value is 271 HV.
- Surface roughness tester used for ozone. The average roughness value is 0.238 μm. The average mean value for hardness is 253 HV.

Discussion

Dental caries is a microbial disease of teeth that is irreversible, resulting in the decalcification of inorganic portions and the destruction of organic substances, thereby leading to cavity formation.[6]

WD Miller proposed the chemicoparasitictheory. Earlier drill and fill was the first treatment choice for carious lesions. But in this new era, minimally invasive dentistry is the first choice of treatment. Managing carious lesions noninvasively is a goal of modern dentistry.[7]

The daily use of fluoride toothpaste is attributed as one of the main reasons for the overall decline of caries incidence. However, there are certain controversies regarding fluoride, as its excessive use can lead to adverse effects and toxicity. Therefore, instead of using fluoride, plant extracts are known to have an effect on

Fig. 1: Enamel blocks embedded into acrylic

Fig. 2: Artificial saliva and demineralizing solution

Fig. 3: Treatment materials

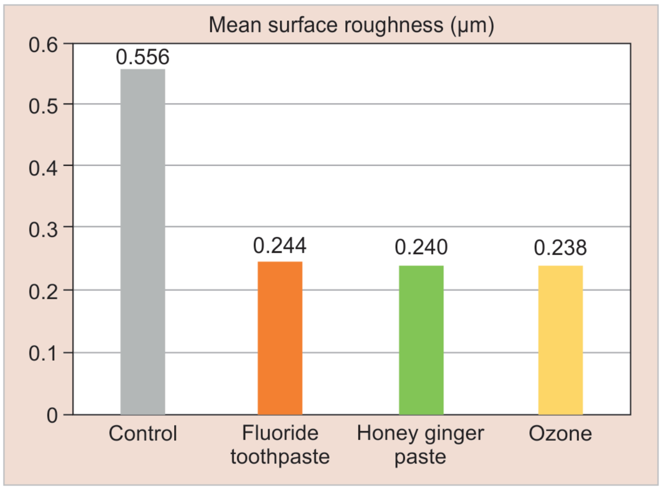

Fig. 4: Comparison of surface roughness among study groups

causative bacteria of tooth decay, and it is proposed that these can be used to prevent and treat dental caries.[8]

This led to a search to find newer remineralizing agents that do not contain fluoride.

Remineralization occurs when the pH returns back to normal that is, it becomes neutral. Ions in saliva are incorporated in the layer of enamel that is demineralized in the form of apatite.[9]

Acids produced by bacteria on the consumption of food ferments sugars to produce organic acids, which lower the surface pH. Resulting in the leaching of ca and phosphate from enamel. The dissolution of enamel continues until the pH returns to normal. It begins at the anatomic level on the crystal surface inside the enamel and can continue unless the process is stopped.

Neutralizing the pH can reverse the demineralizing process. The demineralization process can be reversed if the pH is neutralized and there are sufficient calcium (Ca) 2+ and phosphate ions (PO_4^{3-}) in saliva to inhibit the process of dissolution through the common ion effect. The dynamics of early caries development, during the very initial stages of demineralization, long before the typical "white spot" lesion is established, the outermost enamel shows distinct signs of dissolution at the ultrastructural level.[10]

Multiple demineralization systems have been used to prepare artificial carious lesions. Feagin et al., in 1984 and Arends et al. in 1983 stated that phosphate, Ca, and fluoride ions are added to the demineralization medium to decrease the thermodynamics under saturation of the solution. They also promote the subsurface dissolution of enamel characteristic of natural lesion progression.[11,12]

White et al., in 1987 concluded that sensitivity to both solutions and the presence of fluoride in the media suggest that Carbopol/lactate gels may be extremely useful in mechanistic studies of lesion formation and reversal.[12]

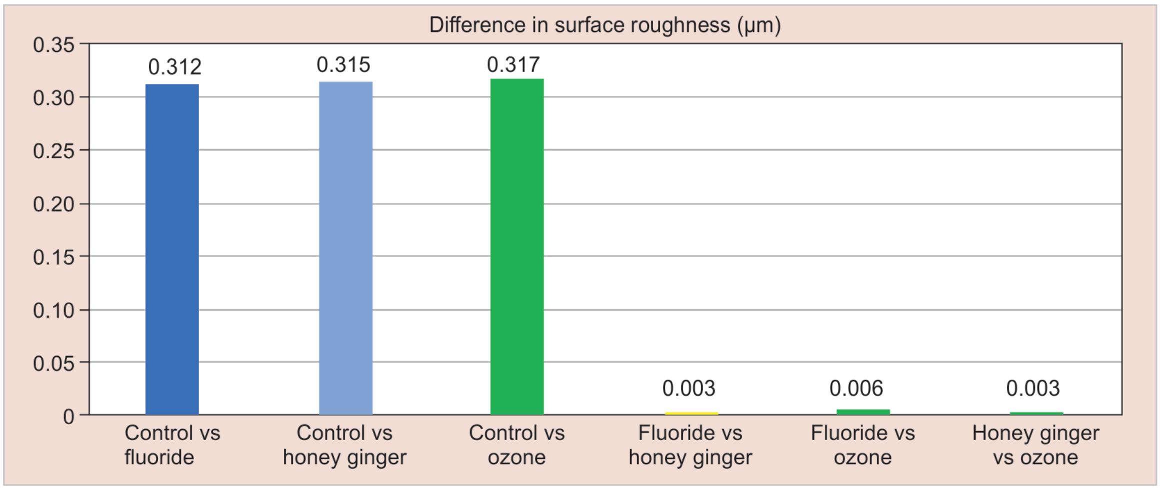

Fig. 5: Intergroup comparison of surface roughness

Table 1: Demineralization–remineralization cycle

Number	*Time (24 hours cycle)*	*Treatment is given to groups II, III, and IV*
1	8:00–9:00	Lactic acid (demineralizing agent)
2	9:00–09:01	Remineralizing agent
3	9:01–13:00	Artificial saliva
4	13:00–14:00	Lactic acid (demineralizing agent)
5	14:00–14:01	Remineralizing agent
6	14:01–19:00	Artificial saliva

Ideal characteristics of the use of a remineralizing agent are white spot lesions formation or subsurface caries formation. So in my study, I have used a combination of these materials as my demineralizing solutions.

High Ca and PO_4^{3-} concentrations in the saliva is maintained by various salivary proteins, which may account for remineralization and development of enamel.[13]

Darshan and Shashikiran used artificial saliva in their study, and they believed that artificial saliva contributed to a slight increase in microhardness, after demineralization.[14] HAp is the main component of enamel. To simulate conditions within the oral cavity, the pH cycling model was used in various studies.[15,16]

In this present study, the pH-cycling protocol used was which is given by Gulcin et al. in 2016. In this study, first, initial caries formation was induced in the samples by keeping the samples in demineralizing solution for 72 hours at a pH of 5.0. The cariogenic challenge was conducted using the same demineralizing and remineralizing solutions described for inducing initial caries development. Application of the remineralizing agent was made for 2 minutes every day. This cycle was repeated for 21 days. A change in solution was done daily to prevent depletion or saturation of the solution and accumulation of enamel dissolution agents. Before each immersion in the demineralization solution, the pastes were applied according to each group.

Profilometry is used to measure enamel or dentin loss caused by erosion or abrasion; it works by measuring surface roughness.[17] Wiegand et al., in 2008 stated that profilometry had been shown as a highly accurate method for the measurement of surface loss by various researchers.[18] Profilometer can give the surface roughness value numerically.[19]

Microhardness measurements can be evaluated by many different parameters like Knoop hardness number and Vickers hardness number, quantitative energy dispersive X-ray analysis. Polarized light microscopy, X-ray diffraction, scanning electron machine, optical coherence tomography, light-induced fluorescence, diagnodent. Structural equation modeling (SEM) is one of the parameters which is used by many researchers. SEM was not chosen due to its high cost in imaging all the samples. That's why we choose Vicker's Indenter as one of the parameters. Vicker's hardness method was used to evaluate microhardness because it is nondestructive, very reliable, rapid, and economical test used compared to hardness tests (Figs 6 and 7). The square-shaped indent obtained was more easy and accurate to measure and detect visually and digitally.[20,21]

It is easy to measure the square-shaped residual indentation obtained by Vickers microhardness measurements under the microscope. Values are determined by optically measuring diagonal lengths of the impression left by the indenter.

Therefore, in this study, the microhardness values for each specimen were measured in two steps; the baseline microhardness and after pH cycling.

In the present study, materials used as fluoride-containing toothpaste, honey-ginger paste and ozone. These are proven individually by many authors. Already worked on fluoride and many forms of fluoride.

In this present study comparison of surface roughness and microhardness among study, groups was done by using one-way analysis of variance test, indicating a significant difference at $p \leq 0.05$. The significant p-value is 0.010* for surface roughness and 0.006* for microhardness. The Intergroup of surface roughness and microhardness was evaluated by using an independent t-test, indicating a significant difference at $p \leq 0.05$. Comparing the surface roughness of the control group with fluoride gives the significant result of 0.043* and microhardness is 0.004*. No significant difference with any treatment material. No statistically significant difference was seen in all treatment regimens (Tables 2 and 3).

Fluoride is one of the most successful cavity prevention agents for preventing dental caries.[22] Fluoride is supplemented in small quantities in multiple products like toothpaste and mouthwash.[23] Anticaries actions of fluoride remain controversial. Fluoride inhibits enolase, which results in the inhibition of the growth of bacteria and a reduction in acid production by the bacteria.[24]

However, fluorosis and fluoride-resistant bacteria have led to the reconsideration of using fluorides.[25]

Inukai et al. showed a reduced Radium in remineralized solution with fluoride; hence, an indication of the ability of sodium fluoride (NaF) to improve the nanomechanical properties, which includes its ability to smoother the enamel surface.[26] Amaechi et al. compared the effectiveness of two kinds of toothpaste containing HAp or 500 ppm fluoride and concluded that the efficacy of 10% HAp was comparable with 500 ppm F^- in remineralizing initial caries and preventing demineralization. Thus the HAP toothpaste is confirmed to be equal to the fluoride toothpaste in this study.[27] Similar to this study, Yimcharoen et al. in 2019, concluded that 500 ppm fluoride-containing toothpaste inhibited lesion progression better than casein phosphopeptide (CPP) containing toothpaste and a 260 ppm fluoride-containing toothpaste. That's why in this present study fluoride-containing toothpaste, which has 458 ppm available, has been used.[14] Opposite to this study Memarpour et al. studied the efficacy of CPP-amorphous calcium phosphate cream for remineralizing eroded enamel was greater than fluoride toothpaste, fluoride varnish, or functionalised tri-calcium phosphate varnish.[28]

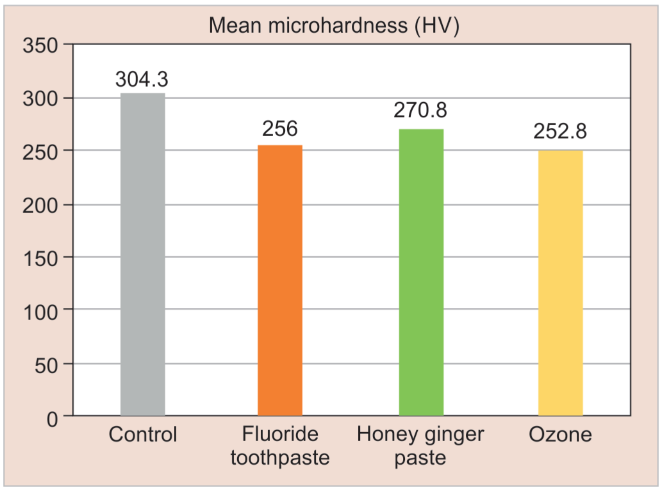

Fig. 6: Comparison of microhardness among study groups

Gündoğar et al. shows that 500 mg/L of the obromine increased the surface hardness and Ca and phosphorus deposition at a level close to the levels obtained with 1,450 ppm fluoride. This indicates that there is some material that reached the level of fluoride.[29]

Intergroup comparison of surface roughness between honey-ginger and the control group is 0.039*, which gives significant results. Intergroup comparison of microhardness between honey-ginger and the control group gives no significant results (Tables 4 and 5).

Honey, clove, ginger, onion, garlic, lime, and cinnamon-like herbs have been used for their antibacterial effect and it is successful.[30,31,32]

Ohara et al. searched 81 edible plants' antibacterial activities against *Streptococcus mutans* (*S. mutans*) in polarity-differing solvents and ginger is found to be effective [minimal inhibitory concentration (MIC) 23 mg/gm and 8 mg/gm].[33]

Supporting this article White found that in hydroalcoholic glycolic or solvents, 5 mg/mL MIC of ginger is effective on *S. mutans*.[34] Patel et al. proved that honey is an important antibacterial agent. Patel et al. reported that honey and ginger are more effective than gentamycin on *S. mutans*.[7] Sarim Ahmad et al. stated that the low moisture content and high viscosity of honey provide a protective barrier against bacterial infection.[33,35]

Chanchala et al. and Mandal et al. stated that the antimicrobial activity in most honey is due to the enzymatic production of hydrogen peroxide. Ahmadi-Motamayel et al. resulted as significant antibacterial activity was detected for honey on *S mutans* in concentrations more than 20% and on *lactobacillus* in 100% concentration.[34] The ginger was washed under clean water and kept to air dry to reduce the bacterial load of the plant material due to handling and transportation. The rhizomes were allowed to sun dry and the outer covering of ginger was peeled for 2 weeks. The dried ginger rhizomes were cut and converted into powder using an electronic blender.

Preparation of ginger honey mixture: the ginger powder was mixed with honey [in a ratio of 8 mg/mL (weight/volume)].[36] Kaul et al. stated that ginger honey showed significant remineralization between 2nd and 3rd week, which may be attributed to a possible slower mechanism of action.[35]

Gocmen et al., in this present study also, the honey-ginger paste was used for 3–4 weeks, supporting this remineralization.[36] KorKut et al. observed a significant amount of remineralization due to the usage of a honey-ginger mixture.[36,37]

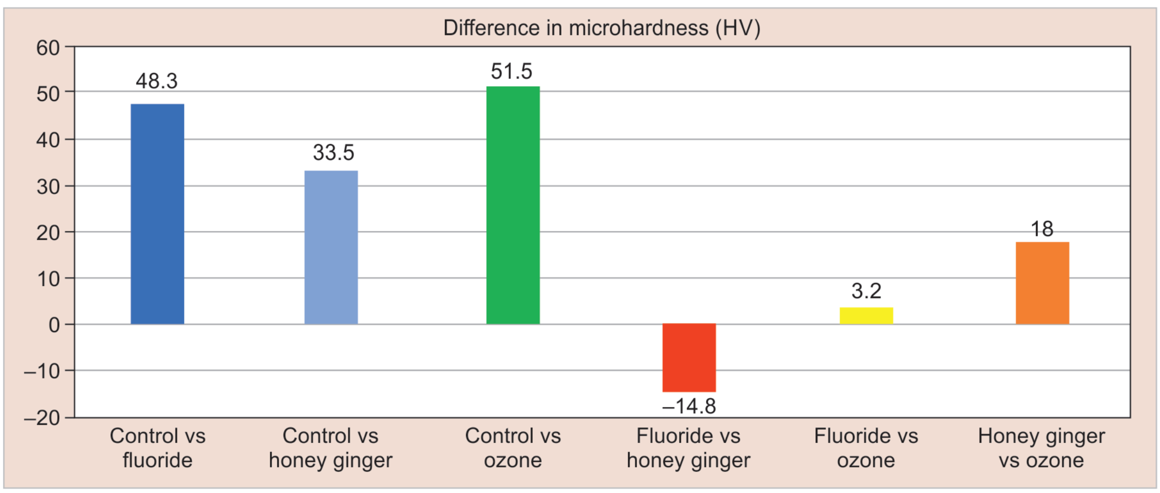

Fig. 7: Intergroup comparisons of microhardness

Table 2: Comparison of surface roughness among study groups

Groups	*N*	*Mean*	*Standard deviation*	*F-value*	*p-value*
Control	10	0.556	0.405	4.372	0.010*
Fluoride toothpaste	10	0.244	0.151		
Honey-ginger paste	10	0.241	0.120		
Ozone	10	0.238	0.158		

One-way ANOVA test; *indicates significant difference at $p \leq 0.05$

Table 3: Comparison of microhardness among study groups

Groups	*N*	*Mean*	*Standard deviation*	*F-value*	*p-value*
Control	10	304.3	38.98	4.865	0.006*
Fluoride toothpaste	10	256	23.73		
Honey-ginger paste	10	270.80	37.52		
Ozone	10	252.80	32.76		

One-way ANOVA test; * indicates significant difference at $p \leq 0.05$

Table 4: Intergroup comparison of surface roughness

Pair	*Difference*	*t-value*	*p-value*
Control vs fluoride	0.312	2.278	0.043*
Control vs honey-ginger	0.315	2.356	0.039*
Control vs ozone	0.317	2.306	0.040*
Fluoride vs honey-ginger	0.003	0.058	0.955 (nonsignificant)
Fluoride vs ozone	0.006	0.084	0.934 (nonsignificant)
Honey-ginger vs ozone	0.003	0.037	0.971 (nonsignificant)

Independent *t*-test; * indicates significant difference at $p \leq 0.05$

Table 5: Intergroup comparison of microhardness

Pair	*Difference*	*t-value*	*p-value*
Control vs fluoride	48.30	3.347	0.004*
Control vs honey-ginger	33.50	1.958	0.066 (nonsignificant)
Control vs ozone	51.50	3.198	0.005*
Fluoride vs honey-ginger	–14.80	0.381	0.306 (nonsignificant)
Fluoride vs ozone	3.20	0.250	0.805 (nonsignificant)
Honey-ginger vs ozone	18.00	1.143	0.268 (nonsignificant)

This could be attributed to mineral variations in the soil, irrigation water, and the atmosphere, and differences in the agrochemicals used during cultivation, such as fertilizers, pesticides, and herbicides. This shows good results for the material, so this has been used as one of my study components.

Comparison of ozone with the control group shows highly significant results. Intergroup correlation doesn't give any significant results.

Ozone is a chemical compound consisting of three oxygen atoms (O_3, triatomic oxygen). Holmes et al. assessed the effect of the addition of ozone in the daily use of a remineralizing patient kit. He concluded that the important effect of the addition of ozone gas.[38]

Huth et al. concluded that ozone application significantly improved noncavitated initial fissure caries in patients at high caries risk over a 3-month period. Szoke conducted a study to evaluate the efficiency of ozone alone and with a remineralizing solution and concluded that ozone treatment either alone or combined with a remineralizing solution is effective for remineralization of initial fissure caries lesions.[4]

The remineralizing ability of ozone is seen alone or with a remineralizing agent.

Baysan et al. reported that ozone used for 10 seconds or 20 seconds dramatically reduced most of the microorganisms in primary root caries lesions without any side effects.[39]

Contradictory to this study, Sandhu KS et al.[40] stated that exposure for short time periods gives inefficient results for a low dose of ozone in our study. This might be a reason for the ozone not reached to the control group value. In our study, we had given 1 minute for each cycle. Schmidlin, Baysan A et al. say that after ozone treatment, we can go for composite or glass ionomer cements restoration.[41] Müller et al. have assessed the antimicrobial potential of ozone gas and photodynamic therapy and concluded that ozone and photodynamic therapy are not efficient compared to mechanical cleaning.[42]

Ozonated water can be used in intracanal irrigants and in infected necrotic canals and ozonized oils can be used as an intracanal dressing reducing the marked anaerobic odor emanating from infected teeth. When used as an irrigant, ozone promotes bone healing and tissue regeneration.

Schmidlin et al.[43] evaluate the effects of ozonized olive oil gel in reducing enamel demineralization around the orthodontic bracket. The use of ozonized olive oil gel shows significantly less decalcification of teeth among orthodontic patients. On the contrary, ozone might have negative effects on resin tooth adhesion related to the oxygen inhibition of polymerization.

It was found that ozone could be kept for a long time in many forms.[44] Ozone is unstable in an aqueous form, so we used it in oil form.

Estrela et al. used ozonated oils to sterilize the root canal to remove necrotic debris. Ozonated oils used for disinfection and irrigation with ozonated oil are quicker than conventional sodium hypochlorite.[45] Ozonated oils are made-up of naturally occurring plant extracts. Ozonized oil is effective against many microbiota.[46]

In the present study, we have used ozonated olive oil. This study supports the adverse effect of ozone as Surmelioglu et al.[47] as ozone pretreatment favorably affected the marginal sealing ability of the tested fissure sealants.

Estrela C et al. mentioned the ability of ozone to remineralize demineralized bovine enamel, but ozone has no effect on remineralization of enamel.[48] According to statistics results, there is no significant difference among the treatment materials. There are few studies that compare themselves.

Johansson et al. conducted a split-mouth study that stated that neither ozone nor fluoride varnish treatments stopped the progression of caries in cavitated lesions. Mese et al. concluded as the stepwise excavation of primary teeth was successful after ozone application.[49]

This study, supported by Ximenes et al., says that O_3 seemed to be a good alternative for caries arrest, and chlorhexidine is considered a good inexpensive but effective mode.[50] Honey-ginger shows more promising results than NaF. These results were concluded with the study done by Bilgin et al. concluded that honey-ginger paste and ozone-based dentifrice could be alternatives for fluoride dentifrices. The results of this study are connected with the study by Krishan et al. In this present study, we used 21 days cycle, and he used 14 days cycle.[51]

Children below 6 years of age are at risk for dental fluorosis due to their tendency to swallow dentifrice. It is not possible to replicate the total oral environment conditions. Various dissimilarities between cycling models and *in vivo* conditions seen. The pH-cycling model does not entirely simulate the oral conditions. The Ph of the oral cavity depends upon the individual's oral hygiene practices, eating habits, fluoride, quality of saliva, composition, and biofilm. Thus, the remineralizing agents tested in the present study should also be evaluated *in vivo*.

Conclusion

In conclusion, it's understood that a patient's oral cavity has various defense mechanisms, one of which is "demineralization-remineralization cycle." This cycle is mainly dependent on the patient's systemic conditions, oral hygiene, dietary pattern, and most of all, the structure of teeth. Treating a lesion by remineralization is the future of dentistry and nonfluoride remineralizing agent provide an option for remineralization without the adverse effect of fluoride. An attempt has been made to review the various remineralization agents and technologies. The public must be informed of the benefits of modern methods of remineralization. In the long-term investing in nonfluoride remineralizing systems now will help in biological and fiscal cost saving. Remineralizing agents should essentially be used in patients at high caries risk, those undergoing orthodontic therapy, in order to avoid demineralized white spot lesions. In this study, demineralization and remineralization occur, but after the cycle, it is not as good as a control group. No significant difference was seen between the treatment groups. Considering the adverse effect of fluoride, we can consider honey-ginger, ozone as a good remineralizing agent as fluoride.

If indigenously obtained remineralizing agents can be used, it would effectively help in an outreach to all parts of the country and can find their way into the preventive and minimally invasive dental care policies for the pediatric population of the nation. In the paste form, in which ozone and honey-ginger are used, they can easily be applied by dental hygienists and school dental nurses. Thus, decreasing the workload on dental manpower.

Since these remineralizing agents are devoid of the fear surrounding the adverse effects of fluoride, they can be used in a widespread manner with a disregard for the fluoride belts of our country. With further *in vivo* studies, the ozone and honey-ginger pastes should be a part of the regular armamentarium of minimally invasive dentistry.

Orcid

Kimaya K Kade https://orcid.org/0000-0001-5580-4864

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