Evaluation of Colour Stability, Surface Roughness and Surface Topography of Resin Infiltrated Enamel against Acidic Challenges: An In- vitro study.

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DOI:10.48047/ecb/2023.12.si4.694

ABSTRACT

Objective: The objective was to determine if the resin infiltration approach could protect demineralized enamel surface from acidic pH.

Materials and methods: For the investigation, 30 healthy upper and lower premolars were chosen, and each was cut vertically into two halves, yielding 60 specimens. The specimens were subsequently split into three groups, with group A serving as the control group, groups B underwent decalcification alone and group C underwent decalcification followed by Icon resin infiltration. According on the kind of storage media, each group was further separated into three subgroups (water, pepsi or sprite). Surface topography, surface roughness, and colour difference were among the evaluation criteria. One-way ANOVA test was used for statistical analysis. **Results:** Even though Pepsi generated the most surface roughness and colour change among the specimens under study, enamel that had resin treated had higher resistance to surface alterations than enamel that were not resin treated. **Conclusion**: Even on acidic challenge, resin infiltration has the capacity to offer and maintain protection against demineralized enamel.

KEYWORDS

White Spot Lesions, Resin Infiltration, Acidic Drinks

INTRODUCTION

The earliest observable sign of dental caries under undisturbed enamel are white spot lesions (WSLs) which are brought on by bacterial organic acids, which weaken the enamel and leave it susceptible to demineralization.

Carious enamel first manifests as a white colour due to light scattering brought on by the differing refractive indices of the air or electrolytes present in the lesion's porosities in comparison to the surrounding sound enamel. If demineralization is not stopped and reversed, WSLs might develop from demineralization to non-cavitated lesions before becoming cavitated. (1)

There has been a significant change in how dental caries is treated in recent years, from the conventional restorative therapy to a more preventive technique known as non-invasion or minimum invasion.

There has been a lot of interest in the application of fissure sealants for occlusal lesions or non-invasive remineralization of carious enamel utilising fluoride and casein phosphopeptide-amorphous calcium phosphate. The remineralization of superficial enamel carious lesions is mostly facilitated by fluoride and CPP-ACP. (2)

Often these procedures alone are unable to stop the caries process due to increasing carious extension or the patient's unwillingness to comply which leads to surface degradation ensuing microcavitation.(3)

The pores in the body of enamel caries allow acids and dissolved minerals to seep through. A distinct approach to superficial sealing is required in order to prevent carious lesions from developing by blocking these pores.(2) Resin infiltration, which is a micro-invasive process, is one of the therapeutic approaches that eliminates the need for conventional repair.(1)

The basic concept of resin infiltration relies on capillary forces to infiltrate and clog the pores of subsurface lesions, restores lost minerals and encase the hydroxyapatite crystals and residual enamel prisms. This technique successfully creates a three-dimensional covalently bound polymer framework blocking the passage of cariogenic acids and dissolved minerals to halt the progression of subsurface lesions.[4]

The intake of carbonated beverages is widespread among today's kids and persists into adulthood. Sports drinks are quite popular, which has led to concerns about how corrosive they may be to tooth enamel.[5]

However, it is yet unclear whether enamel coated with resin can offer long-term defence against various types of alterations that are frequently seen in the oral cavity, like pH variations.

The stability of restorative materials is often correlated with their resistance to deterioration under cyclic variations brought on by a several factors in oral cavity. It is important to imitate the oral environment while evaluating any restorative material, especially when it comes to pH variations.[6]

There is not a lot of research on how pH changes affect the surface properties of enamel coated with resin.

Therefore, the goal of the current investigation was to ascertain if the resin infiltration approach could shield demineralized enamel surface from acidic pH, after being exposed to two different acidic drinks.

MATERIALS AND METHODS

The study used 30 healthy upper and lower premolars that were taken from the Department of Oral and Maxillofacial Surgery's outpatient clinic for orthodontic purposes. **(Figure 1)**

Figure 1: 30 Healthy upper and lower premolars

A total of 60 specimens were created by cutting each tooth crown into two equal halves, and these specimens were then placed in an acrylic block.

There were 18 samples in each of the three groups: B and C, the test group, and A, the control group.

The Group A specimens were not decalcified, the Group B specimens underwent decalcification only, while the Group C specimens underwent decalcification and ICON resin infiltration application.

According to the kind of storage medium, each of the three groups were then split into three subgroups of six samples each, with subgroup 1 being immersed in water (the control), subgroup 2 and subgroup 3 in Pepsi and Sprite, respectively.

Decalcification

The teeth's roots were removed at the CEJ, and the crown portion were split in half mesio-distally, exposing flat buccal and lingual surfaces that were then embedded on 2 x 2 x 1 cm acrylic blocks.**(Figure 2)**

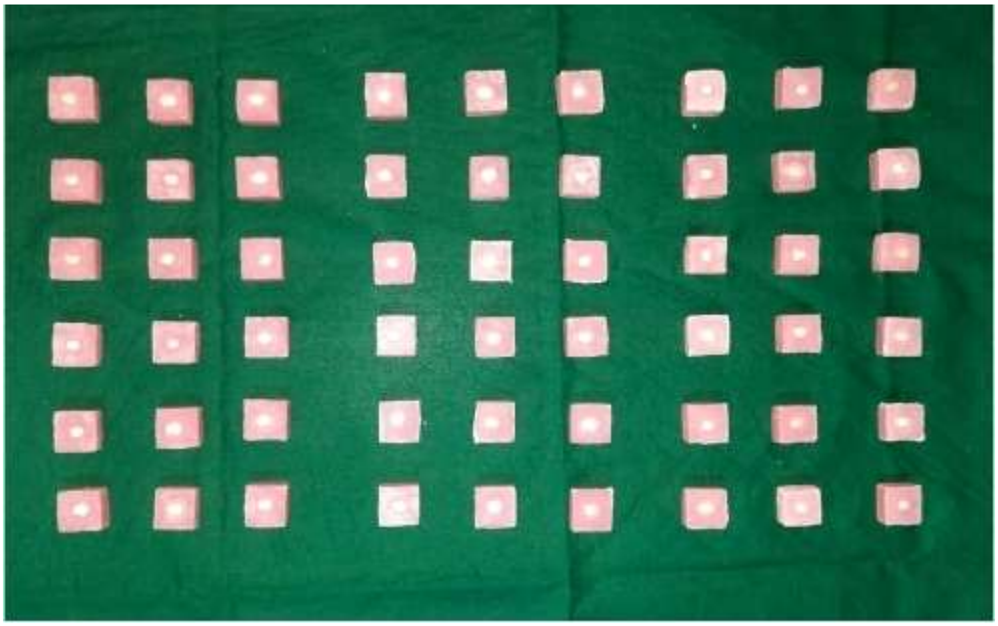


Figure 2: Tooth samples embedded on acrylic blocks of 2 x 2 x 1 cm

A demineralisation solution (50 millimolar CH3COOH solution, 3 millimolar CaCl2 H2O, 3 millimolar KH2PO4, 6 millimolar CH6O7P2, pH 4.95, 37C) was used to artificially produce WSLs on group B and group C specimens, which was maintained for 4 days to create the same.[7]

Resin Infiltrant application

Group C samples were subjected to acid etching, drying, ICON infiltrant application (ICON, DMG, Hamburg, Germany), and light curing which was done in line with the guidelines provided by the manufacturer. **(Figure 3)**

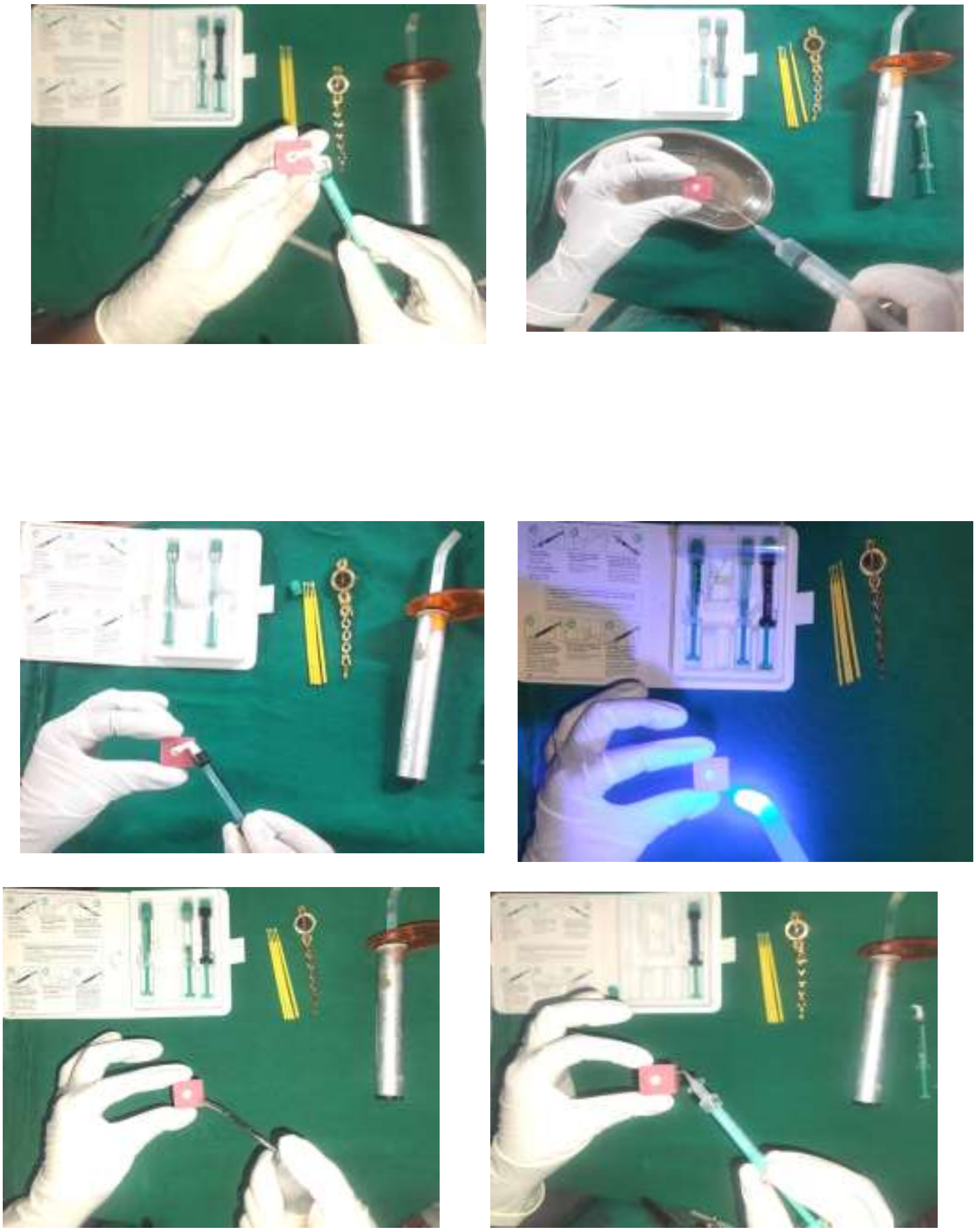


Figure 3: Application of Icon Resin Infiltration (A- ICON etch applied; B- Rinsing; C- Air blowing; D- ICON dry; E- Air blown; F- ICON infiltrant applied; G- Light cured)

Specimens immersion

The samples were submerged for five minutes, five times a day for thirty days in Water, Pepsi, or Sprite. Between rounds of immersion, specimens were maintained in artificial saliva. The beverages were utilised at a temperature of around 4 °C. **(Figure 4)**

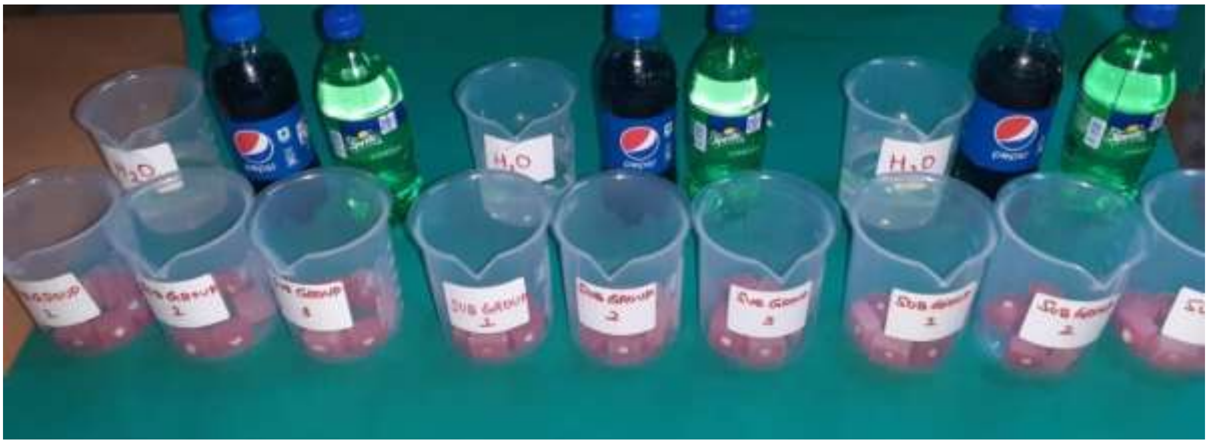


Figure 4: Specimens immersion on their respective storage medium

Evaluation of colour difference

The mean absorbance values between the groups were assessed using a UV-Vis spectrophotometer (UV/VIS Lambda 365).

Surface roughness assessment

Using a digital profilometer (Carl Zeiss E- 35B), surface roughness (Ra) values for each specimen were acquired. The diamond stylus traced the surface of the specimen at a 0.6 mm/s speed and a 4 mm trace length to calculate the roughness profile value. Each specimen underwent this process five times, with the average of the results used to calculate the mean roughness parameter (Ra).

Scanning Electron Microscope

After being sputtered with gold to improve image resolution, randomly chosen specimens were analysed using a (German-made Carl Zeiss Gemini SEM 300) apparatus at a 2000 x magnification.

STATISTICAL ANALYSIS

Version 20.0 of the IBM® SPSS® Statistics Software was used to analyse the gathered data. In order to determine whether there was a statistically significant difference between the groups, the mean surface roughness and colour were compared using a one-way ANOVA.

RESULTS

SEM

In Figure 5, SEM pictures of a selected groups are shown. The surface of the control specimen in Figure 5A clearly displays the distinctive look of fish scales that characterises healthy enamel. A sponge-like structure of enamel deterioration was seen in the decalcified specimens in Figures 5B and C, and it is more pronounced in Pepsi sample **(Figure 5B)**. Less surface defects were visible in scanning electron micrographs of specimens with resin infiltration **(Figure 5D,E)**, indicating improved resistance to the erosive attack by acidic beverages.

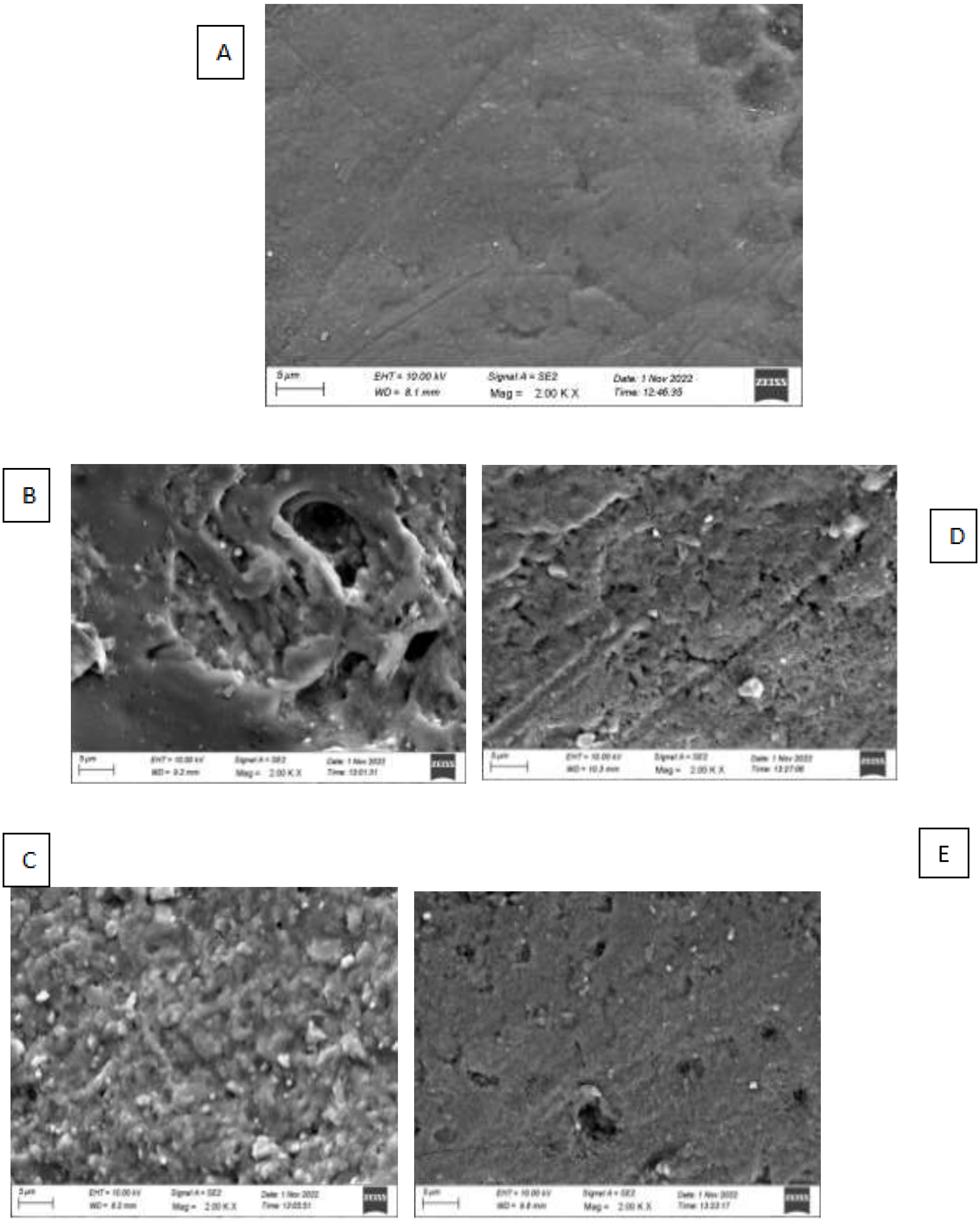


Figure 5 SE micrographs at a magnification of 2000 reveal the surface enamel of the
A: Control. Sample immersed in water

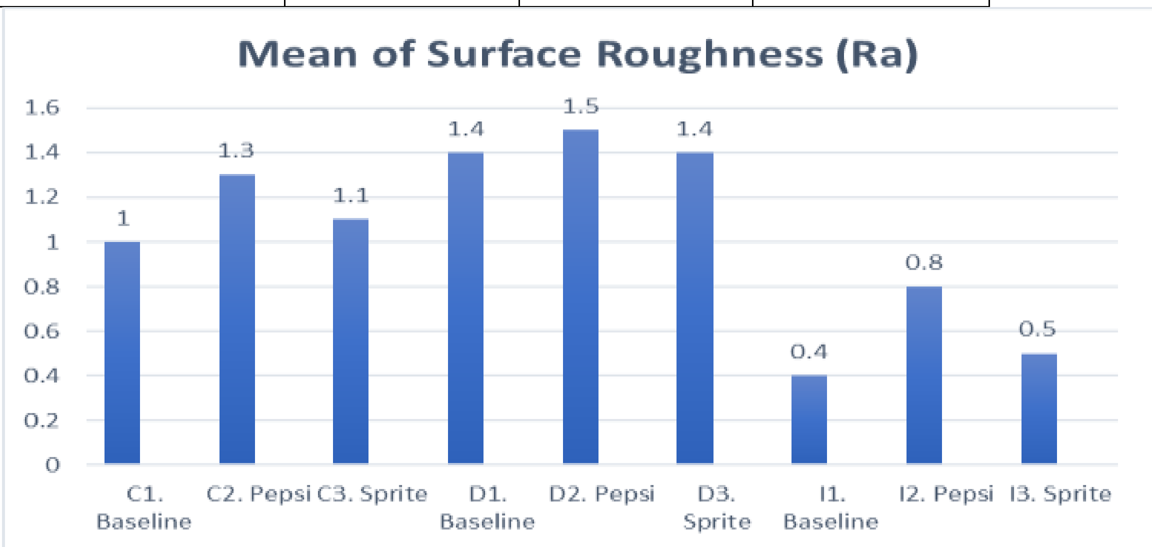
B: Decalcified specimen, immersed in Pepsi.
C: Decalcified sample, immersed in Sprite.
D: Decalcified & resin-infiltrated sample immersed in Pepsi
E: Decalcified & resin-infiltrated sample immersed in Sprite

Surface roughness values

The mean surface roughness (Ra) values, together with the standard deviation, are displayed in **(Table 1)** for all groups. The results indicated that group I1 (ICON control) lowest average Ra value (0.46 m), whereas group D2 (decalcified and submerged in Pepsi) had the greatest mean Ra value (1.50) **(Graph 1).** According to the findings of the ANOVA test, surface roughness values varied between the research groups in a statistically significant way (P = 0.05).

Table 1: Values of Surface Roughness Ra(m) for the groups under study

Group		**Mean**	**Standard Deviation**	**P value**
Control	C1. Baseline	1.083	0.3920	0.05
	C2. Pepsi	1.3367	0.09893	
	C3. Sprite	1.1833	0.21370	
Decalcified	D1. Baseline	1.417	0.3869	
	D2. Pepsi	1.5000	0	
	D3. Sprite	1.4467	0.13186	
Icon	I1. Baseline	0.467	0.0516	
	I2. Pepsi	0.8167	0.17224	
	I3. Sprite	0.5333	0.10328	



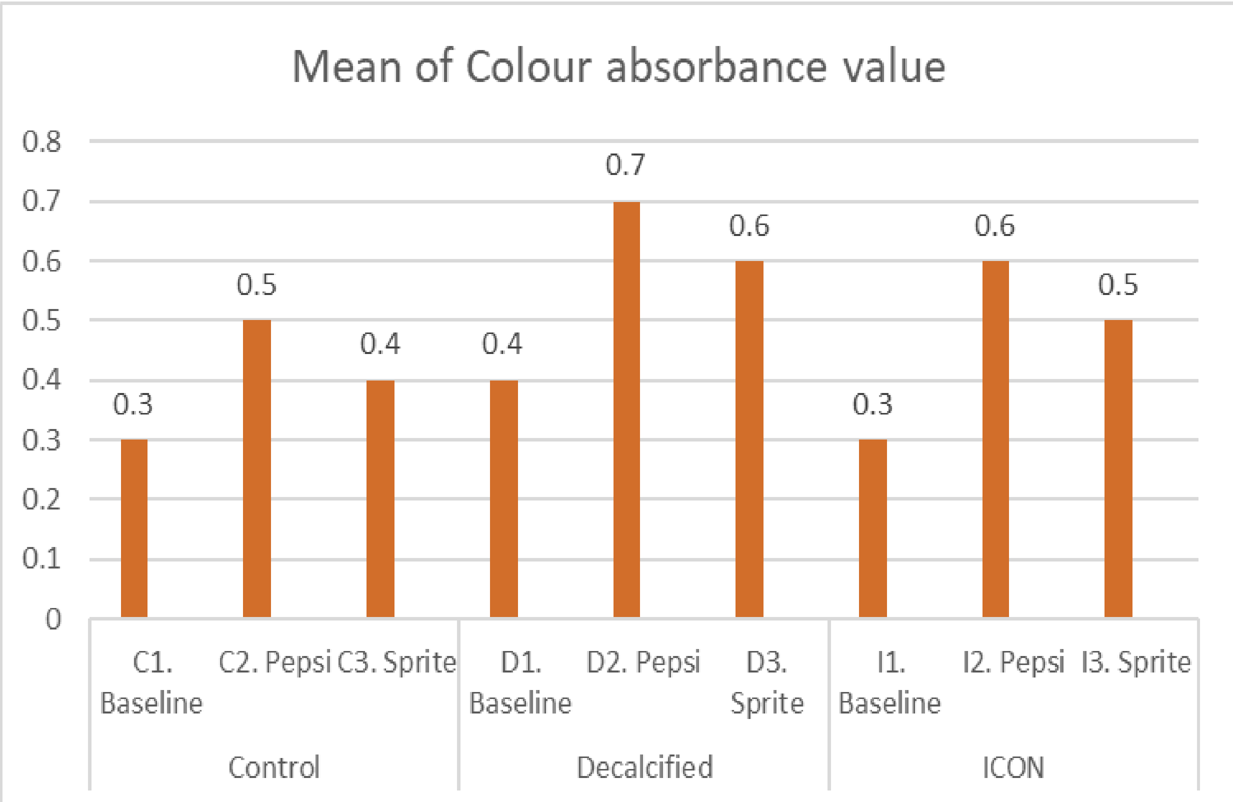
Graph 1: Graph showing Surface Roughness Ra(μm) of studied groups

Colour difference absorbance values

Table 2 displays the mean colour difference absorbance values and standard deviation for each group. The findings revealed that group C1 (baseline) had the lowest mean(0.33), while group D2 (decalcified and submerged in Pepsi) had the highest mean value (0.71) **(Graph 2).** When values from the tested groups were compared, the ANOVA test revealed significant differences (P = 0.05).

Group		Mean	Standard deviation	P value
Control	C1. Baseline	0.33	0.516	0.05
	C2. Pepsi	0.533	0.1366	
	C3. Sprite	0.417	0.1472	
Decalcified	D1. Baseline	0.467	0.1033	
	D2. Pepsi	0.717	0.1472	
	D3. Sprite	0.667	0.1966	
ICON	I1. Baseline	0.383	0.0753	
	I2. Pepsi	0.600	0.1673	
	I3. Sprite	0.550	0.1871	

Table 2: Colour difference (absorbance value) between groups



Graph 2: Graph showing Colour difference (absorbance value) between groups

DISCUSSION

A new technology that bridges the gap between preventing carious lesions and restoring teeth is resin infiltration technique. It is sold under the brand Icon® (DMG Handburg, Germany). It is referred to as a minimally invasive procedure that restores, strengthens, and stabilises demineralized enamel without affecting healthy tooth structure.

The idea behind RI is, to saturate the porous enamel with resin through capillary action, which will stop the spread of the lesion by occluding the tiny pores that allow acids and dissolved elements to diffuse through. This method tries to develop a diffusion barrier within the lesion, not on its surface.(2)

However regarding, its resistance to deterioration by various factors in the oral cavity, concerns still persist. (6)

Therefore, the objective of the current study was to evaluate the effectiveness of ICON resin in providing and maintaining surface protection for demineralized enamel in the presence of two distinct acidic pH beverages (Pepsi and Sprite).

In the present work, specimens treated with ICON resin infiltration shown less surface roughness and colour change even after being exposed to acidic drinks.

Out of which Pepsi was shown to create higher surface roughness and discoloration than Sprite, even in samples that had received ICON treatment. When compared to sprite (pH = 3.3), pepsi (pH = 2.5) is more acidic, which can be used to explain these findings. The beverage Pepsi is darker than Sprite, which might possibly be a contributing factor.

Through in-vivo study, a surface roughness threshold for bacterial retention was (Ra = 0.2), beyond which no further reduction in bacterial accumulation was predicted. If surface roughness value exceeds this level, it leads to increased plaque accumulation at the same time, increasing the risk of periodontal inflammation and caries. (8)

When Ra value exceeds 0.5, patients also frequently perceive surfaces as rough. This study may lead one to think that even when exposed to Sprite (Ra = 0.53), patients would find the infiltrated enamel surface to be smooth and unbothersome, (9) whereas those ingesting Pepsi (Ra = 0.83 m) would experience the surface to be rough even with resin-infiltration

Thus, preventive strategies like as resin iniltration, may be needed to remineralize any demineralized enamel.

LIMITATION:

However, considering that the current study conducted on in- vitro settings, clinical trials should be undertaken to evaluate the efficacy of material.To assess its resistance to the long-term effects of various stimuli encountered in the oral environment, however, more research is required.

CONCLUSION:

In the face of an acidic challenge, the resin infiltrant has the capacity to give and sustain protection to demineralized enamel.

ACKNOWLEDGMENTS:

We appreciate the staff at the mechanical engineering department, Amrita School of Engineering, Ettimadai, Coimbatore, for their assistance in analyzing samples.

CONFLICT OF INTEREST: None

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