



SURFACE CHANGES OF CERAMIC BRACKETS EXPOSED TO DIFFERENT SOLUTIONS (PROPHYLACTIC MOUTHWASHES AND BEVERAGES) – AN IN VITRO STUDY.

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INTRODUCTION

Acceptance of orthodontic treatment drastically increased soon after the introduction of aesthetic brackets among adult and adolescent patients. Ceramic materials are the most widely used. ceramic materials have smooth surface unexposed to intraoral conditions but unfortunately, when exposed to solutions it shows surface roughness. But when ceramic bracket surface property is studied in SEM and AFM ceramic exhibit more surface roughness than metal brackets.¹

SEM requires proper sample preparation such as special coatings or vacuum treatment, and it provides only a two-dimensional image of the surface morphology. The surface topography of biomaterial has been characterized using atomic force microscopy (AFM), which can provide three-dimensional information regarding surface morphology and mechanical properties. AFM has an excellent vertical resolution up to 0.1 Å and requires almost no sample pre-treatment while SEM resolution is approximately 100 Å.

The surface energy, surface roughness, and wettability play critical roles in bacterial adhesion properties and biofilm formation. A rough surface generally allows bacterial colonization by increasing the adhesion areas and preventing dislodgement of bacterial colonies. Bacterial adhesion has special characteristics and depends on direct biofilm interaction with the substrate surface to which it relates. Orthodontic brackets can play an essential role in enamel demineralization, because they provide additional adhesion sites for pathogenic bacteria.³ Orthodontic patients are advised for different oral rinse solutions for different purposes such as antimicrobial agents, remineralizing agents, plaque-controlling agents., etc which will have an impact on the surface properties of ceramics and other properties also. The same patients have been subjected to beverages like coffee, tea, aerated drinks and juices as part of their routine modern lifestyle.²

AIM

Aim of the study was to expose ceramic brackets to different mouthwashes and beverages that will be having a surface roughness effect on ceramic brackets.

OBJECTIVE

The solutions exposure to ceramic bracket will make a huge impact on the surface property and its other properties. And this study will emphasize the effect of ceramic brackets on different solutions.

MATERIALS AND METHODOLOGY

Chlorhexidine, amine fluoride mouthwashes and beverages like coffee, tea, and Carbonated Beverages because of most wide usage. Ceramic brackets (3M Unitek ceramic bracket) of number 60, every group with 10 samples were used (1- distilled water, 2- Chlorhexidine mouthwash solutions, 3-amine fluoride mouthwash, 4- carbonated Beverage, 5-Coffee and 6-Tea) entire brackets are dipped for 24 hours in each solution at 37°C and AFM- atomic force microscopy is used for Three-dimensional assessment of surface roughness.

• STATISTICAL ANALYSIS

The obtained data were analysed using a one-way analysis of variance (ANOVA) using the SPSS software, version 18 (IBM, IL). The level of significance was set to $p < .05$.



Image 1: ceramic bracket



Image 2: ceramic bracket in solutions

• PH OF THE SOLUTION:

using pH meter, Solution pH are assessed

• AFM:

Non-contact mode AFM images were obtained using Park XE7. The wings of the orthodontic brackets were scanned in an air condition at a resolution of 512×512 pixels and a scan rate of 0.8 line/s. All of the scanned images were $30 \mu\text{m} \times 30 \mu\text{m}$, $15 \mu\text{m} \times 15 \mu\text{m}$ and $5 \mu\text{m} \times 5 \mu\text{m}$ in size. Around six sites are scanned for every sample at $15 \mu\text{m} \times 15 \mu\text{m}$ and $5 \mu\text{m} \times 5 \mu\text{m}$ and one site chosen for assessment. Previous studies are done in $30 \mu\text{m} \times 30 \mu\text{m}$ size and a pilot study sample run was done and has same surface roughness range as in previous studies and $15 \mu\text{m} \times 15 \mu\text{m}$ and $5 \mu\text{m} \times 5 \mu\text{m}$ are used for assessing surface roughness.

RESULTS

After 24 hours of ceramic bracket dipped in solutions they are cleansed with distilled water and dried well before processing.

Undiluted solutions are assessed for pH in pH meter and their results noted. Table 1 shows the results

PH ANALYSIS OF THE SOLUTION:

SOLUTION	pH
Distilled water	7
Chlorhexidine	6.6
Amine fluoride	6.02
Carbonated beverage	4
Coffee-prepared	6.4
Tea- prepared	6

Table 1: pH of the solutions used

AFM SURFACE ROUGHNESS:

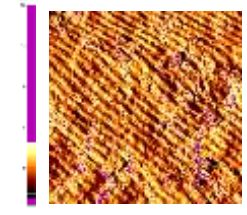
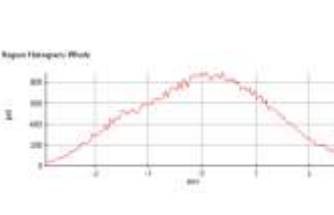
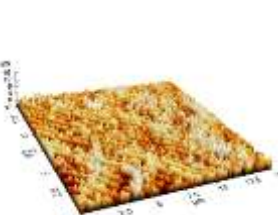
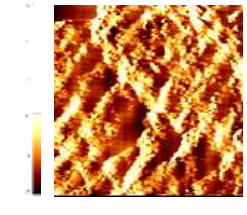
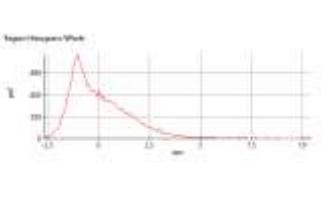
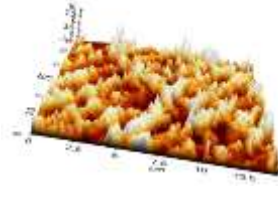
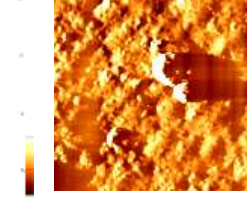
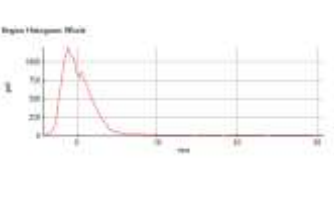
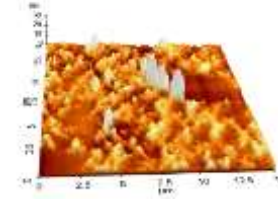
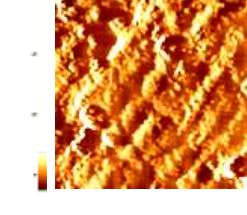
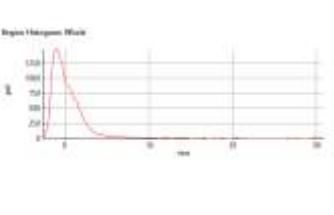
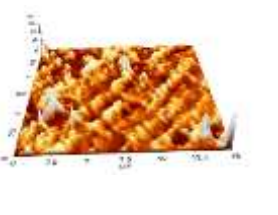
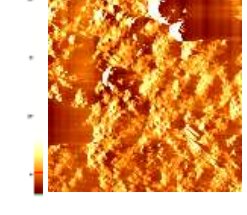
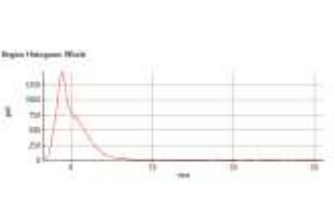
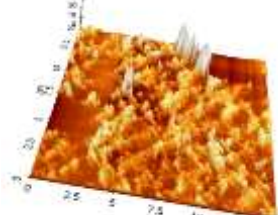
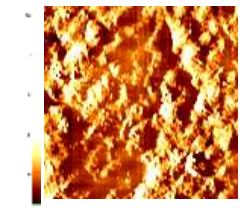
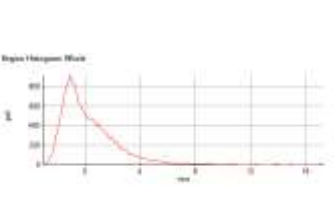
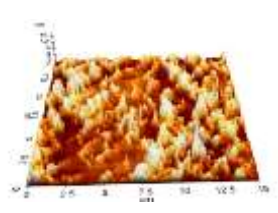
15µm×15µm	2-D VIEW	GRAPH	3-D VIEW
CONTROL			
CHOLOREXIDINE			
AMINE FLUROIDE			
CARBONATED BEVERAGES			
COFFEE			
TEA			

Image 3: AFM of all experimental samples.

5µm×5µm	2-D VIEW	GRAPH	3-D VIEW
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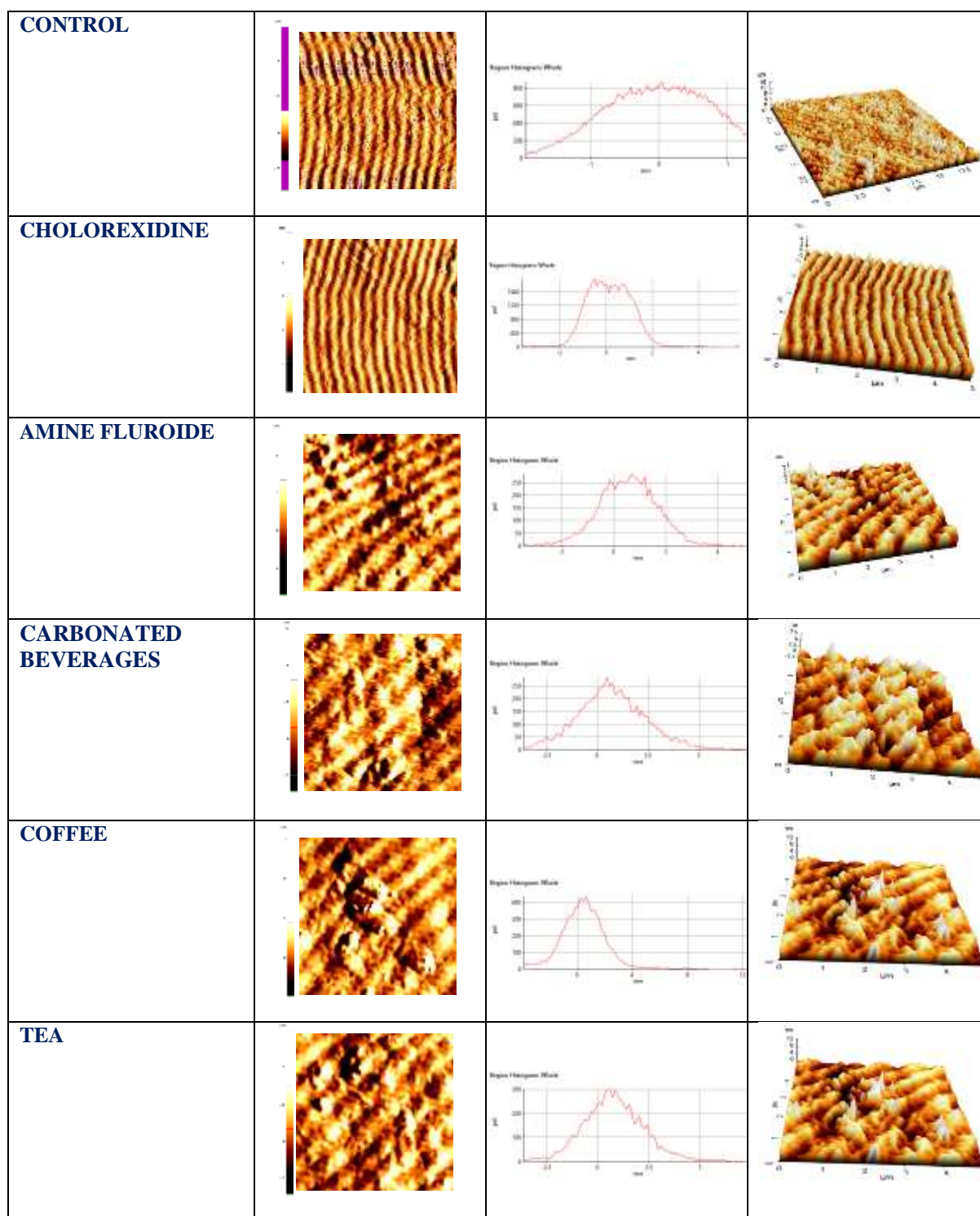


Image 4: AFM of all experimental samples.

5 $\mu\text{m}\times 5\mu\text{m}$	R_{pv}	R_q	R_a
CONTROL	3.476	0.745	0.618
CHLOREXIDINE	9.358	0.880	0.732
AMINE FLUROIDE	8.738	1.088	0.867
CARBONATED BEVERAGES	11.167	1.653	1.296
COFFEE	16.454	1.547	1.159
TEA	11.095	1.476	1.146

Table 2: AFM surface roughness 5 $\mu\text{m}\times 5\mu\text{m}$

15µm×15µm	R _{PV}	R _q	R _a
CONTROL	5.452	1.155	0.951
CHLOREXIDINE	11.362	1.335	1.072
AMINE FLUROIDE	34.872	2.864	1.673
CARBONATED BEVERAGES	33.253	1.867	1.263
COFFEE	34.407	2.888	1.668
TEA	20.276	1.746	1.362

Table 3: AFM surface roughness 15µm×15µm

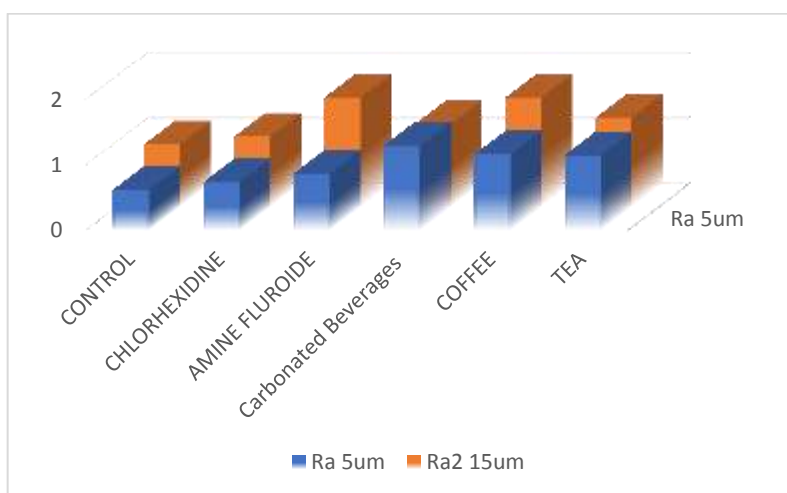


Chart 1: surface roughness in 15µm×15µm and 5µm×5µm sizes in experimental samples.

DISCUSSION:

Control sample in AFM at 30µm×30µm, 15µm×15µm and 5µm×5µm shows results from other previous studies **Gi-Ja Lee et al**¹, **Rabiee SM et al**², **Ki-Ho Park et al**³, and **Pinar Cevik et al**⁵ in 30µm×30µm size and thus 15µm×15µm and 5µm×5µm sizes are used for the current experimental samples.

- Ra (the extension of Ra (arithmetical mean height of a line) to a surface): this parameter expresses the difference in the height of each point as an absolute value compared to the
-
- arithmetical mean of the surface. This parameter is used to evaluate surface roughness.
- Rq (root mean square height): this parameter represents the root mean square of ordinate values within the defined area and is equivalent to the standard deviation (SD) of the height.
- Rpv (Peek velocity): maximum velocity of xyz axis roughness.

Shows significant changes in roughness in different solutions and at various scanning sizes. 15µm×15µm has more surface roughness, root mean square height and Peek velocity than 5µm×5µm size.

When the solution pH is assessed are acidic Carbonated Beverages >Tea >AF >Coffee >Chlorhexidine >Control and acceptable with previous studies⁴.

CONCLUSION:

Based on the current invitro study of exposing ceramic bracket to different solutions and surface roughness in AFM was assessed. A significant amount of difference was seen between control and experimental solutions. When it is assessed in 15µm×15µm and 5µm×5µm surface was much rougher in 15µm×15µm than 5µm×5µm. when compared within the group surface roughness is AF>Coffee> Carbonated Beverages >Tea>Chlorhexidine> Control in 15µm×15µm and AF>Coffee> Tea > Carbonated Beverages >Chlorhexidine> Control. There will be significant amount of surface roughness when exposed in synergistic manner as all the solution has surface roughness in slightly higher compared to one other. Thus, a careful consideration of consuming or using mouthwashes to be taken in consideration.

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