# A COMPARATIVE EVALUATION OF SURFACE HARDNESS AND ABRASIVESNESS OF COMPONEERS, VENEERS AND LAMINATES: INFLUENCE OF COMMONLY CONSUMED BEVERAGES IMMERSION AFTER A SHORT-TERM PERIOD: AN IN-VITRO STUDY.

**DISSERTATION**

**Submitted to**

**BABU BANARASI DAS UNIVERSITY, LUCKNOW, UTTAR PRADESH**

**In the partial fulfilment of the requirement for the degree**

**of**

## MASTER OF DENTAL SURGERY

**In the subject of**

## CONSERVATIVE DENTISTRY & ENDODONTICS


**Submitted by**

**DR. AARUSHI SHEKHAR**

**Under the guidance of**

**DR. AKANKSHA BHATT**

**DEPARTMENT OF CONSERVATIVE DENTISTRY & ENDODONTICS**

**BABU BANARASI DAS COLLEGE OF DENTAL SCIENCES, LUCKNOW**



**Batch: 2019-22** **Enrolment No.: 11903222215**

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# DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation entitled **"A comparative evaluation of surface hardness and abrasiveness of Componeers, Veneers and Laminates: an influence of commonly consumed beverages immersion after a short term period : An in-vitro study"** is a bonafide and genuine research work carried out by me under the guidance of **Dr. Akanksha Bhatt**, Reader, Department of Conservative Dentistry & Endodontics, Babu Banarasi Das College of Dental Sciences, Babu Banarasi Das University, Lucknow, Uttar Pradesh.

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## CERTIFICATE BY THE GUIDE/CO-GUIDE

This is to certify that the dissertation entitled **"A comparative evaluation of surface hardness and abrasiveness of Componeers, Veneers and Laminates: an influence of commonly consumed beverages immersion after a short-term period: An in-vitro study"** is a bonafide work done by **Dr. Aarushi Shekhar**, under our direct supervision & guidance in partial fulfilment of the requirement for the degree of **Master of Dental Surgery (M.D.S.)** in the speciality of Conservative Dentistry and Endodontics.

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This is to certify that this dissertation entitled **"A comparative evaluation of surface hardness and abrasiveness of Componeers, Veneers and Laminates: an influence of commonly consumed beverages immersion after a short term period : An in-vitro study"** is a bonafide work done by **Dr. Aarushi Shekhar**, under the direct supervision & guidance of **Dr. Akanksha Bhatt,** Reader, Department of Conservative Dentistry & Endodontics, Babu Banarasi Das College of Dental Sciences, Babu Banarasi Das University,Lucknow, Uttar Pradesh.

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**Dr. Aarushi Shekhar**

## ACKNOWLEDGEMENT

*"The most important function of education at any level is to develop the personality of the individual and the significance of his life to himself and to others."*

*At the very start, I bow my head to the* ***Almighty GOD****, who blessed me with his worthy blessings, bestowed me with his kind grace, provided me with necessary strength, courage and good health to reach this stage and made it possible to bring out this manuscript.*

*Words cannot describe my emotions for my beloved Parents-* ***Col. Himanshu Shekhar and Mrs. Rajni Sinha*** *who have been my pillars of strength throughout my life. I owe them everything for all the sacrifices, undying support and relentless prayers throughout my educational tenure. I would also thank my sister-* ***Anushkaa Shekhar****, and my beloved husband* ***Dr. Abhimanyu Singh****, who always stood by me in times of joy and distress and helped me in finishing my dissertation.*

*I express my deep sense of gratitude to my in-laws* ***Capt (Retd). Arjun Rana (Indian Navy)*** *and* ***Mrs Anju Rana*** *for their constant support without which it would've been impossible to complete my dissertation.*

*It is a profound sense of gratitude that I express my thankfulness to my mentor and Guide,* ***Dr. Akanksha Bhatt, MDS, Ph.D, Reader, Department of Conservative Dentistry and Endodontics, Babu Banarasi Das College of Dental Sciences, Lucknow,*** *who has been a constant source of inspiration and encouragement to me. The present work bears at every stage the interest of her wise, logical suggestions and meticulous attention to details, which has helped me in bringing this dissertation to its ultimate goal. Without her expert guidance this project would have been buried in complicated jargon.*

## ~Acknowledgment~

*I am deeply indebted to respected* **Dean and Professor and Head of the Department, Dr. B. Rajkumar, Babu Banarasi Das College of Dental Sciences, Lucknow***, for his constant support, caring attitude and advice that has helped me to carry out this work, his vast knowledge and ability to achieve excellence has proved to be very valuable throughout.*

*I'm deeply indebted to my Co-Guide* **Dr. Jaya Singh, MDS, Assistant Professor, Babu Banarasi Das College of Dental Sciences, Lucknow,** *for her priceless suggestions, constant counseling and affectionate attitude that helped me in preparing this thesis with ease. Without her sharp eyes for details and practical knowledge, this thesis would not have seen the light of the day.*

*I would like to express my gratitude to* **Dr. Vishesh Gupta, Dr. Tanu Tewari & Dr. Sandeep Dubey, MDS, Reader, Babu Banarasi Das College of Dental Sciences, Lucknow** *for extending their cooperation and for being there whenever the need arose.*

*I am truly grateful to* **Dr. Palak Singh, Dr. Pragya Paliwal, Dr. Rita Gupta, Dr. Ananya Rawat and Dr. Tarun Saxena MDS, Senior Lecturer, Babu Banarasi Das College of Dental Sciences, Lucknow** *for their help & support in the completion of my dissertation.*

*With deep sense of gratitude, I acknowledge my revered teacher* **Dr. Amit Nigam, Lecturer, Babu Banarasi Das College of Dental Sciences, Lucknow** *for his encouragement and guiding wisdom which many a times supported my sagging spirits.*

*Very special thanks to our beloved teacher* **Dr. Lalit Chandra Boruah,** *who laid the very foundation of our post-graduate life in our department.*

*I would like to thank my colleagues* **Dr.Divya, Dr. Prachi Mishra, Dr. Ananya Jain, Dr. Chris Cherian Geogi, Dr. Rahul Tehria** *for their valuable suggestions and support.*

*I wish my sincere thanks to my seniors* **Dr. Dibyajit Sur and Dr. Sankalp Nigam** *who have been a great source of inspiration and encouragement to me.*

*I would like to thank my juniors,* ***Dr. Atul Krishnan, Dr. Ricku Matthew, Dr. Richu Raju , Dr. Rimjhim Singh, Dr. Laxmi Pandey, Dr. Aishwarya Sudha, Dr. Anuja Kaushik, Dr. Satyam Kashyap and Dr. Aayush Poddar*** *for all their help & support.*

*I would like to acknowledge the support of the non-teaching staff of our department-* ***Mr. Parshuram and Mr. Vaibhav.*** *I would also like to acknowledge college management staff-* ***Dr. Anup, Mrs. Priyanka, Mrs.Succhi, Mr. Santosh, Mr. Girish & Mr. Saurabh*** *for their support.*

*I beg forgiveness from those, whose names I have inadvertently missed but they should find solace that their knowledge has been extended to others by way of this thesis.*

*Above all I bow my head in gratitude tothe almighty and ever loving* **GOD** *for bestowing his blessings on me, & rest my work on his feet.*

***Dr. Aarushi Shekhar***

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# LIST OF ABBREVIATIONS

| ABBREVIATIONS | FULL FORM |
|---|---|
| VHN | Vicker's Hardness Number |
| mm | Millimetre |
| MPa | Megapascal |
| S,M,X,XL | Small, Medium, Large, Extra large |
| pH | Potential of hydrogen |
| GIC | Glass ionomer cement |
| APF | Acidulated phosphate fluoride |
| EP | Erosive potential |
| RMGIC | Resin modified glass ionomer cement |
| CGI | Conventional glass ionomer |
| % | Percentage |
| & | And |
| Ra | Surface  roughness |
| SDR | Smart dentin replacement |
| w/v | Weight by volume |
| µm | Micrometre |
| wt | Weight |
| C | Celsius |
| mL | Millilitre |
| SD | Standard deviation |
| PTT | Phase transformation  toughening |
| LTD | Low  temperature degradation |
| Bis-GMA | Bisphenol A-glycidal methacrylate |
| TEGDMA | Tetraethyleneglycol Dimethacrylate |
| NaOH | Sodium hydroxide |
| Ca | Calcium |
| g | gram |
| mg | milligram |
| HS | Highly significant |

# ABSTRACT

The consumption of commonly available beverages has gained high popularity among the adolescent population, especially 18-35 year olds. Previous studies indicated that these beverages potentially cause dental erosion and their acidity damage restorative materials. The use of dental ceramics has substantially increased over the past few years because of their good aesthetic appearance and ease of handling. The Componeers, Veneers and Laminates have revolutionized aesthetic dentistry. The aim of this in vitro study is to evaluate the effect of various beverages on the surface hardness and abrasiveness of Componeers, Veneers and Laminates.

A total of 60 human permanent anterior teeth (Central incisors) were chosen for this study. The teeth were divided to meet the requirements of the individual samples. Tooth preparation was then carried out using diamond burs and depending upon which sample group it belongs to, the appropriate restoration i.e, Componeers, Veneers (Zirconia) and Laminates (Composite) were placed on the respective teeth. Afterwards these specimens were placed in different test tube vials containing equal amounts of Coca Cola(The Coca Cola Company, Atlanta, USA), Coffee(Nescafe Gold, Switzerland), Red Bull( RedBull gMbH, Austria) and Amul Cool Butterscotch milk(Amul Cooperative Dairies, Anand, Gujarat) This procedure was repeated for 30 days and then the samples were evaluated for surface hardness and surface abrasiveness tests. The results were then statistically analysed using one-way ANOVA followed by post hoc Tukey test.

There was statistically highly significant difference found in Surface Roughness (Micrometer) and Micro-hardness (VHN) among group I (Componeers), II (Veneers) & III(Laminates).

The present in-vitro study indicates that out of all the tested restorative materials: Componeers, Veneers (Zirconia) and Laminates (Composite), Veneers (Zirconia) exhibit highest micro-hardness values whereas Laminates (Composite) exhibit highest surface roughness values. However, further in-vivo studies are required to evaluate further mechanical properties of Componeers, Veneers (Zirconia) and laminates (Composite) in the oral cavity.

**Keywords:** Componeers, Veneers, laminates, micro- hardness, surface roughness.

# INTRODUCTION

Restorative dental materials consist of synthetic components that can be used to repair or replace tooth structure, including primers, bonding agents, liners, cement bases, resin-based composites, compomers, hybrid ionomers, cast metals, metal-ceramics, ceramics, and denture polymers(1). Restorative materials may further be classified as direct restorative materials or indirect restorative materials. According to Phillips' Science of Dental materials 12th edition, a

Direct Restorative material is a cement, metal or resin-based composite, that is placed and formed intraorally to restore teeth and/or to enhance esthetics.

Indirect Restorative material is a ceramic, metal, metal-ceramic, or resin-based composite used extraorally to produce prostheses, to enhance esthetics and/or to restore damaged teeth.

Physical characteristics of restorative materials are an important concern when determining suitable restorative materials because they strongly influence the clinical longevity of restorations(2). Physical properties of importance to dentistry include brittleness, surface hardness, compressive strength, ductility, elastic modulus, surface abrasion, shear strength, tensile strength, fracture toughness, and microtensile strength. Any restoration should be able to reproduce the physiologic behaviour of the natural tooth as much as possible, with biological, biomechanical, functional and aesthetic integration.

One of the most important properties is the material's hardness, which correlates well with compressive strength, resistance to intra-oral softening, and degree of conversion. Surface hardness measures the material's strength to its surface plastic deformation. (3) It is the property of material, which gives it the ability to resist being permanently deformed when a load is applied. A material's hardness is the result of interaction of the properties such as strength, ductility, malleability, resistance to cutting and abrasion. A decrease in the hardness value may indicate a superficial degradation, and therefore a change in its roughness, which collaborates with the accumulation of plaque and consequently the deposition of lactic acid, hence jeopardizing the restoration's longevity. There are several types of surface hardness tests such as Barcol, Brinell, Rockwell, Shore, Vickers and Knoop. Selection of the test is done on the basis of the material being measured.

Another important mechanical property of a restorative material is its abrasiveness. Abrasiveness refers to the finer irregularities of the surface texture that usually results over a period of time or due to the condition of the material. Surface abrasiveness co-relates to the abrasive property exhibited by the surface of a material. Different levels of surface abrasiveness are seen owing to different wear mechanisms of materials. According to variations in wear mechanisms, different fiber orientations relative to the sliding motion can cause a drastic change in the wear behavior of composite resins.

For many years, color, shape, structural and positional abnormalities of anterior teeth have led to important esthetic problems for patients. One of the greatest desires for a patient while going for a dental treatment is the aesthetic transformation of their smiles to include a healthy and harmonious dentition.

Esthetic dentistry can be defined "as the art & science of dentistry applied to create or enhance beauty of an individual within functional & physiological limits". According to Goldstein, it is the art of dentistry in its purest form.

Cosmetic dentistry is application of the principles of esthetics & certain illusionary principles, performed to signify or enhance beauty of an individual to suit the role he/she has to play in his/her day to day life or otherwise[(4)]. It is usually referred to any dental work that improves the appearance (not necessarily the functionality) of teeth, gums and/or bite. It's primary focus is to improve the dental aesthetics which mainly involves the color, position, shape, size, alignment and overall smile appearance. A plethora of treatment options have been described to resolve the esthetic concerns of patients, which include several procedures, such as ceramic veneers, all ceramic crowns, metal ceramic restorations, direct composite veneering as well as componeers.

Therefore, the first and foremost therapeutic option should be a conservative treatment that is being able to modify the shape, size and colour of the teeth and at the same time providing a result according to the patient's expectations.

Componeers[(5)] are polymerised, nanohybrid enamel composite shells. It is a prefabricated composite veneer system or in other words, these are preformed composite shells. They are a relatively new system and are also known as 'same day veneers'. They represent an innovative approach that bridges between ceramic veneers and direct composite veneering and thereby it overcomes the limitation of either approach.

Componeers are basically resin material which is similar to the composite resins that are used in dentistry. They are manufactured from nanohybrid composites which ensure excellent homogenity and stability of the enamel shells. These are extremely thin (dimensions of

0.3mm cervically and 0.6mm incisally) veneers, thus they require minimal tooth preparation and at the same time, they also give a natural appearance to the teeth. This also allows conservation of tooth structure. They even have novel inner surface with micro-retentive feature. This micro-retentive inner surface ensures a lasting and permanent bonding (24 MPa), therefore, conditioning of the veneer is not required, making it a milestone in veneers.

The shiny and naturally designed surface of componeers add a look of vitality to the restoration. One major advantage of Componeers is that it is a single visit procedure and is very cost effective for the general population.

Apart from this, there are several advantages of componeers which include:

- Excellent buccal gloss surface
- Less technique sensitive
- Represents a high quality and long-lasting esthetic restoration
- It is both conservative and cost-effective
- They have excellent color stability with no laboratory procedure, thereby providing an added advantage.
- It's ease of application also makes it extraordinarily time-efficient
- They are also very easily repairable

However, the disadvantages of componeers are :

- They are not as strong as porcelain veneers
- They don't last as long as traditional veneers, but are easy to replace
- They are slightly less stain-resistant than porcelain veneers

The indications for componeers are :

- To correct malpositioned teeth
- To close gaps between anterior teeth (midline diastema)
- To cover discoloured teeth
- Various other smile designing procedures

Contra-indications :

- Severe bone loss
- Poor periodontal status

- Poor oral hygiene
- Severe para functional habits such as bruxism

Before starting the procedure, the most suitable size of the teeth is selected using the componeer contour guide. It basically has 4 size categories, that is S,M,X and XL. It is usually advisable to select a slightly bigger size of componeer as it can be easily trimmed and contoured using the trimming disk to match the required contour of the tooth.

Shade selection is done using the componeer synergy D6 shade guide which contains six dentine cores (A1/B1,A2/B2,A3/B3) and two Enamel shells (Bleach opaque and white opalescent shade). Enamel shell is superimposed over the dentin core and then it is placed adjacent to teeth for shade selection.

Another treatment option for patients demanding aesthetics is Veneers. It was first introduced by Dr. Charles Pincus in the year 1940. Veneering is a minimally invasive restorative procedure for anterior teeth where buccal surface of the tooth is involved and clinical need is mainly about improving the aesthetics[(6)]. Veneering can be done either with porcelain or zirconia veneers or by composites.

The first and foremost important parameter for long term success of a veneer is appropriate case selection. The prime requirements in case selection are a high standard of oral health and hygiene and also, the presence of an adequate area of sound enamel for acid etching.

Among this, the indications of Zirconia veneers are :

- Correction of unaesthetic surface defects such as hypoplastic enamel or enamel lost by erosion or abrasion.
- Masking of discoloration resulting from trauma
- Endodontic treatment
- Tetracycline stains
- Repair of structural deficiencies such as fractured incisal edge, diastema and peg lateral.

Contra-indications :

A decreased success is seen when Zirconia veneers is restored in patients with:

- Inadequate enamel and tooth structure such as amelogenesis and dentinogenesis imperfecta
- When there is an existing large restoration or root canal treated with less tooth structure
- Patients with oral habits causing excessive stress on restoration and excessive interdental spacing.

Zirconia veneers offer various advantages such as:

- They provide a natural tooth appearance.
- Zirconia veneers are stain resistant.
- A color can be selected to make dark teeth appear whiter.
- They generally don't require as much shaping as crowns do, yet they are stronger and look better.

However, downsides to zirconia veneers include:

- The process cannot be undone.
- Veneers cost more than composite resin bonding.
- They usually cannot be repaired if they chip or crack.
- Because enamel has been removed, the tooth may become more sensitive to hot and cold foods and drinks.
- Zirconia veneers may not exactly match the color of your other teeth. Also, the color cannot be altered once it’s in place.
- Though not likely, zirconia veneers can dislodge and fall off.
- Teeth with veneers can still experience decay, possibly necessitating full coverage of the tooth with a crown.
- Veneers are not a good choice for people with unhealthy teeth (for example, those with decay or active gum disease), weakened teeth (as a result of decay, fracture, large dental fillings), or for those who don't have enough existing enamel on the tooth surface.

- People who clench and grind their teeth are poor candidates for zirconia veneers, as this can cause the veneers to crack or chip.

The next important clinical parameter is the shade selection procedure. Proper shade selection is done using shade guide. However, unlike componeers, precise tooth preparation is required for Veneers as most authors agree on the importance of tooth preparation to achieve long term success of Veneers. Shaini et al reported that 90% of the restorations placed in their patients were on unprepared teeth and concluded that this could be the reason for low success rates in their study(7). Therefore, tooth preparation is mandatory in order to:

- Get definite finish line
- Provide space
- Get fluoride-rich layer
- Rough surface for better retention.

There are four different main designs of tooth preparation commonly mentioned:

- Window preparation : In which the incisal edge of the tooth is preserved
- Feather preparation : In which the incisal edge of the tooth is prepared bucco-palatable, but the incisal length is not reduced
- Bevel preparation : In which the incisal edge of the tooth is prepared bucco-palatable, and the length of the incisal edge is reduced slightly (0.5-1mm)
- Incisal overlap preparation : In which the incisal edge of the tooth is prepared bucco-palatable, and the length is reduced (about 2mm), so the veneer is extended to the palatal aspect of the tooth.

Another treatment option for patients is composite veneers or laminates. Direct composite veneers allow operator to control and evaluate entire procedure from shade selection to final morphology usually in a single appointment.

Composite veneers(8) are used in situations where smaller changes have occurred:

- Chipping or discoloration of natural teeth
- Minor misalignments of teeth
- Composite cannot fill in large spaces

With the advent of microhybrid and nanohybrid composites, finishing and polishing of these restorations can rival that of porcelain. In 1997, Peumans et al. found 89% success rate of direct composite veneers after 5-year follow-up.

Composite veneers offer various advantages over zirconia veneers such as:

- It's main advantage is that it can be used directly, resulting in less chair time with an excellent initial aesthetic.
- Composite veneers do not require massive preparations. Therefore, enamel can be preserved for good adhesion
- Using resin composite to veneer on the anterior teeth is much convenient as it can be done in one appointment with a good aesthetic outcome and also reasonable longevity.
- Composite veneers are more affordable. The cost is almost half that of porcelain veneers.
- Composite veneers can be easily repaired if damaged.
- Esthetics and durability of composite materials have improved dramatically over years.

However, composite veneers have some inherent disadvantages like:

- They are more prone to discolouration and wear. For better results, experience skill is required.
- It shares the same limitations and physical properties of direct composite restorations such as polymerization shrinkage, and excessive wear.
- Composite resin preparation consists of removing more tooth structure to allow placement of the desired shape.
- Composite veneers are not as durable as zirconia veneers and more maintenance is required as they are more likely to be chipped.

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Now, to be clinically successful, aesthetic restorative materials are required to have long-term inertness. Consumption of beverages with low pH and acidic foods and drinks potentially cause dental erosion which may be detrimental to this inertness and influence mechanical and physical characteristics such as surface hardness and abrasiveness over time[(9)]. Since caffeinated beverages, aerated beverages and milk based beverages are the most commonly consumed beverages by the Indian population, this study focuses to evaluate the effect of short- term immersion in these beverages and their effect on surface hardness and abrasiveness of laminates, veneers and componeers.

## AIM OF THE STUDY:

The aim of this in vitro study is to evaluate the effect of various beverages on the surface hardness and abrasiveness of laminates, veneers and componeers.

## OBJECTIVES:

1. To evaluate the surface hardness and abrasiveness of Componeers, veneers and laminates when immersed in coffee.
2. To evaluate the surface hardness and abrasiveness of Componeers veneers and laminates when immersed in Red Bull.
3. To evaluate the surface hardness and abrasiveness of Componeers veneers and laminates when immersed in Coca Cola.
4. To evaluate the surface hardness and abrasiveness of Componeers veneers and laminates when immersed in Amul cool (butterscotch) milk based drink.
5. To conclude which beverage causes the most changes in surface hardness and abrasiveness of componeers, laminates and veneers.

# REVIEW OF LITERATURE

1. **West NX, Maxwell A, Hughes JA, Parker DM, New combe RG, Addy M.[10] (1998)** conducted a study, the aim of which was to develop and validate, using a negative control, a model to accurately measure erosion in situ due to a single aetiological agent over a relatively short time period. It was concluded that this method has confirmed the erosive potential of orange juice in situ.
2. **Edwards M et al[11] (1999)** measured the initial pH of several widely available soft drinks and determined their buffering capacities. The buffering capacities was ordered as follows: fruit juices\fruit-based carbonated drinks and flavoured mineral waters\non fruit-based carbonated drinks\sparkling mineral waters\still mineral water. It was concluded that fruit juices and fruit-based carbonated beverages,with their increased buffering capacities, may induce a prolonged drop in oral pH.
3. **Hughes JA, West NX, Parker DM, Newcombe RG, Addy M.[12] (1999)** conducted a study to determine whether an experimental blackcurrant juice drink with added calcium was less erosive to enamel both in vitro and in situ compared with a proprietary orange juice product. The results demonstrated that the experimental blackcurrant juice drink with calcium is markedly less erosive than orange juice, particularly and importantly in situ.
4. **Larsen M.J, Nyvad B[13] (1999)** compared the pH and the buffering effect of various soft drinks with their erosive effects and the solubility of apatite. They concluded that orange juice with pH 4.0, supplemented with calcium and phosphate did not erode the enamel as the calcium and phosphate saturated the drink with respect to apatite.
5. **Abu-Bakr NH, Han L, Okamoto A, Iwaku M.[14] (2000)** evaluated the amount of fluoride released from compomer restorative materials after immersion in various media. It was concluded that over a 60-day period, materials immersed in 100% orange juice released the highest amount of fluoride, which could be attributable to the erosive effect of the medium. Materials immersed in deionized water released the least amount of fluoride. Among the tested compomers, Compoglass released the most fluoride.
6. **Larsen M.J ,Richards A.[15](2001)** compared the erosive capabilities of some fruit-flavoured drinks, fresh or saturated with Calcium Fluoride. They concluded that non-carbonated fruit-flavoured drinks contain considerable amounts of acids which, in

vitro, induce erosions in teeth similar to those induced by carbonated soft drinks. Saturation with Calcium Fluoride reduced the in vitro development of erosions by 28% induced by drinks with pH above 3.

7. **Hughes JA, Jandt KD, Baker N, Parker D, Newcombe RG, Eisenburger M, Addy M.[16](2002)** did a study to further modify an originally low erosive blackcurrant drink product by the addition of a gum, to manipulate more favourably other drink parameters. It was concluded that the original blackcurrant drink produced significantly less erosion than the experimental drink.
8. **Mathew T, Casamassimo PS, Hayes JR[17] (2002)** evaluated the prevalence of dental erosion caused by soft drinks, sports drinks, to determine the prevalence of dental erosion in athletes in large Midwestern State University in the USA. The results showed no association between dental erosion and the use of sports drinks, quantity and frequency of consumption, years of usage and non sport usage of sports drinks.
9. **Garcia-Godoy F, Garcia-Godoy A, Garcia-Godoy[18] (2003)** evaluated the effect of Oral B APF Minute foam on the surface roughness, Hardness and morphology of high viscosity glass ionomer cements (GIC's). It was found that foam application time had no significant effect on the surface roughness of ketac Molar and Vitremer. Fuji IX GP showed that 1 or 4 minute applications had lower values after 2 years.
10. **West NX, Hughes JA, Parker DM, Moohan M, Addy M.[19](2003)** evaluated the erosive effects in situ of an experimental formulation carbonated drink with added calcium, compared to a conventional carbonated drink over a 20 day period using a similar design as in previous studies. This study had shown that it is possible to modify carbonated soft drinks in a manner similarly shown with non-carbonated soft drinks, to minimise dental erosion.
11. **Da Fonte Porto Carreiro A, Dos Santos Cruz CA, Vergani CE[20] (2004)** evaluated the effect of ageing in distilled water on the hardness and compressive strength of a direct composite resin Z100, a feldspathic porcelain and three indirect composites (Artglass, Soldidex and Targis). And resulted that composite materials Z100 promoted the highest VHN values, regardless of ageing periods. Also, the Soldidex and Z100 had the highest compressive strength values. The ageing in water reduced the hardness for all composites but had no long term effect on compressive strength.

12. **Jensdottir T, Bardow A, Holbrook P[21] (2004)** conducted a study, the objective of which was three-fold; (1) to test the erosive potential (EP) of various soft drinks, (2) to determine properties related to the soft drinks that were important for EP, and (3) to test possibilities of reducing the EP of soft drinks by modification. It was concluded that several properties related to soft drinks had an impact on their EP upon long exposure time to teeth and that moderate modification could be a helpful measure to reduce the EP of soft drinks.
13. **Mckenzie Aliping M , Linden RW, Nicholson JW[22] (2004)** compared the interaction of tooth coloured dental restorative materials for 1day, 1 week, 1,3,4,6 months, and 1 year and then stated that fruit juices were shown to pose a greater erosivethreat to toothcoloured materials than Coca-Cola.

14. **Badra VV, Faraoni JJ, Ramos RP, Palma- Dibb RG[23] (2005)** compared the influence of different beverages on the microhardness and surface roughness of microfilled , hybrid and flowable resin. Composites were fabricated and divided into three groups and after performing the experiment they stated that the greater number of immersions in beverages resulted in a more accentuated impact on the resin properties.

15. **Coombes JS[24] (2005)** compared the composition and rationale for the use of sports drink along with recent studies investigating the relationship betweensportsdrinks and dental erosion. The study expounded that for most athletes and individuals engaged in physical activity, the use of sports drinks does not provide any benefit over water. There is in vitro evidence of drinks such as wine, fruit juices and carbonated soft drinks having maximum erosive potential.
16. **Hemingway C.A, Parker D.M, Addy M, Barbour M.E[25] (2006)** investigated how enamel loss due to erosion, and due to cycling of erosion and abrasion, depends on composition of soft drinks. They concluded that enamel loss by erosion is exacerbated by subsequent abrasion. The amount of softened enamel removed by tooth brushing is a function of the chemical composition of the erosive medium.
17. **Kitchens M, Owens BM[26] (2007)** evaluated the effect of carbonated and non-carbonated beverages, bottled and tap water, on the erosive potential of dental enamel with and without fluoride varnish protection. They concluded that both carbonated and non-carbonated beverages displayed a significant erosive effect on dental enamel.

18. **Malinauskas BM, Aeby VG, Overton RF, Carpenter- Aeby T, Barber- Heidel K[27] (2007)** determined energy drink consumption patterns among college students used for six situations, namely for insufficient sleep, to increase energy, while studying, driving long periods of time, drinking with alcohol, and to treat a hangover, and prevalence of adverse side effects. It was concluded that users consumed one energy drink with a reported frequency of 1-4 days per month.

19. **Owens BM, Kitchens M[28] (2007)** used scanning electron and light microscopy in a study to qualitatively evaluate the erosive potential of carbonated cola beverages as well as sports and high-energy drinks on enamel surface substrate. As verified by microscopic evaluation, all tested beverages displayed enamel dissolution in the following order: Red Bull>Gatorade>Coca-Cola Classic>Diet Coke.
20. **Honório HM, Rios D, Francisconi LF, Magalhães AC, Machado MA, Buzalaf MA.[29] (2008)** evaluated the effect of a prolonged erosive pH cycling on the superficial microhardness change (SMHC) and the erosive wear of different restorative materials such as RMGI - resin-modified glass-ionomer, CGI - conventional glass-ionomer, CR- composite resin, A - amalgam and immersion media used were a cola drink (erosive medium) and artificial saliva. Scanning electron microscopy images showed pronounced enamel erosive wear on groups submitted to erosive pH cycling when compared with groups maintained in saliva and it was concluded that the prolonged pH cycling promoted significantly higher alterations (SMHC and erosive wear) on the glass-ionomer cements than the Composite resin and amalgam.
21. **Yanikoğlu N, Duymuş ZY, Yilmaz B.[30] (2009)** compared the surface hardness of five light-cured composite resins namely: filled (Estelite), nanofil (AElite), unfilled (Valux Plus), hybrid (Tetric ceram), and Ormocer-based (Admira) composite resins. The composite specimens were immersed in different solutions (tea, coffee, Turkish coffee, mouthwash, cola, and distilled water) and it was found that the reinforced nano-hybrid composite material immersed in cola for 30 days had the lowest surface hardness (33.20), whereas hybrid composite material immersed in cola for 24 hours had the highest surface hardness (156.00). It was concluded that the five different materials exhibited different hardnesses, and that the hardness values of composite materials were statistically different in different immersion solutions.

22. **Ana Luísa Botta Martins de Oliveira, Patrícia Petromilli Nordi Sasso Garcia, Patrícia Aleixo dos Santos, Juliana Álvares Duarte Bonini Campos[31] (2010)**evaluated the finishing and polishing effect on the surface roughness and hardness of Filtek Supreme XT, in fluoride solutions. The results showed that the surface roughness and microhardness of the Filtek Supreme XT were influenced by the finishing and polishing procedure, independently of the immersion methods.

23. **Thippeswamy et al[32] (2010)** performed a study to analyze the fluoride content in bottled water, juices and carbonated soft drinks that were commonly available in Davangere city.It was concluded that regulation of the optimal range of fluoride in bottled drinking water, carbonated soft drinks and fruit juices should be drawn for the Indian scenario.
24. **Ibrahim MH[33] (2011)** evaluated the effects of various beverages on microhardness, surface roughness, and solubility of esthetic restorative materials such as conventional glass ionomer, resin-modified glass ionomer, compomer, and composite resin and it was concluded that low pH beverages were the most aggressive media for glass ionomers and compomer and by contrast, composite resin was relatively less affected. Microhardness of tested materials was significantly decreased after immersion in the various beverages, whereas surface roughness and solubility were increased with the exception of natural milk.
25. **Miranda Dde A1, Bertoldo CE, Aguiar FH, Lima DA, Lovadino JR-Braz Oral Res.[34] (2011)** evaluated the effect of different mouthwashes on superficialroughnessand Knoop hardness of two resin composites. Eighty specimens were prepared and divided into eight experimental groups and it was concluded that the mouthwashes containing hydrogen peroxide and/or alcohol decrease the microhardness of the resins tested; however, the mouthwash containing hydrogen peroxide had a higher deleterious effect on roughness.
26. **Seifert SM , Schaechter JL, Hershorin ER, Lipshultz SE[35] (2011)** evaluated the effects and extent of energy drink consumption among children, adolescents, and young adults. It was concluded that 30% to 50% of adolescents and young adults consume energy drinks containing high and unregulated amounts of caffeine, which cause serious adverse effects in children, adolescents, and young adults with seizures, diabetes, cardiac abnormalities, or mood and behavioral disorders or those who take certain medications also that energy drinks had no therapeutic benefit.

27. **Lussi A, Megert B, Shellis RP, Wang X.[36](2012)** performed a study with the aim: (1) to assess the erosive potential of different dietary substances and medications; (2) to determine the chemical properties with an impact on the erosive potential. Erosive challenge caused a statistically significant reduction in Surface hardness for all agents except for coffee, some medications and alcoholic drinks, and non-flavoured mineral waters, teas and yogurts.
28. **Erdemir Ugur, Yildiz Esra, Eren Meltem Mert, Ozel Sevda[2] (2013)** evaluated the effect of sports and energy drinks on the surface hardness of different composite resin restorative materials over a month period. They hence concluded that the effect of sports and energy drinks on the surface hardness of a restorative material depends on the duration of exposure time, and the composition of the material.
29. **Andrea et al[37] (2014)** evaluated the influence of erosive conditions on the wear resistance of aesthetic direct restorative materials. Dental filling materials had different behaviour under the same erosive condition, however all investigated aesthetic restorative materials showed surface degradation. These findings suggest that erosive wear resistance of tooth coloured restoratives could influence their longevity in intraoral acidic conditions.
30. **Karaman E, Tuncer D, Firat E, Ozdemir OS, Karahan S.[38] (2014)** investigated the influence of different staining beverages on color stability, surface roughness and microhardness of silorane and methacrylate-based composite resins. It was concluded that cola and coffee altered, to some degree, the color, surface roughness and/or microhardness of the tested resin composites, depending on the characteristics of the materials.
31. **Rajvardan et al[39] (2014)**evaluated and compared the erosive potential of carbonated drink (cola) and fruit juice (orange fruit juice) by measuring the surface roughness (Ra) values on two commonly used dental restorative materials. Significant surface changes of the dental restorative materials can take place when exposed to low pH drinks for a prolonged period.
32. **Lussi A, Carvalho TS[40] (2015)** analysed the erosive potential of 30 substances (drinks, candies, and medicaments) on deciduous enamel, and analyse the associated chemical factors with enamel dissolution. They concluded that drinks, foodstuffs and medications commonly consumed by children can cause erosion of deciduous teeth

and erosion is mainly associated with pH, titratable acidity and calcium concentration in the solution.

33. **Silva et al[41] (2015)** conducted a study was to determine the effect of different solutions cola soft drink (CSD) and coffee on roughness and microleakage of composite resin restorations. It was concluded that CSD and coffee change the surface roughness and increase the microleakage of restorations.
34. **DA Silva MA, Vitti RP, Sinhoreti MA, Consani RL, Silva-Júnior JG, Tonholo J.[42] (2016)** evaluated the microhardness and surface roughness of composite resins immersed in alcoholic beverages. The composite resins used were-Durafill (Heraeus Kulzer), Z250 (3M-ESPE) and Z350 XT (3M-ESPE) and the samples were immersed in artificial saliva, beer, vodka and whisky and it was concluded that the effect of these beverages on dental composites is depended upon the chemical composition, immersion time, alcohol content and pH of solutions.
35. **Panda et al[43] (2017)** aimed to estimate the pH of the commonly available soft drinks in the Indian market and to assess the detrimental effects of the juices and beverages on the tooth surface by measuring the weight loss of the tooth sample. It was concluded that the pH of both carbonated drinks and fruit juices was below the critical pH. The weight loss was also seen after every 24 hours in all the carbonated drinks and beverages. The study showed that these commercial beverages are harmful to the tooth structures.
36. **Shroff et al[44] (2018)**aimed to evaluate the erosive potential of twenty beverages (8 carbonated drinks and 12 packaged fruit juices). It was concluded that most of the beverages tested in this study showed erosive potential. The carbonated drinks caused significant dental erosion.
37. **Yousef Alothman and Maryam Saleh Bamasoud[7](2018)** compared the survival rate of dental veneers according to different preparation designs and different material types and concluded that incisal overlap preparation seems to have the most predictable outcome from all the preparation designs.
38. **Chowdhury et al[45] (2019)** conducted a study the objective of which was to quantify and assess the concentration of fluoride in commonly used oral care products, fruit juices, bottled waters, soft drinks, favoured bottled milk and milkshakes and to determine the pH of carbonated sweet drinks and drinks marketed in India. It was concluded that, the wide variety of dentifrices and toothpowders available in India,

most brands do not indicate the fluoride levels on their packaging or inserts. Similarly, the unregulated acidic pH values of carbonated sweet drinks are not only potentially contributing to non-carious tooth loss (enamel erosion and dentine erosion), but are also a contributing factor to the weight gain observed in Indian adolescents.

39. **Elwardani G, Sharaf AA, Mahmoud A.[46] (2019)** evaluated and compared the surface roughness and colour change of microhybrid and nanocomposite after exposure to beverages commonly consumed by children.(Filtek Z250 and Filtek Supreme) It was concluded that both composites showed no significant difference in roughness and colour change at all measurement times. There was a significant increase in surface roughness and colour change in all immersion solutions tested over time. Coca-Cola caused unacceptable colour change.
40. **Scribante A, Bollardi M, Chiesa M, Poggio C[47] (2019)** conducted a study the purpose of which was to investigate mechanical properties of different esthetic restorative materials after exposure to acidic drink. Nine different composites were tested: nanofilled (Filtek Supreme XTE, 3M ESPE), microfilled hybrid (G-ænial, GC Corporation), nanohybrid Ormocer (Admira Fusion, Voco), microfilled (Gradia Direct, GC Corporation), microfilled hybrid (Essentia, GC Corporation), nanoceramic (Ceram.X Universal, Dentsply De Trey), supranano spherical hybrid (Estelite Asteria, Tokuyama Dental Corporation), flowable microfilled hybrid (Gradia Direct Flo, GC Corporation), and bulk fill flowable (SureFil SDR flow, Dentsply De Trey). They concluded that acidic drink immersion significantly reduced flexural values.
41. **Meenakshi CM, Sirisha K[48] (2020)** aimed to evaluate the effect of acidic beverages on surface roughness and color stability of Filtek™ Bulk-Fill posterior restorative composite in comparison with Filtek P60 posterior restorative composite. It was concluded that the surface roughness and color change of both composites increased significantly in acidic beverages and more in Coca-Cola. Bulk-fill exhibited better surface quality and color stability than P60.
42. **Szalewski L, Wójcik D, Bogucki M, Szkutnik J, Różyło-Kalinowska I.[49] (2021)** conducted a study, the aim of which was to investigate the influence of common beverages on the mechanical properties of composite resins. The mean flexural strength of composites was highest in distilled water and it was reduced after one week in different beverages. They concluded that all tested beverages had an

influence on Vickers microhardness of tested composite resins. Flexural strength of only one material was statistically significantly influenced by tested beverages.

# MATERIALS & METHODS

The present in-vitro study was conducted in the Department of Conservative Dentistry & Endodontics, Babu Banarasi Das College of Dental Sciences, Lucknow in Collaboration with Praj metallurgical laboratory, Pune. The study was done to evaluate the effect of various beverages on the surface hardness and abrasiveness of laminates, veneers and componeers.

## SUBJECT SELECTION

## SOURCE OF DATA

The study was carried out in the Department of Conservative Dentistry and Endodontics, Babu Banarasi Das College of Dental Sciences, Lucknow.

A total of 60 human permanent maxillary central incisors were collected. The collected teeth were cleaned using ultrasonic scaler and then stored in 0.9% normal saline until further use.

The following inclusion and exclusion criteria were set to select the teeth:

Inclusion criteria

- Non carious human single rooted teeth
- Sound and intact human single rooted teeth with normal morphology

Exclusion Criteria

- Teeth with any crack, caries or calcification
- Teeth with developmental anomaly
- Teeth with any restoration.
- Endodontically treated teeth

Following materials and armamentarium were used:

## TABLE A: ARMAMENTARIUM AND MATERIALS REQUIRED

- For Sample preparation:

| S.No. | Material & Armamentarium | Manufacturer |
|---|---|---|
| 1. | Ultrasonic Scaler with Tips | Coltene, Switzerland |
| 2. | Airotor | NSK, Japan |
| 3. | Micromotor (slow speed)<br>Contrangle handpiece<br>Connector<br>Control Box | Unicorn Denmart, India |
| 4. | Crown preparation burs | S S white |
| 5. | Normal Saline (0.9%w/v NaCl ) | Beryl Drugs Ltd., India |
| 6. | Disposable syringe of 5ml | Dispo Van, India |
| 7. | 30 gauge needle | Oro, India |
| 8. | Autoclave | Confident, India |
| 9. | Modelling Wax | Pyrex, India |
| 10. | Kidney tray | IndiaMart |

- For restoration

| S.no. | Material & Armamentarium | Manufacturer |
|---|---|---|
| 1. | Componeer | Coltene Brilliant |
| 2. | Zirconia Veneer | Apex Dental Lab,<br>Lucknow |
| 3. | Composite Laminate | Apex Dental Lab, |

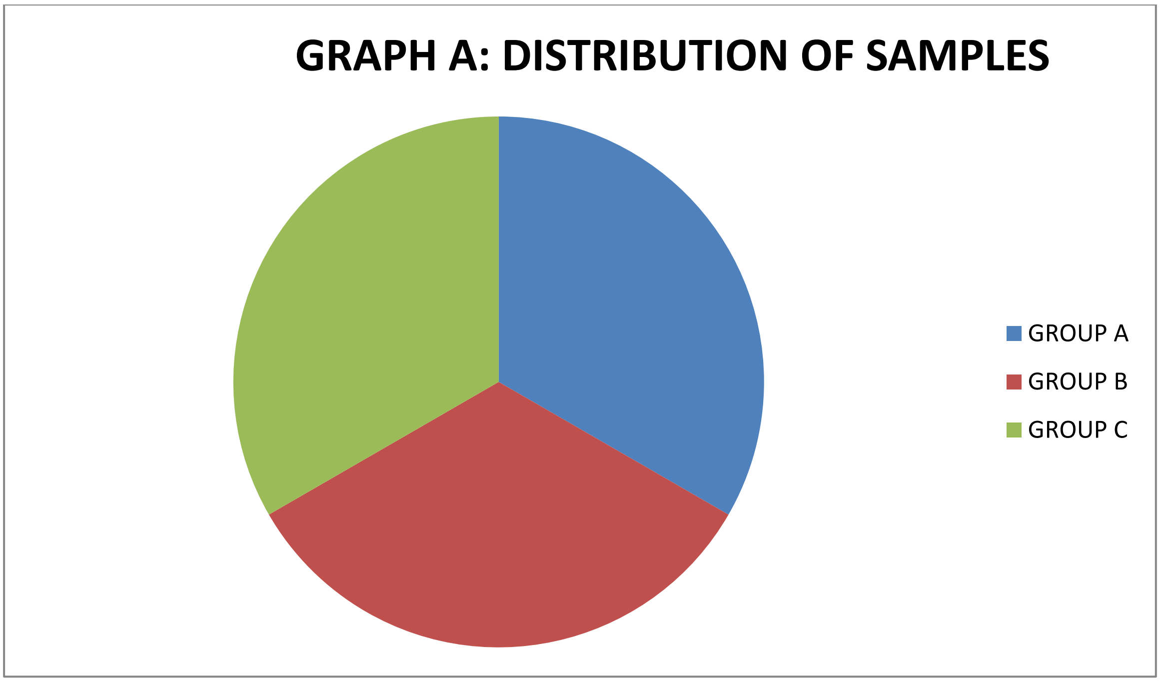
| | | |
|---|---|---|
| | | Lucknow |
| 4. | Etchant (37% phosphoric acid) | Coltene |
| 5. | One coat bond SL | Coltene |
| 6. | Componeer holder | Coltene |
| 7. | Componeer placer | Coltene |
| 8. | Componeer modeling instrument MBC | Coltene |
| 9. | Packable Composite | Coltene |
| 10. | Curing Light | Woodpecker, China |
| 11. | Composite Restorative Instruments<br>Heidman filling spatula<br>Goldstein flexi thin<br>Paddle condensor<br>Freedman duckhead instrument<br>Beavertail Ball burnisher | GDC, India |
| 12. | Applicator tips | |
| 13. | Superfine polishing disk | Shofu |
| 14. | Electric toothbrush | Oral-B, Braun, France |
| 15. | Dentifrice | Colgate, India |
| 16. | Customised brushing apparatus | |
| 17. | Microhardness tester | Reichert Austria Make |
| 18. | Profilometer | Mitutoyo, Japan |

## TABLE B: COMPOSITION OF THE RESTORATIVE MATERIAL

| Restorative material | Composition |
|---|---|
| Componeer | Organic matrix: BISGMA, TEGDMA. Photoinitiator and co-initiators. Inorganic filler size - 0.02 to 2.5μm (80 wt%) |
| Zirconia Veneers | a glassy matrix, containing a homogeneous crystalline structure made of lithium silicate crystals, is reinforced with tetragonal zirconia fillers (about 10% by weight) |
| Composite laminates | Highly filled nano-hybrid composite filling material (83%) |

## TABLE C: DISTRIBUTION OF SAMPLES

| GROUPS | NUMBER OF SAMPLES | TYPE OF RESTORATION |
|---|---|---|
| GROUP A | 20 | COMPONEER |
| GROUP B | 20 | VENEER |
| GROUP C | 20 | LAMINATE |




# METHODOLOGY

## SAMPLE COLLECTION

- Sixty anterior human teeth (central incisors) extracted for Periodontal reasons were obtained from Department of Oral and Maxillofacial Surgery, BBDCODS, Lucknow: after taking Patient consent.
- Teeth collected were cleaned for any tissue remnants, plaque and calculus on the root with ultrasonic scalers.
- Out of the collected teeth, the sample selection was done following the inclusion and exclusion criteria.

## SPECIMEN PREPARATION

## TOOTH PREPARATION:

- The teeth were divided to meet the requirements of the individual samples.
- Tooth preparation was then carried out using diamond burs depending on the case requirement.

## SEQUENCE OF TOOTH PREPARATION:

### Labial Surface Reduction:

**Depth of preparation:** 0.3-0.5 mm

- The surface was prepared by placing horizontal depth orientation grooves/depth cuts by sinking the three tiered depth cutting diamond bur into the tooth.
- They were placed in two planes - one set within the cervical half which is parallel to long axis or cervical half of labial surface and the incisal portion to follow the labial/facial contour.
- The remaining tooth structure between the depth cuts was then removed using the flat - end tapering diamond and the preparation was extended proximally 1 mm.
- For a standard preparation, a definitive chamfer finish line was placed at the cervical margin.

### Labial margin placement:

- Clinically, supragingival margins are preferred.
- Subgingival margins may be indicated for aesthetic reasons. The depth cuts should be placed 0.5mm apical to the crest of free gingival, so that after final finishing they will be 1mm deep.

### Proximal Reduction:

- Contact area should be preserved as much as possible.

### Incisal Reduction:

- Window type of preparation (i.e., in which the incisal edge of tooth is preserved) was done.

### Finishing:

- Finishing of the labial axial surface was done using a flat-end tapering fissure bur.

- The finish line was finished using end-cutting diamond which has non-cutting smooth sides with diamond points impregnated only at the tip.

## RESTORATION:

- The samples were autoclaved under steam at 121 C, 15 lbs pressure for 15 minutes.
- After sterilization, the samples were mounted on wax.
- After tooth preparation, the componeer or the veneer trial is mandatory.
- The originally selected componeer was trimmed, reduced, shaped and sized to match the desired effect.
- After the componeer trial was completed, the restoration was carried out depending on the sample group it belongs to.

### Placement of the adhesive:

- 37% phosphoric acid gel etchant was applied for 20 seconds to all of the prepared tooth structure.
- The area was rinsed thoroughly with water spray for 60 seconds to remove the etchant.
- The etched area was then blot-dry with the help of a damp cotton pellet, a foam pellet, or a disposable brush to remove the excess water.
- Bonding agent is then applied over the tooth with the help of a microbrush.
- The adhesive was then gently air dried with the help of a chip-blower to evaporate any solvent (acetone, alcohol, or water), then light cured for 20 seconds.
- Bonding agent was also applied over the componeer shell and veneer and left uncured.

### Insertion and light-activation of the composite:

- The selected shade of composite layer was applied over the tooth surface using Goldstein flexi thin composite filling instrument and componeer was adapted over the tooth surface for Group I, Zirconia Veneer for Group II and composite laminate for Group III.

### Contouring and finishing:

- The excess composite was removed and light cured cervically and then from the incisal and palatal aspects respectively.
- Finishing and polishing was done using abrasive strips, silicon rubber points and flexible aluminium oxide disks (Super- Snap mini kit, SHOFU)
- The abrasive disks were mounted on a mandrel specific to the disk type, in a contra-angle hand piece at low speed, and was used for finishing and polishing.
- After restoration, all specimens were then stored in distilled water in a lightproof container for 24 hours at 37°C to ensure complete polymerization.

## IMMERSION IN VARIOUS BEVERAGES:

- Afterwards 4 specimens from each experimental group were individually stored in vials containing 5 ml of distilled water (pH 6.58) for 24 hours, and kept in an incubator at 37 degree celsius as a control solution and the distilled water was renewed daily upto 1 month.
- The other specimens from each experimental group were individually immersed (n=4) in vials containing 5ml of
    - Coca Cola(The Coca Cola Company, Atlanta, USA; pH 2.6)
    - Coffee (Nescafe Gold, Switzerland; pH 4.85)
    - Red Bull (RedBull gMbH, Austria; pH 3.54)
    - Amul Cool Butterscotch milk (Amul Cooperative Dairies, Anand, Gujarat; pH 6.7)
- They were immersed for 2 mins daily at room temperature (23±1C)
- After the immersion period in test solutions, the samples were washed with distilled water and the specimens were maintained in distilled water at 37C during the rest of the day.
- The vials were sealed to prevent evaporation of both the control and test solutions.
- All the specimens were refreshed daily.
- For the entire experimental period, newly opened test solutions were used each day
- This procedure was repeated for 30 days.

## SURFACE HARDNESS MEASUREMENTS:

- Surface hardness of the specimens was evaluated using Vickers method with a microhardness tester (Reichert Austria Make, Sr.No.363798,) at a load of 100 g with an indentation time of 10 sec (Vickers pyramid: diamond right pyramid with a square base and an angle of  = 136° between the opposite faces at the vertex).
- The dimensions of the indentations were evaluated using the optical microscope of the hardness tester and the data were independently averaged and reported in Vickers Hardness Numbers (VHN).

## PROCEDURE FOR ABRASION:

## Customized brushing model:

- A custom made brushing apparatus was constructed by an expert consultation. The apparatus was designed to deliver uniform force and uniform unidirectional motion to the tooth surface.
- The customized brushing apparatus consists of :
    - Motor: To deliver a uniform force and move the toothbrush in back and forth direction.
    - Handle: To which toothbrush can be attached
    - Base: To support the whole apparatus.
- A commercial electric toothbrush was used in this investigation (Oral-B®, Braun, France) with the following parameters: load of the toothbrush standardized at 250 g, medium hardness toothbrush head, and rotation sense changing every 30 sec.
- The electric toothbrush was mounted on the brushing apparatus and fixed firmly, so that there was no lateral movement during brushing.
- A commercially available standard dentifrice (Colgate, India) was used throughout the study. Toothpaste in pea shape was squeezed over the mounted specimens and then they were subjected to brushing cycle.
- The brushing regimen was carried out, in a direction, perpendicular to the long axis of the tooth, with a uniform force as it naturally happens in oral cavity.
- A single specimen was brushed for 2 min period, twice daily, for 1 month.

- After the brushing regimen was over, the surface roughness of all the specimens were calculated using a profilometer.

## ANALYSIS OF THE SAMPLE

After obtaining the values of each group, the following tests were performed using SPSS (Statistical Package for Social Sciences) Version 24.0 (IBM Corporation, Chicago, USA):

- One-way analysis of variance (ANOVA)
- Post hoc Tukey's HSD analysis.

Fig 1- Samples


Fig 2- Ultrasonic sealer with tips

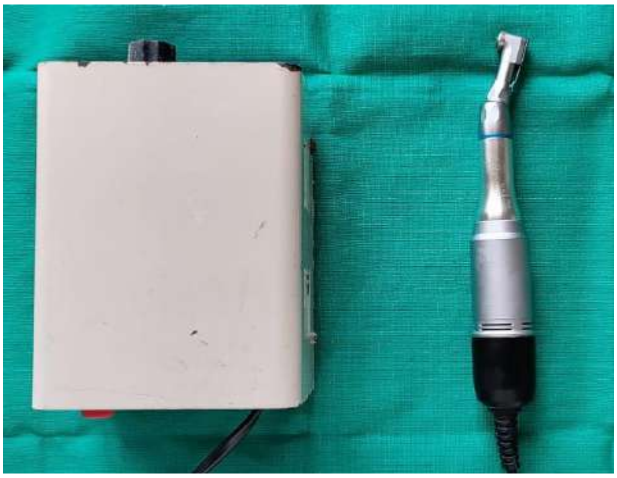


Fig 3- Micromotor (slow speed)-
Contrangle handpiece, connector, control box


Fig 4- Crown Preparation burs

Fig 5- Autoclave


Fig 6- Modelling wax, Kidney tray

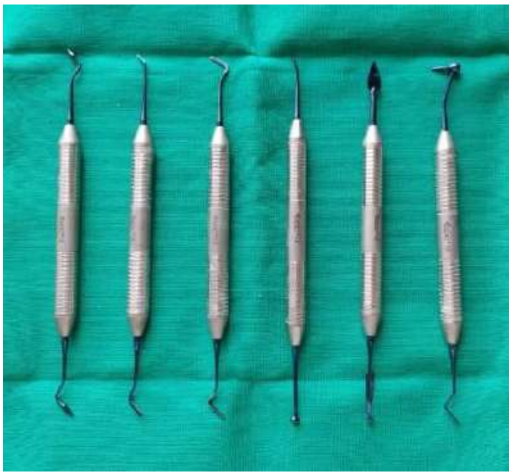


Fig 7- Composite restorative instruments


Fig 8- Superfine polishing disk

Fig 9- Armamentarium for restoration

Fig 10- Tooth preparation

Fig 11- Prepared sample mounted on wax

Fig 12- Zircovia Veneer

Fig 13- Componeer

Fig 14- Composite laminates

Fig 15- Finishing and polishing of the sample

Fig 16- Sample mounted on acrylic for testing


Fig 17- Vicker's hardness test of sample


Fig 18- Surface abrasiveness test of sample using profilometer

# OBSERVATION AND RESULTS

**Table 1: Comparative evaluation of Surface Roughness (Micrometer) among group I (Componeers), II(Veneers)& III(Laminates).**

| Groups | Restorative Material | Number | Surface Roughness (Micrometer) | |
|---|---|---|---|---|
| | | | MEAN | SD |
| Group I | Componeers | 20 | 0.07920 | 0.011358 |
| Group II | Veneers | 20 | 0.30600 | 0.050912 |
| Group III | Laminates | 20 | 0.40860 | 0.153957 |
| TOTAL | | | 0.26460 | 0.166648 |
| ANOVA 'F' Value | | | 64.514 | |
| Significance 'P' Value | | | 0.001(HS) | |

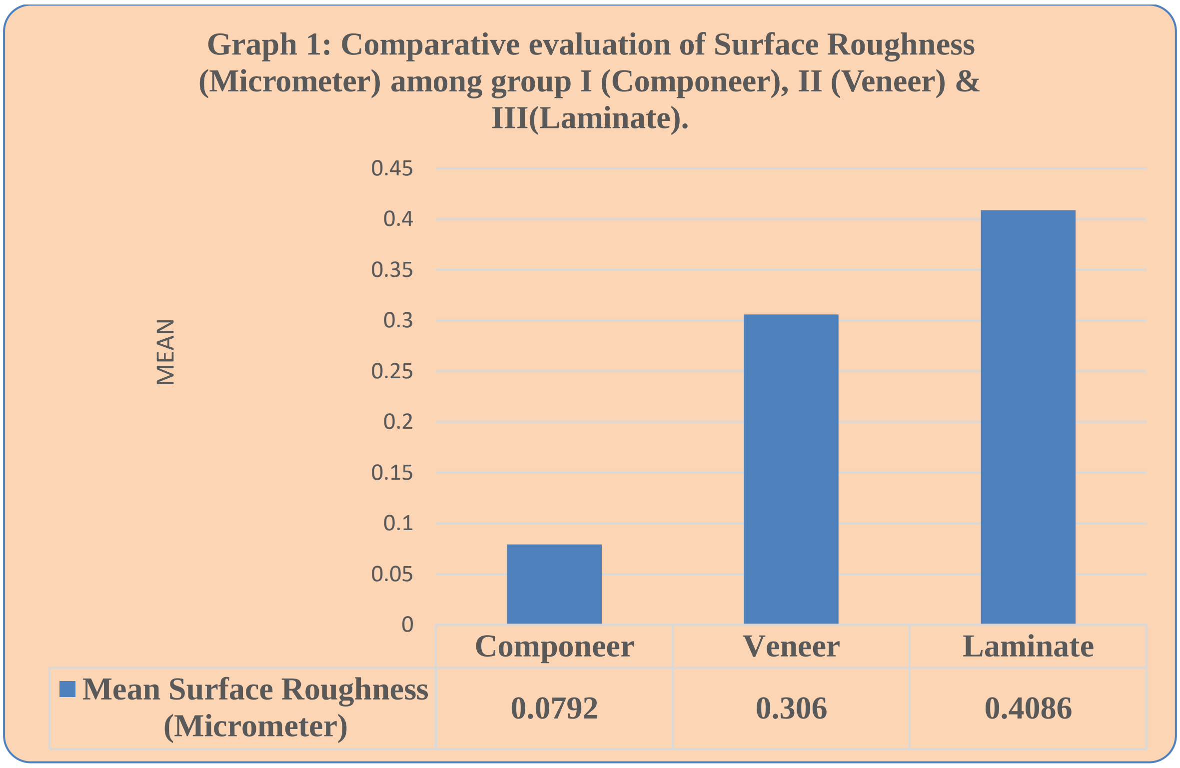


Table 1/figure 1 reveals Comparative evaluation of Surface Roughness (Micrometer) among group I (Componeers), II (Veneers) & III(Laminates). Total 60 samples of restorative material were taken for the study to compare surface roughness. They were randomly divided in to three groups. Group I is componeers, group II is Veneers and group III is laminates. Mean surface roughness were found highest in laminates i.e. 0.40860±0.153 micrometer and it was lowest among componeers i.e. 0.07920±0.0113 micrometer. ANOVA test was applied to find significant difference between groups. There was statistically highly significant difference found in Surface Roughness (Micrometer) among group I (Componeers), II (Veneers) & III(Laminates). (P=0.001)

**Table 1(a): Tukey's Post Hoc Analysis for inter group Comparison of Surface Roughness.**

| Groups | Mean Difference in Surface Roughness | Significance 'P' Value |
|---|---|---|
| Group I vs II | -0.226800 | 0.001(HS) |
| Group I vs III | -0.329400 | 0.001(HS) |
| Group II vs III | -0.102600 | 0.001(HS) |

**Table 1(a) reveals Tukey's Post Hoc Analysis for inter group Comparison of Surface Roughness. Mean difference in surface roughness was found -0.226800, -0.329400&-0.102600 between Group I vs II, Group I vs III, &Group II vs III respectively.**

**Table 2: Comparative evaluation of Micro-Hardness (VHN) among group I (Componeers), II(Veneers) & III(Laminates).**

| Groups | Restorative Material | Number | Micro-Hardness (VHN) | |
|---|---|---|---|---|
| | | | MEAN | SD |
| Group I | Componeers | 20 | 82.370 | 6.9385 |
| Group II | Veneers | 20 | 349.110 | 16.5706 |
| Group III | Laminates | 20 | 91.170 | 5.4981 |
| TOTAL | | | 174.217 | 125.2192 |
| ANOVA 'F' Value | | | 3903.022 | |
| Significance 'P' Value | | | 0.001(HS) | |

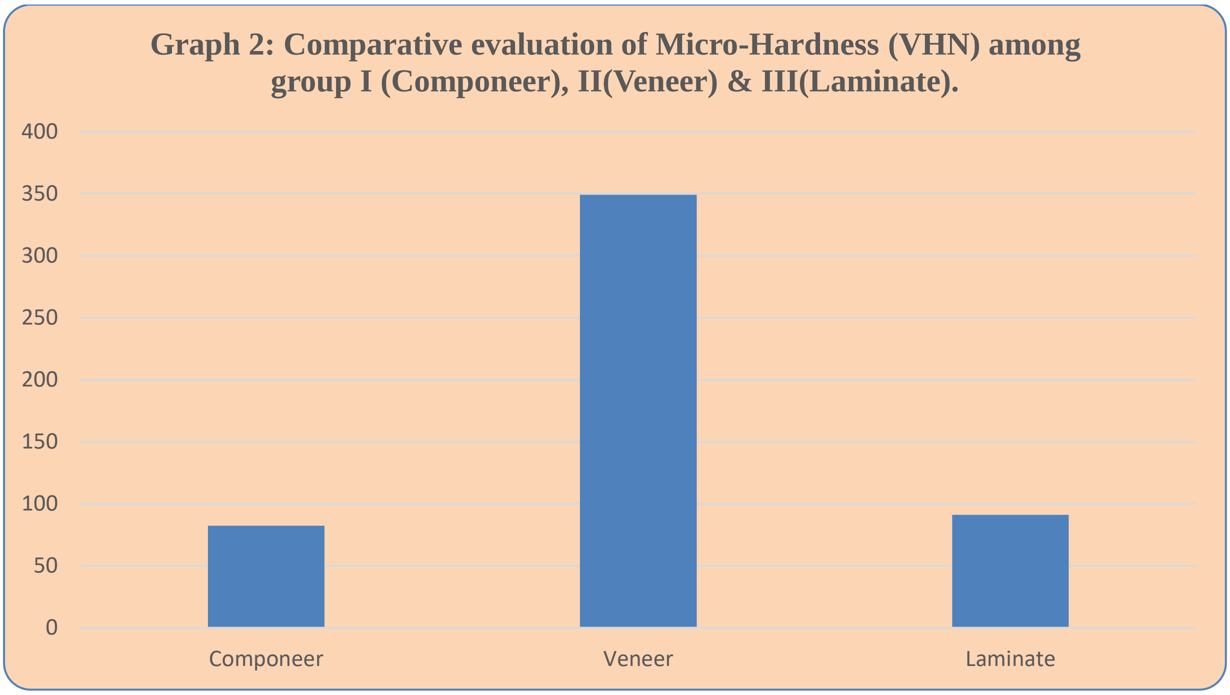



Table 2/figure 2 reveals Comparative evaluation of **Micro-Hardness (VHN)** among group I (Componeers), II (Veneers) & III(Laminates). Mean **Micro-Hardness (VHN)**were found highest in **Veneers** i.e. **349.110±16.570VHN** and it was lowest among componeers i.e. **82.370±6.9385VHN**. ANOVA test was applied to find significant difference between groups. There was statistically highly significant difference found in **Micro-Hardness (VHN)**among group I (Componeers), II (Veneers) & III(Laminates). **(P=0.001)**

**Table 2(a): Tukey's Post Hoc Analysis for inter group Comparison of Micro-Hardness (VHN).**

| Groups | Mean Difference in Micro-Hardness (VHN) | Significance 'P' Value |
|---|---|---|
| Group I vs II | -266.7400 | 0.001(HS) |
| Group I vs III | -8.8000 | 0.034(S) |
| Group II vs III | 257.9400 | 0.001(HS) |

**Table 2(a) reveals Tukey's Post Hoc Analysis for inter group Comparison of Micro-Hardness (VHN). Mean difference in Micro-Hardness (VHN)was found -266.7400, -8.8000&-257.9400between Group I vs II, Group I vs III, & Group II vs III respectively.**

**Table 3: Comparative evaluation of Surface Roughness (Micrometer) among Subgroup I, II, III, IV, V of Group I(Componeers)**

| Groups | Immersing Solution | Number | Surface Roughness (Micrometer) | |
|---|---|---|---|---|
| | | | MEAN | SD |
| Subgroup I | Control | 4 | 0.07000 | .001155 |
| Subgroup II | Coca-cola | 4 | 0.07100 | .003464 |
| Subgroup III | Coffee | 4 | 0.09400 | .004619 |
| Subgroup IV | Redbull | 4 | 0.09050 | .004041 |
| Subgroup V | Amul milk | 4 | 0.07050 | .000577 |
| TOTAL | | 20 | 0.07920 | .011358 |
| ANOVA 'F' Value | | | 55.938 | |
| Significance 'P' Value | | | 0.001(HS) | |

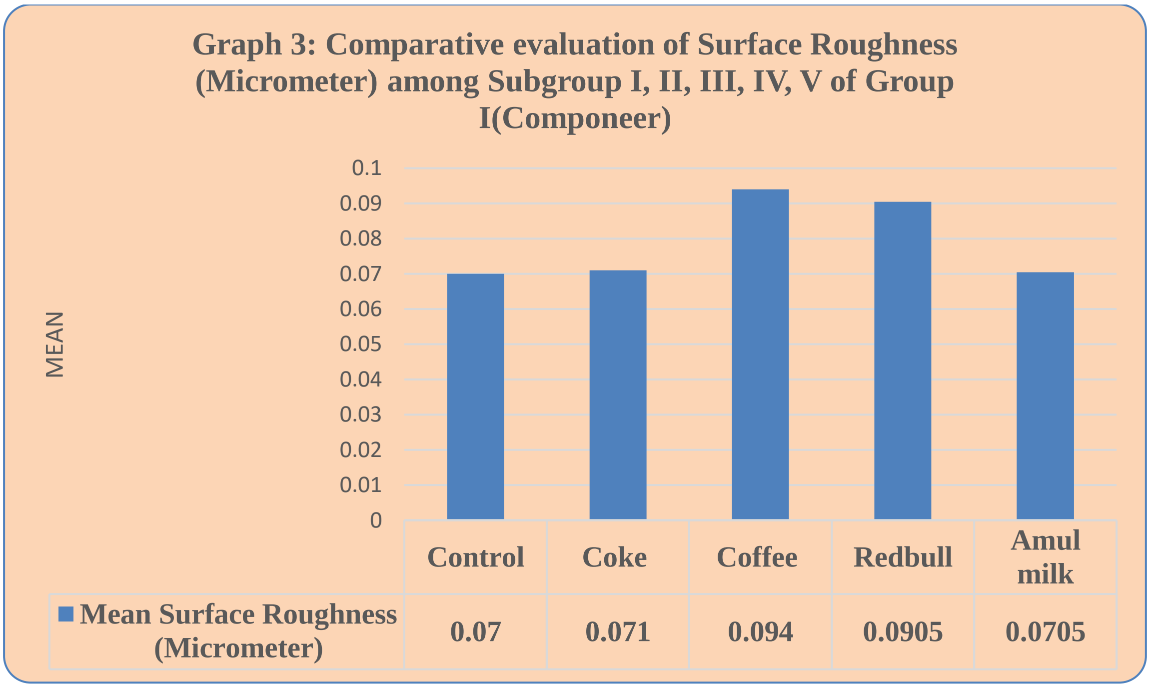



Table 3/figure 3 reveals Comparative evaluation of Surface Roughness (Micrometer) among Subgroup I, II, III, IV, V of Group I(Componeers). 20 samples of group I componeers were immersed in 5 different immersing solutions. Mean surface roughness were found highest among subgroup III( Coffee) and lowest among subgroup V(Amul Milk). It was

0.09400±0.004619&0.07050±0.000577 micrometer among subgroup III(Coffee) & Subgroup V(Amul Milk) respectively. There was statistically highly significant difference found in Surface Roughness (Micrometer) among Subgroup I, II, III, IV, V. (P=0.001)

**Table 3(a): Tukey's Post Hoc Analysis for inter subgroup Comparison of Surface Roughness.**

| Sub-Groups | Mean Difference in Surface Roughness | Significance 'P' Value |
|---|---|---|
| **Subgroup I vs II** | **-.001000** | **0.991(NS)** |
| **Subgroup I vs III** | **-.024000*** | **0.001(HS)** |
| **Subgroup I vs IV** | **-.020500*** | **0.001(HS)** |
| **Subgroup I vs V** | **-.000500** | **0.999(NS)** |
| **Subgroup II vs III** | **-.023000*** | **0.001(HS)** |
| **Subgroup II vs IV** | **-.019500*** | **0.001(HS)** |
| **Subgroup II vs V** | **.000500** | **0.999(NS)** |
| **Subgroup III vs IV** | **.003500** | **0.551(NS)** |
| **Subgroup III vs V** | **.023500*** | **0.001(HS)** |
| **Subgroup IV vs V** | **.020000*** | **0.001(HS)** |

**Table 3(a) reveals Tukey's Post Hoc Analysis for inter subgroup Comparison of Surface Roughness. There was statistically highly significant difference found in Surface Roughness between subgroups except subgroup I vs II, I vs V, III vs IV.**

**Table 4: Comparative evaluation of Micro-Hardness (VHN) among Subgroup I, II, III, IV, V of Group I (Componeers)**

| Groups | Immersing Solution | Number | Micro-Hardness (VHN) | |
|---|---|---|---|---|
| | | | MEAN | SD |
| Subgroup I | Control | 4 | 86.700 | .3464 |
| Subgroup II | Coca-cola | 4 | 80.500 | 5.1962 |
| Subgroup III | Coffee | 4 | 87.000 | 5.7735 |
| Subgroup IV | Redbull | 4 | 71.650 | 3.7528 |
| Subgroup V | Amul milk | 4 | 86.000 | 1.1547 |
| TOTAL | | 20 | 82.370 | 6.9385 |
| ANOVA 'F' Value | | | 11.321 | |
| Significance 'P' Value | | | 0.001(HS) | |

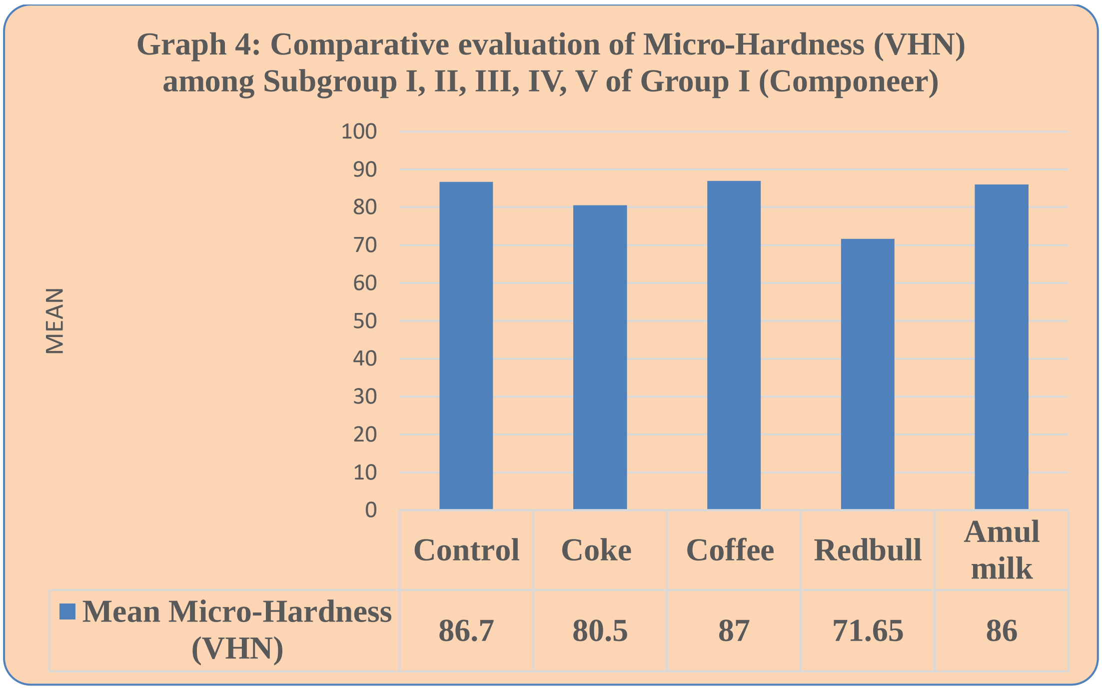



Table 4/figure 4 reveals Comparative evaluation of **Micro-Hardness (VHN)** among Subgroup I, II, III, IV, V of Group I(Componeers). 20 samples of group I componeers were immersed in 5 different immersing solutions. Mean **Micro-Hardness (VHN)** was found highest among subgroup III( Coffee) and lowest among subgroup IV(Redbull). It was **87.000±5.77&71.650±3.752** VHN among subgroup III(Coffee) & Subgroup IV(Redbull)respectively. There was statistically highly significant difference found in **Micro-Hardness (VHN)** among Subgroup I, II, III, IV, V. (P=0.001)

**Table 4(a): Tukey's Post Hoc Analysis for inter group Comparison of Micro-Hardness (VHN).**

| Sub-Groups | Mean Difference in Micro-Hardness (VHN) | Significance 'P' Value |
|---|---|---|
| Subgroup I vs II | 6.2000 | 0.214(NS) |
| Subgroup I vs III | -.3000 | 1.000(NS) |
| Subgroup I vs IV | 15.0500* | 0.001(HS) |
| Subgroup I vs V | .7000 | 0.999(NS) |
| Subgroup II vs III | -6.5000 | 0.180(NS) |
| Subgroup II vs IV | 8.8500* | 0.040(S) |
| Subgroup II vs V | -5.5000 | 0.314(NS) |
| Subgroup III vs IV | 15.3500* | 0.001(HS) |
| Subgroup III vs V | 1.0000 | 0.996(NS) |
| Subgroup IV vs V | 14.3500 | 0.001(HS) |

**Table 4(a) reveals Tukey's Post Hoc Analysis for inter subgroup Comparison of Surface Roughness. There was statistically highly significant difference found in Surface Roughness between subgroups except subgroup I vs II, I vs III, I vs V, II vs III. II vs V & III vs V.**

**Table 5: Comparative evaluation of Surface Roughness (Micrometer) among Subgroup I, II, III, IV, V of Group II(Veneers)**

| Groups | Immersing Solution | Number | Surface Roughness (Micrometer) | |
|---|---|---|---|---|
| | | | MEAN | SD |
| Subgroup I | Control | 4 | 0.33500 | .005774 |
| Subgroup II | Coca-cola | 4 | 0.21150 | .004041 |
| Subgroup III | Coffee | 4 | 0.30250 | .006351 |
| Subgroup IV | Redbull | 4 | 0.34250 | .006351 |
| Subgroup V | Amul milk | 4 | 0.33850 | .007506 |
| TOTAL | | 20 | 0.30600 | .050912 |
| ANOVA 'F' Value | | | 326.036 | |
| Significance 'P' Value | | | 0.001(HS) | |

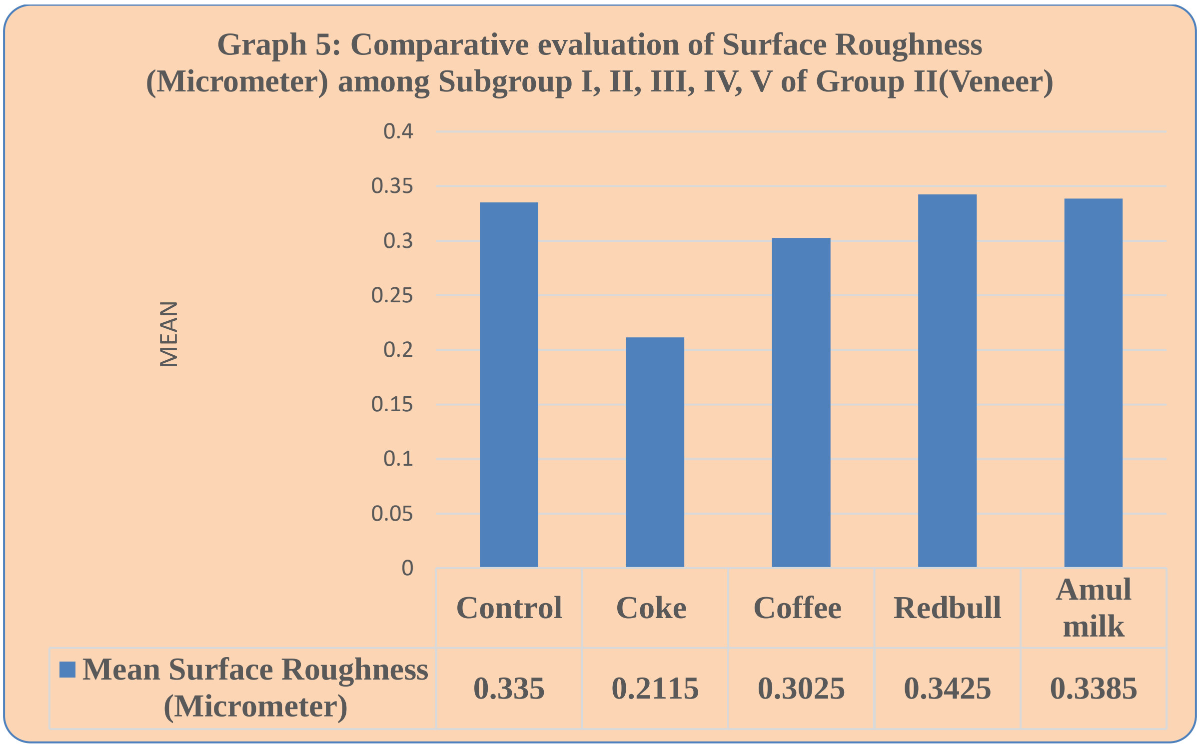



Table 5/figure 5 reveals Comparative evaluation of Surface Roughness (Micrometer) among Subgroup I, II, III, IV, V of Group II(Veneers). 20 samples of Group II(Veneers)were immersed in 5 different immersing solutions. Mean surface roughness were found highest among subgroup IV(Red bull) and lowest among subgroup II (Coca-cola). It was **0.34250**±0.**006351**&**0.21150**±0.**004041** micrometer among subgroup IV (Red bull)& Subgroup II (Coca-cola). respectively. There was statistically highly significant difference found in Surface Roughness (Micrometer) among Subgroup I, II, III, IV, V. (P=0.001)

**Table 5(a): Tukey's Post Hoc Analysis for inter group Comparison of Surface Roughness.**

| Sub-Groups | Mean Difference in Surface Roughness | Significance 'P' Value |
|---|---|---|
| Subgroup I vs II | .123500* | 0.001(HS) |
| Subgroup I vs III | .032500* | 0.001(HS) |
| Subgroup I vs IV | -.007500 | 0.443(NS) |
| Subgroup I vs V | -.003500 | 0.923(NS) |
| Subgroup II vs III | -.091000* | 0.001(HS) |
| Subgroup II vs IV | -.131000* | 0.001(HS) |
| Subgroup II vs V | -.127000* | 0.001(HS) |
| Subgroup III vs IV | -.040000* | 0.001(HS) |
| Subgroup III vs V | -.036000* | 0.001(HS) |
| Subgroup IV vs V | .004000 | 0.883(NS) |

**Table 5(a) reveals Tukey's Post Hoc Analysis for inter subgroup Comparison of Surface Roughness. There was statistically highly significant difference found in Surface Roughness between subgroups except subgroup I vs IV, I vs V, IV vs V.**

**Table 6: Comparative evaluation of Micro-Hardness (VHN) among Subgroup I, II, III, IV, V of Group II (Veneers)**

| Groups | Immersing Solution | Number | Micro-Hardness (VHN) | |
|---|---|---|---|---|
| | | | MEAN | SD |
| Subgroup I | Control | 4 | 366.500 | 1.7321 |
| Subgroup II | Coca-cola | 4 | 327.400 | 8.5448 |
| Subgroup III | Coffee | 4 | 343.850 | 12.5285 |
| Subgroup IV | Redbull | 4 | 342.300 | 3.8105 |
| Subgroup V | Amul milk | 4 | 365.500 | 1.7321 |
| TOTAL | | 20 | 349.110 | 16.5706 |
| ANOVA 'F' Value | | | 22.284 | |
| Significance 'P' Value | | | 0.001(HS) | |

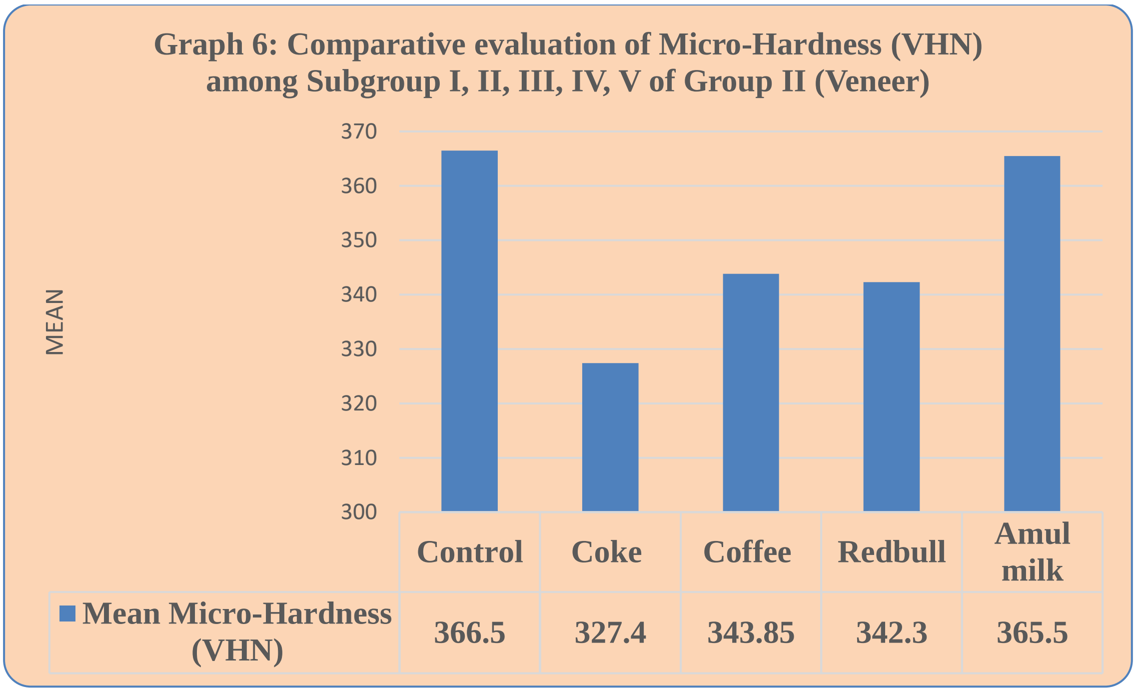



Table 6/figure 6 reveals Comparative evaluation of **Micro-Hardness (VHN)** among Subgroup I, II, III, IV, V of **Group II (Veneers**). 20 samples of **Group II (Veneers)**were immersed in 5 different immersing solutions. Mean **Micro-Hardness (VHN)** was found highest among subgroup V( Amul milk) after control and lowest among subgroup II(Coca-cola). It was **365.500±1.7321&327.400±8.5448**VHN among subgroup V(Amul milk)&subgroup II(Coca-cola) respectively. There was statistically highly significant difference found in **Micro-Hardness (VHN)** among Subgroup I, II, III, IV, V. (P=0.001)

**Table 6(a): Tukey's Post Hoc Analysis for inter group Comparison of Micro-Hardness (VHN).**

| Sub-Groups | Mean Difference in Micro-Hardness (VHN) | Significance 'P' Value |
|---|---|---|
| Subgroup I vs II | 39.1000* | 0.001(HS) |
| Subgroup I vs III | 22.6500* | 0.003(HS) |
| Subgroup I vs IV | 24.2000* | 0.002(HS) |
| Subgroup I vs V | 1.0000 | 1.000(NS) |
| Subgroup II vs III | -16.4500* | 0.034(S) |
| Subgroup II vs IV | -14.9000 | 0.061(NS) |
| Subgroup II vs V | -38.1000* | 0.001(HS) |
| Subgroup III vs IV | 1.5500 | 0.998(NS) |
| Subgroup III vs V | -21.6500* | 0.005(HS) |
| Subgroup IV vs V | -23.2000 | 0.003(HS) |

**Table 6(a) reveals Tukey's Post Hoc Analysis for inter subgroup Comparison of Surface Roughness. There was statistically highly significant difference found in Surface Roughness between subgroups except subgroup I vs V, II vs III. II vs IV & III vs IV.**

**Table 7: Comparative evaluation of Surface Roughness (Micrometer) among Subgroup I, II, III, IV, V of Group III (Laminates)**

| Groups | Immersing Solution | Number | Surface Roughness (Micrometer) | |
|---|---|---|---|---|
| | | | MEAN | SD |
| Subgroup I | Control | 4 | 0.48000 | .011547 |
| Subgroup II | Coca-cola | 4 | 0.58050 | .004041 |
| Subgroup III | Coffee | 4 | 0.35550 | .038682 |
| Subgroup IV | Redbull | 4 | 0.14650 | .005196 |
| Subgroup V | Amul milk | 4 | 0.48050 | .000577 |
| TOTAL | | 20 | 0.40860 | .153957 |
| ANOVA 'F' Value | | | 332.669 | |
| Significance 'P' Value | | | 0.001(HS) | |

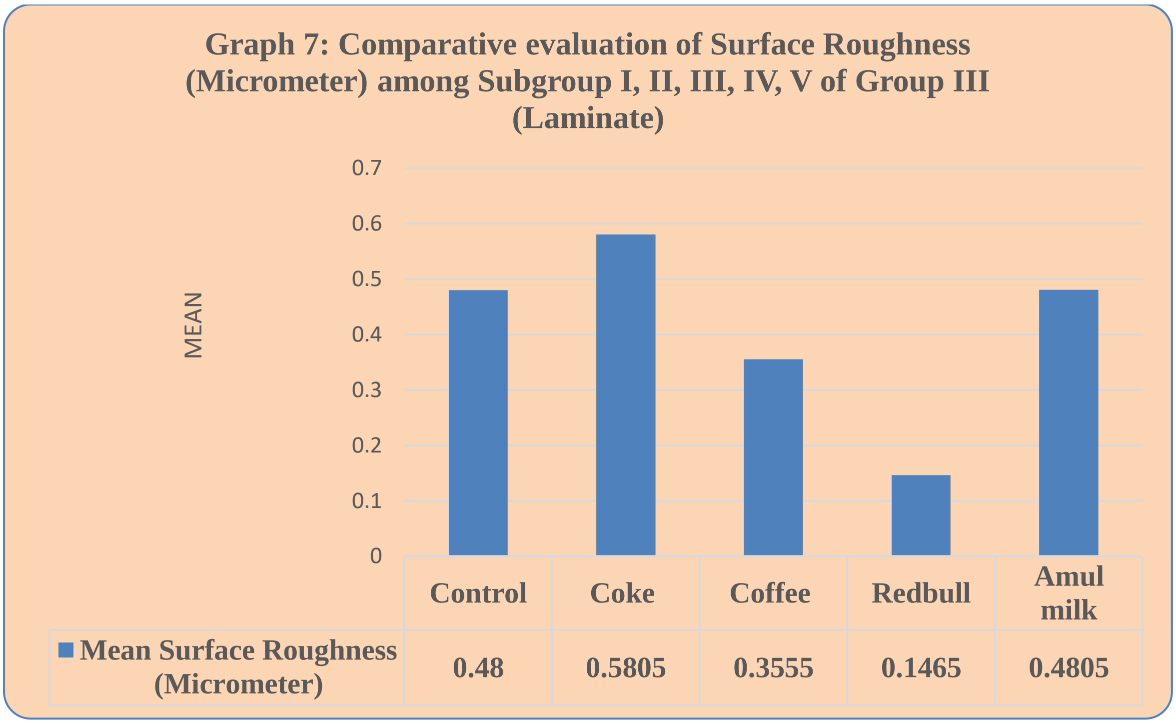



Table 7/figure 7 reveals Comparative evaluation of Surface Roughness (Micrometer) among Subgroup I, II, III, IV, V of **Group III (Laminates)**. 20 samples of **Group III (Laminates)**were immersed in 5 different immersing solutions. Mean surface roughness were found highest among subgroup II(Coca-cola) and lowest among subgroupIV(Red Bull). It was **0.58050±.004041**&**0.14650±.005196**micrometer among subgroup II (Coca-cola) &subgroup IV (Red Bull). respectively. There was statistically highly significant difference found in Surface Roughness (Micrometer) among Subgroup I, II, III, IV, V. (P=0.001)

**Table 7(a): Tukey's Post Hoc Analysis for inter group Comparison of Surface Roughness.**

| Sub-Groups | Mean Difference in Surface Roughness | Significance 'P' Value |
|---|---|---|
| **Subgroup I vs II** | **-0.100500*** | **. 0.001(HS)** |
| **Subgroup I vs III** | **0.124500*** | **0.001(HS)** |
| **Subgroup I vs IV** | **0.333500*** | **. 0.001(HS)** |
| **Subgroup I vs V** | **-0.000500** | 1.000(NS) |
| **Subgroup II vs III** | **0.225000*** | **0.001(HS)** |
| **Subgroup II vs IV** | **0.434000*** | **0.001(HS)** |
| **Subgroup II vs V** | **0.100000*** | **. 0.001(HS)** |
| **Subgroup III vs IV** | **0.209000*** | **. 0.001(HS)** |
| **Subgroup III vs V** | **-0.125000*** | **0.001(HS)** |
| **Subgroup IV vs V** | **-0.334000** | **. 0.001(HS)** |

**Table 7(a) reveals Tukey's Post Hoc Analysis for inter subgroup Comparison of Surface Roughness. There was statistically highly significant difference found in Surface Roughness between subgroups except subgroup I vs V**

**Table 8: Comparative evaluation of Micro-Hardness (VHN) among Subgroup I, II, III, IV, V of Group III (Laminates)**

| Groups | Immersing Solution | Number | Micro-Hardness (VHN) | |
|---|---|---|---|---|
| | | | MEAN | SD |
| Subgroup I | Control | 4 | 96.500 | .5774 |
| Subgroup II | Coca-cola | 4 | 83.800 | 5.0807 |
| Subgroup III | Coffee | 4 | 91.450 | 2.5981 |
| Subgroup IV | Redbull | 4 | 88.500 | 3.4641 |
| Subgroup V | Amul milk | 4 | 95.600 | .6928 |
| TOTAL | | 20 | 91.170 | 5.4981 |
| ANOVA 'F' Value | | | 12.072 | |
| Significance 'P' Value | | | 0.001(HS) | |

**Figure 8: Comparative evaluation of Micro-Hardness (VHN) among Subgroup I, II, III, IV, V of Group III (Laminate)**

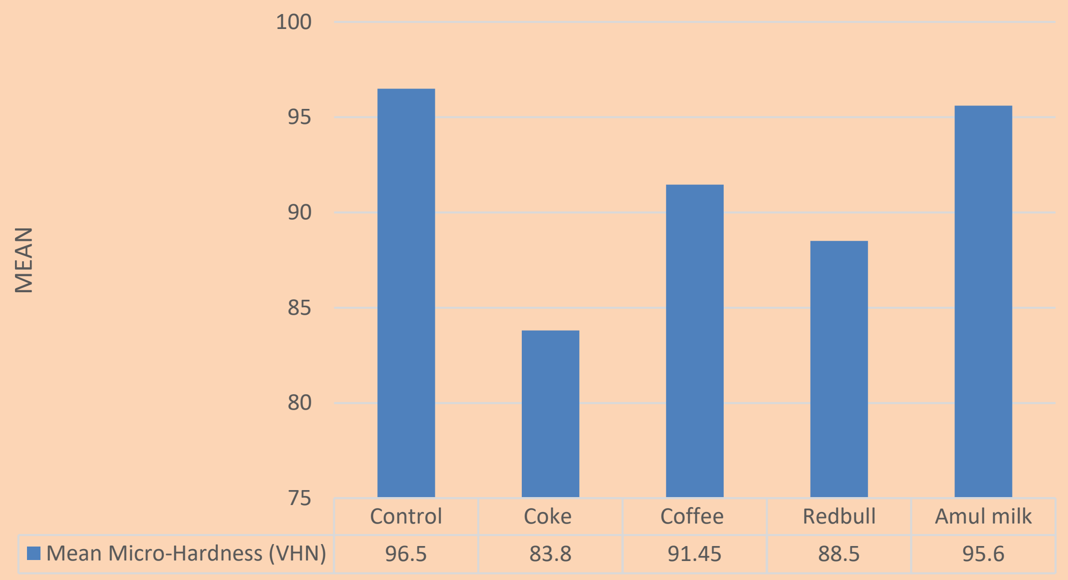



Table 8/figure 8 reveals Comparative evaluation of **Micro-Hardness (VHN)** among Subgroup I, II, III, IV, V of **Group III (Laminates)**. 20 samples of **Group III (Laminates)**were immersed in 5 different immersing solutions. Mean **Micro-Hardness (VHN)** was found highest among subgroup V(Amul milk) after control and lowest among subgroup II(Coca-cola). It was **95.600±.6928&83.800±5.0807**VHN among subgroup V (Amul milk)&subgroup II (Coca-cola) respectively. There was statistically highly significant difference found in **Micro-Hardness (VHN)** among Subgroup I, II, III, IV, V. (P=0.001)

**Table 8(a): Tukey's Post Hoc Analysis for inter group Comparison of Micro-Hardness (VHN).**

| Sub-Groups | Mean Difference in Micro-Hardness (VHN) | Significance 'P' Value |
|---|---|---|
| Subgroup I vs II | 12.7000* | 0.001(HS) |
| Subgroup I vs III | 5.0500 | 0.177(NS) |
| Subgroup I vs IV | 8.0000* | 0.014(S) |
| Subgroup I vs V | .9000 | 0.993(NS) |
| Subgroup II vs III | -7.6500* | 0.019(S) |
| Subgroup II vs IV | -4.7000 | 0.230(NS) |
| Subgroup II vs V | -11.8000* | 0.001(HS) |
| Subgroup III vs IV | 2.9500 | 0.646(NS) |
| Subgroup III vs V | -4.1500 | 0.336(NS) |
| Subgroup IV vs V | -7.1000* | 0.032(NS) |

**Table 8(a) reveals Tukey's Post Hoc Analysis for inter subgroup Comparison of Surface Roughness. There was statistically highly significant difference found in Surface Roughness between subgroups except subgroup I vs III, I vs V. II vs IV & III vs IV, III vs V, IV vs V.**

# DISCUSSION

The present in-vitro study was conducted in the Department of Conservative Dentistry and Endodontics, Babu Banarasi Das College of Dental Sciences, Lucknow in collaboration with Praj metallurgical laboratory, Pune.

The present study was aimed to determine the effect of various beverages on the surface hardness and abrasiveness of Componeers, Veneers and Laminates.

A plethora of treatment options have been described to resolve the esthetic concerns of patients, which include several procedures. [(50)]As Componeers, Veneers and Laminates are at the forefront of current restorative procedure protocols in conservative dentistry for anterior tooth, these materials were chosen for the study.

Zirconia veneers comprise a conservative and highly esthetic treatment that also offer high predictability and good clinical performance in the long term. [(51)] Several ceramic materials are currently indicated for veneers: lithium disilicate, feldspathic ceramic, feldspathic reinforced with leucite, fluorapatite, and lithium silicate reinforced with zirconia. [(51)]

Componeers consists of resin material which is similar to the composite resins that are usedin dentistry. They are manufactured from nanohybrid composites which ensure excellenthomogenity and stability of the enamel shells. These are extremely thin (dimensions of0.3mm cervically and 0.6mm incisally) veneers, thus they require minimal tooth preparationand at the same time, they also give a natural appearance to the teeth. [(55)]

In this study, 60 human maxillary central incisors were taken into consideration after accomplishing the inclusion and exclusion criteria. Maxillary central incisors were chosen because the highest esthetic concerns are expressed for anterior teeth. The size and form of the maxillary anterior teeth are important not only to dental esthetics but also to facial esthetics. [(54)]

During consumption of food or drinks, the teeth or the restorations come in contact with food/drinks only for a short period of time before it gets washed away with saliva. However, to the best of our knowledge, in previous studies, substrates usually had contact with acidic food or drink for a prolonged period of time and the situation did not account for the role of saliva.

Therefore, in the present study, the restorative materials were immersed in various drinks for 2 min a day and then they were stored in distilled water for the rest of the day. Distilled water was used instead of artificial saliva because the artificial saliva storage medium is not considered to be a more clinically relevant environment. Moreover, according to a study by Turssi, et al 2002(61)they evaluated the influence of storage media on the micromorphology of resin-based materials and it was concluded that the distilled water and artificial saliva storage media showed similar results.

Since caffeinated beverages, aerated beverages and milk based beverages are the most commonly consumed beverages by the Indian population(62,63,64), this study focuses to evaluate the effect of short- term immersion in these beverages and their effect on surface hardness and abrasiveness of Componeers, Veneers and Laminates.

The present results reveal that there was a statistically highly significant difference found in the surface hardness and surface abrasiveness among Componeers, Veneers and Laminates where the mean micro-hardness VHN was found to be highest in Zirconia Veneers i.e. 349.110±16.570VHN.

One of the reason for highest surface hardness of Zirconia Veneers was because of its phase transformation toughening (PTT) mechanism that prevented crack propagation in the material(66). Under the effect of mechanical, thermal and/or combined stresses, the adsorbed energy breaks part of the atomic bonds of its polycrystalline structure and transforms tetragonal crystals to a stabler monoclinic phase at the crack tip and around the crack by localized compressive stresses. This shows a contemporary 4–5% increase in crystals volume, thereby creating significant compressive stresses within the material.(66) According to Fernando et al(66), Surface finishing technique did not influence the mechanical performance and neither did the cementation technique.

On the contrary, fracture resistance has been reported to be significantly influenced by preparation design and low temperature degradation(LTD). The LTD is a multifactorial phenomenon affected by several variables like crystal dimension, temperature, surface defects, manufacturing techniques, percentage and distribution of stabilizing oxides, mechanical stress and wetness.(67)Out of these factors, mechanical stress and wetness are known to significantly accelerate zirconia aging.(67) Although aging is considered a risk factor for mechanical failure, till date no univocal correlation has been evidenced between this phenomenon and the failures affecting zirconia during clinical service. Also, LTD is known to cause worsening of zirconia characteristics, contributing to the onset of micro-cracks, toughness reduction, increased wear, roughening and plaque accumulation, till a surface degradation, affecting both mechanical and optical properties.It was inferred that the material and geometrical characteristics are crucial to optimize longevity of zirconia restorations.[68]

In the present study, the Componeer and Composite Laminates showed similar Vicker's Hardness number even with different composition and manufacturing mechanisms. Hardness is defined as the resistance to surface indentation and can be used as an indirect method for measuring the degree of polymerisation. The hardness of a material is extremely influenced by their composition[69]. The most common scientific classification used for resin composite is related to the inorganic size. These materials can be classified as microfilled, microhybrid and nanocomposites (i.e., nanofill or nanohybrid) according to the filler size[69,70] . Microhybrid composites usually show higher hardness in comparison to nanofilled and microfilled resin, since materials with high inorganic filler size tend to exhibit higher mechanical properties. In this study, componeers and composite laminates show similar inorganic content, which explains the Vicker's hardness values observed.

Surface abrasiveness is affected by toothbrush design, brushing frequency, brushing pressure and abrasivity of dentifrice. In the present study, the mean surface roughness was found highest in laminates i.e., 0.40860±0.153 micrometer and it was lowest among componeersi.e. 0.07920±0.0113 micrometer.

According to Jones et al., Wear was defined as a progressive loss of substance from the surface of a body as a result of mechanical action. Like erosion, wear can cause changes in the surface condition of restorative materials and can compromise marginal adaptation. Even though toothbrushing is the most effective method to control bacterial biofilm, its action can cause degradation of dental tissues as well as restorative materials.[72]

Other studies have shown that composite resins with an organic matrix based on high molecular weight monomers such as Bis-GMA are more resistant and harder to remove by abrasive procedures, exfoliating a smaller number of inorganic particles. [70,71,72]

A number of studies have concluded that due to the shorter distance between the particles and the presence of small filler particles, the material has low wear resistance.[71]

This idea is also supported by the results of other studies like Condon et al., Sulong et al. and Suzuki et al., which argue that small particles give the matrix low wear resistance. On the other hand, Hashemikamangar*et al*. argues that flowable composite resins are less resistant to wear compared to higher viscosity resins.

In another study by Wick et al, it was reported that there was no correlation between the surface roughness obtained after the finishing and polishing procedures and the final wear of resin-based materials.

Data from the literature considered that the degradation of composite resins is caused by the chemical degradation of polymers following the penetration of water into its structure and the consequent release of oligomers and monomers through the pores created by mechanical wear.

It was found that, initially, there is a superficial degradation of the polymer, and later the surface roughness increases by the appearance of cracks due to increased osmotic pressure at the interface between the organic matrix and filler particles, respectively. These results are inconsistent with those obtained in the study conducted by Carvahlo et al. in which soft bristles created a rougher surface due to the ability of soft bristles to hold toothpaste better and the flexibility of the filaments, which ensures a larger contact area between toothbrushes or toothpaste and restorative materials. From a clinical point of view, the increase of the surface roughness of restoration materials will reduce wear resistance and increase the accumulation of bacterial biofilm, leading to secondary caries or impaired aesthetics.

Coca-Cola is a popular soft drink with the lowest pH among the beverages in the present study. After immersing the specimens in the beverages, Coca-Cola produced significantly rough surfaces. It has been reported that a low pH in acidic food and drink induces erosive wear in materials. Although Coca-Cola is the lowest titratable acidity, but Coca-Cola is a carbonate beverage containing carbonic acid and phosphoric acid which promotes dissolution and easily eroded the materials. The erosive potential of an acid drink is not exclusively dependent on its pH, but is also strongly influenced by its titratable acid content in beverages. The pH values present only a measure of the free hydrogen ion concentration. It does not present the hydrogen ion remaining in the undissociated form. Thus, the potential degradation of acidic agents should be considered for both the pH value and titratable acidity.(77)

The influence of the acidity increasingly dissolves the matrix, along with any unstable glass particles in a low pH value drink. High acidity might have a greater softening effect on the resin matrix, thus promoting the dislodgement and leaching out of filler particles and reducing the load resistance of restorative materials. In comparison to componeers and laminates, zirconia veneers was found to be less affected by low pH beverages or acid solution.[78]

Carbonated beverages contain carbonic acid formed by carbon dioxide in solution, i.e. “carbonated”. These beverages also contain inorganic acids such as phosphoric acid to stimulate taste and counteract sweetness. Carbonated and non-carbonated beverages such as fruit-flavored or high sugar concentration drinks consist of organic acids such as citric (orange), tartaric (grape), maleic (apple) and ascorbic (vitamin C) all of which can contribute to the beverage acidity, but can be used as modifying or “buffering” and flavoring agents. Carbonated beverages start with a low pH, but have been found not to require as much titration using sodium hydroxide (NaOH) as do non-carbonated or fruit-based drinks containing multiple refined carbohydrates (sugars).Generally, the more titration required, the higher the buffering capacity, with a corresponding increase of erosion potential of dental enamel. Research by Edwards et al. and Wongkhantee et al. that tested the titratable acidity of different beverages verified the results of the present study. The titratable acidity or buffering capacity of Red Bull was significantly higher than the carbonated beverages or coffee drinks indicating an increased potential for erosion of enamel to occur. [79]

Beverages with a strong buffering capacity can also interfere with natural salivary buffering effects, or competition with saliva, on these beverages.Red Bull drink which revealed significant surface roughness values contain sucrose and glucose compounds that have been shown to cause a substantial reduction in plaque pH, production of acids, and in turn surface erosion of enamel (hydroxyapatite). Research has reported that beverages containing citric acid have shown an increased potential for the dissolution of hydroxyapatite due to the formation of calcium citrate and the chelating (calcium binding) action of citric acid that withdraws Ca ions from the beverage, resulting in an increased dissolution tendency due to loss of common ion effect. Red Bull high-energy drink contains sodium citrate (sodium salt of citric acid), a buffering agent which is thought to aid in maintaining the pH levels in soft drinks; however, is also sequestering agent that binds to calcium. Red Bull contains calcium-pantothenate and several other additives (glucuronolactone, inositol, pyridoxine HCL).[80] The addition of calcium is presumably to account for earlier depletion during attraction to the citrate compound. The remaining additives are B-complex vitamins, all of which could negatively impact the erosion potential of enamel, although evidence supporting this conclusion could not be verified by the current literature. It is the authors’ supposition that the high degree of enamel dissolution noted in the present study associated with sports and high-energy drinks is primarily caused by the addition of high concentrations of refined carbohydrates (sucrose, glucose) that promotes acid production. Citric acids and/or citrates are added as buffering and flavoring agents, although these additions can concurrently bind to calcium, promoting increased titratable acidity levels. In turn, calcium and phosphates are added to compensate for this loss of calcium.(81)

The results of this present study showed that microhardness decreased from the 1st week until the end of the 28 days period of immersion in coffee. Although the pH of coffee is nearly 7, coffee is composed of water, and the effect of water uptake can degrade polymer materials.

When polymer materials absorb water, coupling agents cause hydrolysis and loss of chemical bond between filler particles and the resin matrix. Filler particles dislodge from the outer surface of the material causing surface roughness and decreasing hardness. The effect upon the resin matrix and the degradation of the resin-filler interface and inorganic fillers may also play a role in the reduction of surface hardness.(80) This may explain why Componeers and Laminates, which contains silica/barium glass, shows hardness decrements when exposed to beverages. Factors which influenced water absorption of polymer-based materials included the types of resin. A hydrophobic resin like hydroxyethylmethacrylate absorbs more water than one like bis-GMA. Filler loading may affect the water absorption of materials, with higher filler loading expecting to show a lower uptake. The last factor which influences water absorption of polymer-based tooth-color filling materials is the presence of voids during the mixing or production of these materials.(82)

Pereira et al. broke down the contents of milk based beverages. It contained 1200 mg of calcium per liter. One glass of cow milk (245 g) contained 119–124 mg of calcium that fulfills 37–40% of the body’s calcium requirement. Cow milk is also a good phosphate source and thus reduced changes in surface hardness and abrasiveness can be attributed to its high phosphate content and low acidic content. (82)

# CONCLUSION

Within the limitations of this in vitro study, it may be concluded that all tested beverages influenced the Vickers microhardness and surface abrasiveness of tested restorative materials. The results of our study have shown substantial differentiation of mechanical properties of the materials used in conservative dentistry nowadays, depending on different conditioning environments. The results can influence the choice of the material used by a dentist, after taking into account the patient's eating habits.

It can also be concluded that Zirconia Veneers are amongst the most versatile materials available for Esthetic treatment. Their strength is unrivalled for and it has been rightly termed "ceramic steel" as it's the strongest ceramic material around. They are highly durable and can last anywhere between 10 to 30 years with proper care.

However, further in-vivo studies are required to evaluate the mechanical properties of Zirconia Veneers in the oral cavity.

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# ANNEXURES

## ANNEXURE 1:

**Babu Banarasi Das University**
**Babu Banarasi Das College of Dental Sciences,**
**BBD City, Faizabad Road, Lucknow – 226028 (INDIA)**

**Dr. Lakshmi Bala**
Professor and Head Biochemistry and
Member-Secretary, Institutional Ethics Committee

**Communication of the Decision of the VIII$^{th}$ Institutional Ethics Sub-Committee**

**IEC Code: 03** **BBDCODS/03/2020**

**Title of the Project:** A Comparative Evaluation of Surface Hardness and Abrasivesness of Componeers, Veneers and Laminates: Influence of Commonly Consumed Beverages Immersion after A Short Term Period: An In-Vitro Study.

**Principal Investigator:** Dr. Aarushi Shekhar **Department:** Conservative Dentistry and Endodontics

**Name and Address of the Institution:** BBD College of Dental Sciences Lucknow.

**Type of Submission:** New, MDS Project Protocol

Dear Dr. Aarushi Shekhar,

The Institutional Ethics Sub-Committee meeting comprising following four members was held on 18$^{th}$ March, 2020.

| | | |
|---|---|---|
| 1. | Dr. Lakshmi Bala<br>Member Secretary | Prof. and Head, Department of Biochemistry, BBDCODS, Lucknow |
| 2. | Dr. Amrit Tandan<br>Member | Prof. & Head, Department of Prosthodontics and Crown & Bridge, BBDCODS, Lucknow |
| 3. | Dr. Sahana S.<br>Member | Reader, Department of Public Health Dentistry, BBDCODS, Lucknow |
| 4. | Dr. Sumalatha M.N.<br>Member | Reader, Department of Oral Medicine & Radiology, BBDCODS, Lucknow |

The committee reviewed and discussed your submitted documents of the current MDS Project Protocol in the meeting.

The comments were communicated to PI thereafter it was revised.

**Decisions: The committee approved the above protocol from ethics point of view.**

Forwarded by:

Lakshmi Bala
18/03/20

**(Dr. Lakshmi Bala)**
Member-Secretary
IEC

Member-Secretary
Institutional Ethic Committee
BBD College of Dental Sciences
BBD University
Faizabad Road, Lucknow-226028

**(Dr. B. Rajkumar)**
Principal
BBDCODS

PRINCIPAL
Babu Banarasi Das College of Dental Sciences
(Babu Banarasi Das University)
BBD City, Faizabad Road, Lucknow-226028

**ANNEXURE 2:**

**BABU BANARASI DAS COLLEGE OF DENTAL SCIENCES (FACULTY OF BBD UNIVERSITY), LUCKNOW**

**INSTITUTIONAL RESEARCH COMMITTEE APPROVAL**

The project titled **"A Comparative Evaluation of Surface Hardness and Abrasivesness of Componeers, Veneers and Laminates: Influence of Commonly Consumed Beverages Immersion after A Short Term Period: An In-Vitro Study"** submitted by **Dr Aarushi Shekhar** Post graduate student from the **Department of Conservative Dentistry and Endodontics** as part of MDS Curriculum for the academic year 2019-2022 with the accompanying proforma was reviewed by the Institutional Research Committee present on **19th December 2019** at BBDCODS.

The Committee has granted approval on the scientific content of the project. The proposal may now be reviewed by the Institutional Ethics Committee for granting ethical approval.

**Prof. Vandana A Pant**
Co-Chairperson

**Prof. B. Rajkumar**
Chairperson

**ANNEXURE 3:**

PRAJ
Metallurgical Laboratory

B-38, Indira Shankar Nagari,
Paud Road, Near Kothrud PMT Depo,
Kothrud, Pune - 411 038.
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DENTAL MATERIAL TEST FACILITY
MDS Thesis in various fields
i.e. Orthodontic, Prosthodontics, Endodontics, Periodontics, Oral Surgery, etc.

# TEST REPORT

Date: 27/01/2022

Name : **Dr. Aarushi Shekhar**
Name of the institute : Babu Banarasi Das College of Dental Sciences,Lucknow.
Subject of research : A comparative evaluation of surface Hardness and abrasiveness of Componeers,Veneers and laminates influence of commonly consumed beverages immersion after a short term period : An in vitro study.

**1.0 Surface roughness**

Machine specifications : Surface Roughness Tester, Mitutoyo, Japan. Model: SJ 210
Stylus Speed: 0.5mm/s, Cut off Length: 1.25 mm

| Sr. No. | Sample ID. | Surface Roughness, Ra (in µm) |
|---|---|---|
| 1 | Componeer_Control | 0.069 |
| 2 | Componeer_Coke | 0.068 |
| 3 | Componeer_Coffee | 0.090 |
| 4 | Componeer_Redbull | 0.087 |
| 5 | Veneer_Control | 0.330 |
| 6 | Veneer_Coke | 0.208 |
| 7 | Veneer_Coffee | 0.297 |
| 8 | Veneer_Redbull | 0.337 |
| 9 | Laminate_Control | 0.470 |
| 10 | Laminate_Coke | 0.577 |
| 11 | Laminate_Coffee | 0.322 |
| 12 | Laminate_Redbull | 0.142 |

1

## ANNEXURE 3:

PRAJ
Metallurgical Laboratory

B-38, Indira Shankar Nagari,
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Website: www.prajlab.com

DENTAL MATERIAL TEST FACILITY
MDS Thesis in various fields
i.e. Orthodontic, Prosthodontics, Endodontics, Periodontics, Oral Surgery, etc.

Date: 27/01/2022

**2.0 Microhardness**

Machine specifications : Microhardness Tester, Reichert Austria Make, Sr.No.363798, Load- 100 g, Reference Standard: ISO 6507

| Sr. No. | Sample ID. | Microhardness in HV |
|---|---|---|
| 1 | Componeer_Control | 86.4 |
| 2 | Componeer_Coke | 76.0 |
| 3 | Componeer_Coffee | 82.0 |
| 4 | Componeer_Redbull | 68.4 |
| 5 | Veneer_Control | 365 |
| 6 | Veneer_Coke | 320 |
| 7 | Veneer_Coffee | 333 |
| 8 | Veneer_Redbull | 339 |
| 9 | Laminate_Control | 96.0 |
| 10 | Laminate_Coke | 88.2 |
| 11 | Laminate_Coffee | 93.7 |
| 12 | Laminate_Redbull | 91.5 |

TEST CONDUCTED BY

SACHIN
TEST ENGINEER

A.M.BHAGAT
PROPRIETOR

PRAJ METALLURGICAL LABORATORY PUNE

2

**ANNEXURE 4:**

PRAJ
Metallurgical Laboratory
B-38, Indira Shankar Nagari,
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Website: www.prajlab.com

DENTAL MATERIAL TEST FACILITY
MDS Thesis in various fields
i.e. Orthodontic, Prosthodontics, Endodontics, Periodontics, Oral Surgery, etc.

Date: 27/01/2022

*TO WHOMSOEVER IT MAY CONCERN*

*This is to certify that Dr. Aarushi Shekhar, final year MDS, Babu Banarasi Das College of Dental Sciences, has done her comparison of surface hardness and abrasiveness of componeers, veneers and laminates from PRAJ Metallurgical Laboratory, Kothrud, Pune.*

TEST CONDUCTED BY

SACHIN
TEST ENGINEER

A.M.BHAGAT
PROPRIETOR

PRAJ METALLURGICAL LABORATORY PUNE

## ANNEXURE 5:

Curiginal

### Document Information

| | |
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### Sources included in the report

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| W | URL: https://www.slideshare.net/drrajatsachdeva/componeers-140574029<br>Fetched: 2020-04-30T16:15:37.6870000 | 1 |
| W | URL: https://www.slideshare.net/NaveedAnJum50/laminates-veneers-in-dentistry<br>Fetched: 2022-03-31T19:07:39.1470000 | 1 |
| W | URL: https://www.science.gov/topicpages/v/vickers+microhardness+vhn<br>Fetched: 2019-10-13T08:35:05.6030000 | 1 |
| W | URL: https://www.researchgate.net/publication/320412611_Evaluation_of_hardness_and_wear_of_surface_treated_zirconia_on_enamel_wear_An_in-vitro_study<br>Fetched: 2020-10-30T07:33:31.2800000 | 2 |
| W | URL: https://www.hindawi.com/journals/ijd/2016/8346782/<br>Fetched: 2020-12-11T13:04:42.1400000 | 1 |