Original Research Paper

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Dentistry

IMPACT ON SURFACE ROUGHNESS AND DESTAINING PROPERTY BY PH-SENSITIVE DENTURE CLEANSERS: AN IN-VITRO STUDY.

Sarjubala Nongthombam*	PG Student, Department of Prosthodontics, Crown and Bridge & Oral Implantology, J.N Kapoor DAV (C) Dental College, Yamunanagar. *Corresponding Author
Dr Aman Arora	Professor and HOD, Department of Prosthodontics, Crown and Bridge & Oral Implantology, J.N Kapoor DAV (C) Dental College, Yamunanagar.
Dr Monika	Associate Professor, Department of Prosthodontics, Crown and Bridge & Oral Implantology, J.N Kapoor DAV (C) Dental College, Yamunanagar.
Dr Viram Upadhyaya	Associate professor, Department of Prosthodontics, Crown and Bridge & Oral Implantology, J.N Kapoor DAV (C) Dental College, Yamunanagar.

ABSTRACT **Aim:** The aim of the study was to compare the cleansing efficiency of three denture cleansers with different pH on destaining property and surface roughness of heat cured denture base material. **Settings And Design:** In vitro-comparative study. **Materials And Methods:** A total of 45 specimens of heat cured denture base material were fabricated and subjected to baseline color and surface roughness measurements using spectrophotometer and surface profilometer respectively. Specimens were stained with turmeric and color measurements of stained specimens were made. All the stained specimens were divided into three groups for removal of stains with denture cleansers having different pH: Valclean(acidic), Polident(neutral), Clinsodent(basic) and colour and surface roughness measurements of cleansed specimens were made. The colour measurements (ΔE) and mean surface roughness measurements (Ra) values obtained were collected and statistically analysed. **Statistical Analysis Used:** One-way ANOVA and Post hoc Bonferroni test. **Results:** One way ANOVA test revealed that the mean colour difference of three groups were statistically different. A further post hoc Bonferroni test for color measurement revealed that Polident group had significantly lesser mean colour difference score. On the other hand ,the One-Way ANOVA test results for surface roughness measurement indicated a significant difference among the groups with p- value <0.05. The post hoc Bonferroni comparison of surface roughness revealed that Clinsodent group showed minimum surface roughness. **Conclusion:** It was concluded that Polident showed statistically significant greater cleansing efficiency followed by Clinsodent and Valclean. When comparing the surface roughness, highest surface roughness was observed in Polident followed by Valclean and Clinsodent.

KEYWORDS : Denture cleansers, heat cured denture resins, cleansing ability, surface roughness.

INTRODUCTION

Regardless of any material used for prostheses fabrication ,the denture tends to stain by our food habits and to a great extent, the amount of staining depends upon the level of finishing and polishing of the dentures.[2] Stains of betel and tobacco (paan chewing),beverages like tea, coffee, cola and turmeric(common ingredient of Indian food) along with bacterial plaque accumulate on the dentures of an average Indian patient due to the diverse food habit . A continued neglect of home care and lack of suitable cleansing results in accumulation of these undesirable substances on the surface of dentures which contributes as one of the factors responsible for producing bad odor and adverse tissue response. [8] Denture cleaning being an important part in maintenance of prosthesis and reducing the oral problems, needs to be performed effectively as well as routinely.[10]

Although many authors have assessed the cleansing efficiency of denture cleansers on various denture base materials but there is limited literature available on the efficiency of denture cleansers with different pH such as acidic, alkaline and neutral in the removal of food stains from denture base materials and its influence on physical properties like surface roughness .The present study was designed and carried out to assess the effectiveness of three commonly used denture cleansers having different pH (Valclean- acidic, Clinsodent- alkaline, and Polident- neutral) on heat cured denture base material in the removal of turmeric stains to observe the color changes using UV Visible spectrophotometer and surface roughness using surface profilometer .

The study was null hypothesized that all the three denture cleansers will be equally effective in the removal of turmeric stains from heat cure denture base material and there would be no change in surface roughness following immersion in these denture cleaners.

MATERIALS AND METHODS

Fabrication Of Specimens

A total of 45 discs shaped specimens of dimension 3 mm thickness and 20 mm diameter (according to ADA specification no.12) were fabricated of heat cured denture base material by the compression molding technique. After finishing and polishing of the specimens (Fig.1), initial color and surface roughness measurements were made using UV-VIS spectrophotometer and surface profilometer respectively (Fig.2).

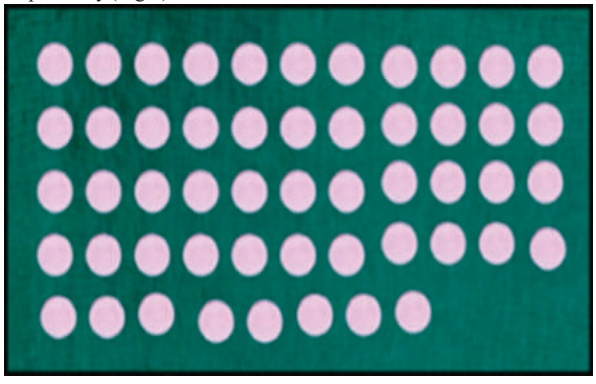


Fig-1: Finished And Polished Heat Cured Specimens.

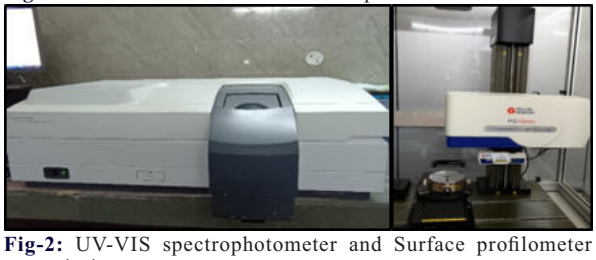


Fig-2: UV-VIS spectrophotometer and Surface profilometer respectively

Application Of Stains To The Specimens

Staining of the specimens was done by immersing them in the turmeric solution prepared by dissolving 5 gm of turmeric in 1L of distilled water and solution was kept for boiling followed by simmering for 5 minutes and filtered through filtered paper. The specimens were immersed into the staining solution for 2 hours every day for 30days to simulate monthly exposure time with beverages or food in the oral cavity.

Color Measurement Of Stained Specimens

After 30 days specimens were rinsed in distilled water, dried and second color measurements of all the stained specimens (Fig.3) were made using UV-VIS Spectrophotometer(Agilent Technologies, Cary 5000 UV-Vis-NIR).

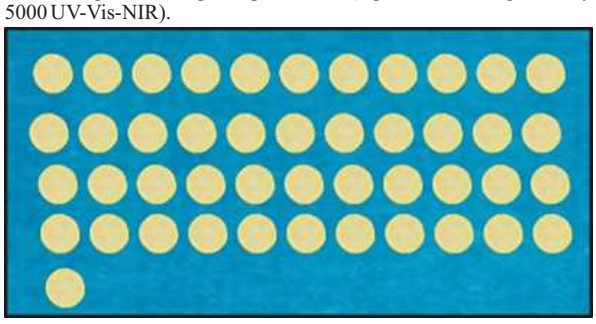


Fig-3 : Specimens Stained With Turmeric

Removal Of Stains Using Denture Cleanser

All the stained specimens were divided into three groups containing 15 specimens each for the removal of stains using three denture cleansers having different pH :

Group 1 − Valclean (acidic denture cleanser)
Group 2 − Polident (neutral denture cleanser)
Group 3 − Clinsodent (basic denture cleanser).

Denture cleansing solution was prepared by dissolving one tablet of denture cleanser for Polident and Clinsodent and one teaspoon of Valclean denture cleanser powder in 150 ml of warm water (according to the manufacturers' directions) . All the specimens in Groups 1, 2, and 3 were immersed in their respective denture cleansing solution (Fig.4) ensuring that the solutions covered all specimens and was kept for 8 hours each day for 10 days to simulate the denture cleansing action of 1 month.

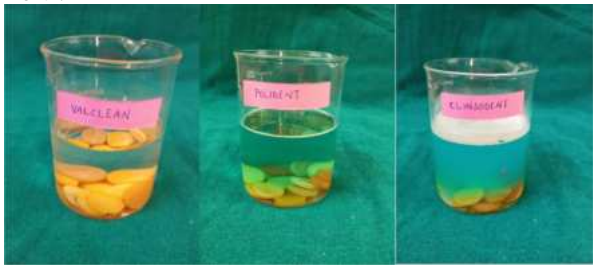


Fig-4 : Specimens Immersed In Respective Denture Cleansers

Specimen Testing For Cleansing Effects And Surface Roughness Of Cleansed Specimens

At the end of 10 days, the specimens were rinsed in distilled water ,dried and third color measurements of cleansed specimens were made using UV-VIS spectrophotometer while surface roughness measurements of cleansed specimens were made using surface profilometer (Taylor Hobson, PGI Optics).

Color Analysis

For evaluating color difference, the spectrophotometric readings were converted to International Commission on Illumination system (CIELAB). This system is based on three parameters for defining color: L, a, and b, they represented lightness, red-green component, and yellow-blue component of color, respectively. Measurements were made in 3 randomly selected areas near the centre of each specimen. The average of three readings was recorded.

The color change (ΔE) of each specimen was calculated using the following equation:

$\Delta E = L)2 + (\Delta[(\Delta a)2 + (\Delta b)2]½$ Where ΔE was color change, +a represented red and −a represented green, while yellow corresponded to +b and blue to −b. ΔL, Δa, and Δb represented the color differences measured in L, a, and b values before and after immersion of specimens. The color measurements (ΔE) values of three groups: Group 1 − Valclean, Group 2 − Polident, Group 3 − Clinsodent and within group categories: -unstained(initial color measurement), stained and cleansed were calculated.

Surface Roughness Analysis

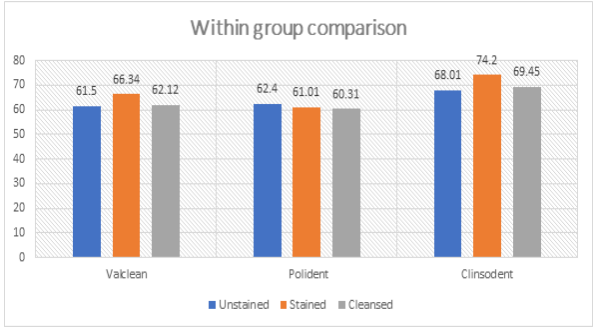
Surface roughness was analyzed using surface profilometer. The stylus of analyser moved across the specimen surface and recorded three lines with 1mm distance. The mean surface roughness(Ra) of three lines was calculated. The Ra value is the arithmetic average of all specimens of the profile through the mean sample length. The mean differences in surface roughness before and after immersion were also calculated. All the measurements were recorded by one operator.

RESULTS

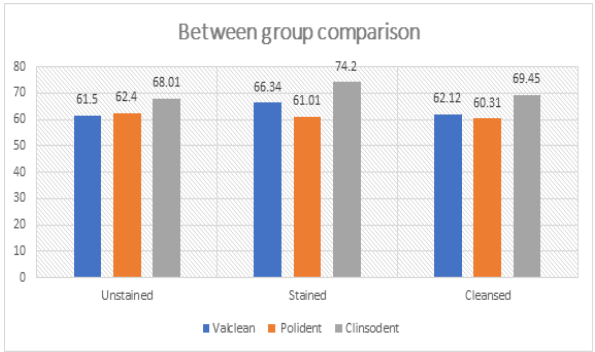
The results and statistical analysis of the study are summarized in Tables 1-3 and graphs 1-3. All the color and surface roughness measurements values obtained were tabulated and subjected to the statistical analysis using the statistical package **SPSS 26.0** (SPSS Inc., Chicago, IL) and level of significance was set at **P<0.05**. ONE WAY ANOVA test followed by BONFEERONI Post hoc test was performed to analyze mean color difference[Table-2 and Graph-2] and mean surface roughness among three groups (Valclean, Polident and Clinsodent)[Table-3 and Graph-3] and three within group categories (Unstained, Stained and Cleansed) of specimens.[Table-1and Graph-1].The results revealed that Group 2(Polident) showed statistically significant lesser mean scores of **ΔE** (color difference) when compared to Group 3(Clinsodent) followed by Group 1 (Valclean).[Graph-2]

For surface roughness measurement, statistical difference in the mean surface roughness values was observed with the highest showed by Polident followed by Valclean while Clinsodent showed the least.[Graph-3].

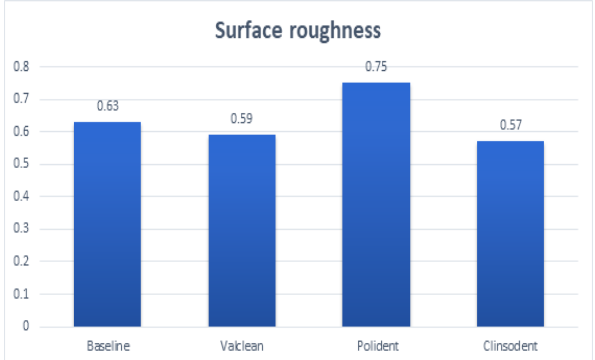
GRAPHS AND TABLES:



Graph-1: Shows the ΔE (color difference) of Unstained, stained and cleansed values of three groups(valclean, Polident and Clinsodent).



Graph-2: Shows Cleansing efficiency between three groups (Valclean, Polident and Clinsodent).



Graph-3: Shows intergroup comparison of surface roughness(Ra) of three groups(Valclean, Polident and Clinsodent).

Table – 1: Displays Within Group Comparison Of Cleansing Efficiency Of Valclean, Polident and Clinsodent (U:unstained, S:stained,C:Cleansed)

	Unstained	Stained	Cleansed	One Way Anova	Bonferroni HSD post-hoc
Valclean	61.50±5.85	66.34±9.07	62.12±12.31	0.32	U=S=C
Polident	62.40±4.83	61.01±5.99	60.31±5.36	0.70	U=S=C
Clinsodent	68.01±5.07	74.20±6.25	69.45±5.36	0.01*	S>(U=C)

Table-2:Displays Between Group Comparison Of Cleansing Efficiency Of Three Groups (V:Valclean, P:Polident , C:Clinsodent).

	Unstained	Stained	Cleansed
Valclean	61.50±5.85	66.34±9.07	62.12±12.31
Polident	62.40±4.83	61.01±5.99	60.31±5.36
Clinsodent	68.01±5.07	74.20±6.25	69.45±5.36
One Way Anova	0.0001*	0.0001*	0.01*
Bonferroni HSD posthoc	C>(V=P)	C>(V=P)	C>(V=P)

Table -3: Displays Intergroup Comparison Of Surface Roughness Of Three Groups .

Baseline	0.63±0.17
Valclean	0.59±0.24
Polident	0.75±0.21
Clinsodent	0.57±0.05
One Way Anova	0.01*
Bonferroni HSD posthoc	P>C(B=V)

DISCUSSION

Care of dentures and the mucosal tissues of the edentulous mouth can be important for overall health, especially in older persons.[15] The surface of the acrylic denture base can influence the oral health profile of denture wearers. The acrylic base is in direct contact with oral tissues and improper surface texture of the base facilitates the accumulation of microorganism .The surface texture of acrylic dentures depends on many factors such as residual methyl methacrylate monomer, polymerization methods, polymerization cycle, storage time in water and denture cleaning protocol. [30] Exogenous stains from dietary products accumulate on the denture in spite of all attempts to produce a self -cleansing design of dentures. Additionally, a denture is exposed to multiple food stains without any intermediate cleansing intervals in a day.[8] Staining of the denture by the food we consume could be a major cosmetic concern for denture wearers Therefore, this study was conducted to compare and evaluate the cleansing efficiency of three types of denture cleansers in removal of turmeric stains and surface roughness created after using the cleansers on heat cured denture base resin.

Turmeric ,a major food ingredient used by the Indian population is a common staining agent. Staining with turmeric is more because the colorant of turmeric is polar. Moreover, whenever the colorant is more polar, it stains more as denture base resins are hydrophilic attracting more water-soluble dyes on the surface.[2] In the present study ,turmeric solutions have been used to evaluate the color change in heat cured denture base material which is similar to the study by Priyanka P Makhija et al.[26]

Although the most widely used method of denture cleansing seems to be the usage of soap and brush, but a large number of geriatric patients have a loss of manual dexterity and are physically challenged, hence unable to accomplish mechanical denture cleansing effectively. Therefore, the usage of immersion type of cleansers helps them to keep the dentures clean and devoid of any deposits.[2]

In the present study, the results demonstrated that the **ΔE** (color difference) mean value of Group 2(Polident) were significantly lesser than Group 3(Clinsodent) and Group 1(Valclean).These findings suggest that Polident(neutral pH) has greater cleansing efficiency (destaining ability)when compared to Valclean(acidic pH) and Clinsodent(basic pH). The probable cause for the efficient cleansing action of Polident could be attributed to the ingredients present in it. Polident denture cleanser contains sodium perborate, sodium percarbonate, and potassium monopersulfate as an active ingredient which are all oxidants and bleaches. Sodium perborate when dissolved in water decomposes releasing peroxides which in turn decomposes releasing oxygen and due to bleaching effect of oxygen, it mechanically removes the stains from the dentures. Sodium lauryl sulphate present in it loosens debris and reduces surface tension, also the effervescent ingredients such as sodium bicarbonate and citric acid helped to break the denture cleanser tablet and disperse the other ingredients.[2] The results of the study by Anand Porwal et al. and Robin Mathai Joseph et al. [1]are also in accordance to the present study.

In contrary ,the study by Gujrathi Richa et al. [2] found that Valclean showed statistically significant greater stain removal efficiency than Polident followed by Clinsodent from flexible denture base material. The reason for variations in mean scores of the above-mentioned study could be because of the different type of material used by them (flexible denture base material) when compared to the present study.

Also, according to the results of present study ,the mean color difference between Group 2 (Polident) and Group 3 (Clinsodent) was not statistically significant indicating that Clinsodent showed an intermediate effect that was not distinct . The mean difference between Group 1 (Valclean) and Group 3 (Clinsodent) was 9.75 ± 4.52, which suggests that Clinsodent (basic)has greater stain removal efficiency than Valclean(acidic) but lesser than Polident (neutral).The cause for obtaining the results could be lesser bleaching action of ingredients present in it. Clinsodent is sodium perborate-based denture cleanser and due to bleaching action of oxygen, it removes the stains from the dentures and alkaline pH of Clinsodent indicate that there are more OH^- ions than H^+ ions in the denture cleanser solution showing lesser degree of stain removal of the specimens immersed in it when compared to Polident.[2] The results of the study by Vrinda R. Shah et al [3] .are in accordance to the present study.

On the other-hand Group 1 (Valclean) had the highest mean ΔE of 16.91 ± 19.51, revealing significant differences in ΔE between Group 1 (Valclean) and Group 2 (Polident), with a mean difference of 13.21 ± 5.24.These results suggest that Valclean caused a significantly greater change in ΔE compared to Polident indicating lesser efficiency of stain removal. The probable cause for the lesser efficient cleansing action of Valclean could be attributed to lesser immersion time employed in the present study and could also be because of the different type of denture base material used in the present study, also as mentioned and recommended by the manufacturer of Valclean, it is an exceptionally effective cleanser for Valplast Flexible Partials .In the contrary ,the denture base material used in the present study was heat cured denture base material which can be a probable reason for its less stain removal efficiency.

The study by Vrinda R. Shah et al. [3] suggest that specimen prepared from flexible denture base materials showed more color change as compared to acrylic resins. Specimen immersed in Valclean showed noticeable and appreciable color change after 3 and 6 months of immersion, respectively.[3] In contrary the duration of immersion time employed in the present study was 10 days to simulate the denture cleansing action of 1 month(8 hour per day) which contributes in support to the results of the present study. The result of the present study partially agrees with those from the study by Polychronakis et al. [20], who reported a greater color change in nylon denture base materials as compared to heat cured acrylic resin.

The results for surface roughness measurement demonstrated that Group 2(Polident) has caused more surface roughness when compared to Group 1(Valclean) and Group 3(Clinsodent). This increase in surface roughness with Polident (neutral)could be attributed to the cleansing agent peroxide contain, level of oxygenation and soaking temperatures and also soaking time. The results of the study by Kubra Degirmenci et al [30] .are in accordance to the present study. The pH affects the degradation rates of the polymer because the breaking strength of the polymer depends markedly on the pH.

On the other hand, the probable reason for obtaining lesser mean scores of surface roughness of Valclean(acidic) when compared to Polident (neutral)could be attributed to the reaction of ingredients present in it to different type of denture base material and it could also be due to duration of immersion. Peracini et al .[15] stated that immersed acrylic resin samples in alkaline peroxide solution for 6 days showed increased surface roughness of the resins. This finding is consistent with the results of our study.

Rukiye Durkan et al.[16] studied the effect of denture cleansers on the

surface roughness, hardness and color stability of two polyamides and PMMA polymer after immersion in Corega(Potassium Monopersulfate) ,Protefix(sodium bicarbonate) and Valclean and stated that the highest surface roughness was observed in polyamide resin and no difference was observed in PMMA resins in which similar results are also observed in the present study.

Whereas the cause for obtaining lesser mean surface roughness results of Clinsodent (basic)when compared to Polident(neutral) and Valclean(acidic) could be due to lesser bleaching action of ingredients present in it and also it could due to different immersion time .The current study is also consistent with the findings of Dayanand Ashok Huddar et.al [14] who showed that heat cured specimens immersed in Clinsodent have showed decreased surface roughness and tensile bond strength. Therefore, variations in the materials and methods of different studies hinders a direct comparison.

LIMITATIONS OF THE STUDY

The present study is limited by several factors:

1. The lack of accurate simulations of oral conditions, such as salivary composition and pH levels or the presence of biofilm due to infection control considerations .
2. Other commonly used food stains were not considered in the present study.
3. This study also did not examine the effects of temperature changes.
4. The effect of different chemical denture cleansers was studied only on one type of denture base resin.
5. Time period of the study was limited to one month although, denture cleansers may be used for much longer time .
6. The present study focused on cleansing efficiency and surface roughness only.

CONCLUSION

The following conclusions were drawn that

1. The hypothesis of the present study that all three denture cleansers: Valclean(acidic pH),Polident (neutral pH) and Clinsodent (basic pH) will be equally effective in the removal of turmeric stains from heat cured denture base material and also no surface roughness will be created after immersion was rejected .
2. The effect of Polident denture cleanser showed greater stain removal efficiency(cleansing ability) followed by Clinsodent and Valclean.
3. Also, for surface roughness evaluation, Polident showed more surface roughness followed by Valclean and Clinsodent.
4. It can be stated that Clinsodent can safely be used as denture cleanser for heat cured denture base material where as Polident should be used with caution by considering the proper immersion time while Valclean can be employed for stain removal by considering proper preparation method and immersion time and temperature for heat cured denture base material.

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