

EVALUATION OF COLOR STABILITY OF DIFFERENT HEAT CURE ACRYLIC DENTURE BASE RESINS IN FIVE DIFFERENT BEVERAGES: AN INVITRO SPECTROPHOTOMETRIC STUDY

Original
Research
Paper

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ABSTRACT Aim: The purpose of this study was to evaluate the color stability of five commercially available heat cure acrylic denture base resins when submitted to five different beverages and food colorants used in Kashmir.

Materials and methods: Five testing solutions used for the study were turmeric solution, tea, saffron kehwa, namkeen tea and gurgur tea. Each solution was prepared and divided into five parts so that 5 specimens of each brand of acrylic resin were immersed into the specific solutions. The samples were tested for color change prior to immersion in test solutions subsequently after 1 month, 3 months and 6 months respectively. The samples were then tested for color reflectance using spectrophotometer. The data obtained were statistically analysed using ANOVA (analysis of variance) and student t test.

Results: All the brands of heat cure denture base acrylic resins tested in this study showed statistically significant color changes in the testing solutions. Ashvin showed highest color change variation in all the testing solutions followed by Pyrax, DPI, Trevalon and SR Triplex respectively. SR Triplex showed least discoloration in all the testing solutions.

Conclusion: All the 5 staining solutions showed more significant color change during the first 1 month of immersion in the respective solutions for all five heat cure denture base resins. The color change was not very appreciable between 3rd and 6th month of the experimental exposure for denture base acrylic resins.

Key words:

color stability,
heat-cured acrylic resin,
organic acids,
Spectrophotometer.

Source of Support: Nil

Conflict of Interest: Nil

INTRODUCTION : Edentulism is an irreversible and undermining condition of oral cavity. It leads to psychological deterioration of the patient as the restoration of natural smile is often difficult. Prosthesis made of acrylic polymers is an appropriate remedy to this problem. Initially wood, metal, porcelain, vulcanite were used to fabricate denture. In 20th century, acrylic resin was used to manufacture denture. In the long run, success of any aesthetic material is determined by colour match and the color stability of material [1, 2]. Acrylic resin mimics the color and contour of the oral soft tissue. Due to the exposure to various media,

such as coffee, tea, and medicaments; such as chlorhexidine and whitening agents, colour of denture base resin gets altered [3].

Colorimetry is the science used to quantify the human [color perception](#). To determine color variations, two mainly used color systems are Munsellcolor system and standard Commission Internationale de L' Eclairage (CIE Lab) color system⁴. A growing number of dental colorimeters and evaluation systems have been developed, some of which are applicable to the colorimetric assessment of dental materials⁵. Spectrophotometer is one such evaluation

system which is sensitive and reliable[6].

As the beverages taken by Kashmiri population are slightly different such as turmeric solution, tea, saffron kehwa, namkeen tea and gurgur tea. This study was done to check the color stability of 5 commercially available denture base acrylic resins (SR Triplex, DPI, Trevalon, Pyrax and Ashvin) in different beverages used in Kashmir (turmeric solution, tea, saffron kehwa, namkeen tea and gurgur tea)[7].

Aims: The aim of this study was to evaluate the color stability of five commercial brands of heat cure denture base acrylic resins when submitted to beverages and food colorants used in Kashmir.

Objectives:

1. To evaluate the effect of Turmeric solution (main part of Wazwan) on color stability of SR Triplex, DPI, Trevalon, Pyrex and Ashvin heat cure acrylic denture base resins.
2. To evaluate the effect of tea on the color stability of SR Triplex, DPI, Trevalon, Pyrex and Ashvin heat cure acrylic denture base resins.
3. To evaluate the effect of Namkeen tea on color stability of Triplex SR, DPI, Trevalon, Pyrex and Ashvin heat cure acrylic denture base resins.
4. To evaluate the effect of Gurgur tea (used in Ladakh) on color stability of Triplex SR, DPI, Trevalon, Pyrex and Ashvin heat cure acrylic denture base resins.
5. To evaluate the effect of Saffron Kehwa on color stability of Triplex SR, DPI, Trevalon, Pyrex and Ashvin heat cure acrylic denture base resins.
6. To compare the color stability of Triplex SR, DPI, Trevalon, Pyrex and Ashvin heat cure acrylic denture base resins in all 5 beverages.
7. To evaluate the average color changes after intervals of 1, 3, and 6 months.

Material and methodology

Preparation of the Specimens:

Six Co-Cr metal master dies, measuring 1.5 mm in thickness, 20 mm in length and 10 mm in width were fabricated for the standardization of the samples. The stainless steel dies were invested in the dental flasks using conventional Type III dental stone (Figure1). After the dental stone was completely set, the rectangular dies were removed (Figure 2)[8]. A thin coat of petroleum jelly was coated onto the investing medium. The monomer and polymer of the heat cure acrylic resin (SR Triplex, DPI, Trevalon, Pyrex and Ashvin) was proportioned (3:1) as per manufacturer's instructions; mixed and packed in the dough stage in the mould space of the dental flask[9]. The flask assembly was introduced into the designed bench press,

and pressure was applied incrementally. Slow application of pressure permitted the resin dough to flow evenly throughout the mould space. The polymerization cycle followed in an acrylizer for resin processing was done at 74oC for 2 hours followed by 100oC for 1 hour. After polymerization the denture flask was cooled slowly to room temperature and bench cooled overnight10. Subsequently, the flask was immersed in tap water for 15 min. The rectangular resin specimens thus fabricated were polished with the help of 80, 100, 120 sandpaper. 25 specimens each were fabricated for five heat cure denture base resins. A total of 125 samples were fabricated (Figure 3)[11].



Fig-1.Master die invested in Type III dental stone

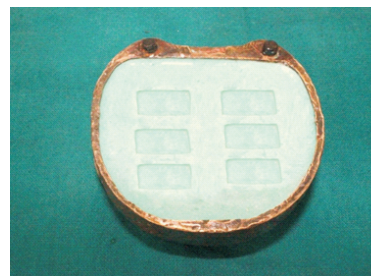


Fig-2.Mould space

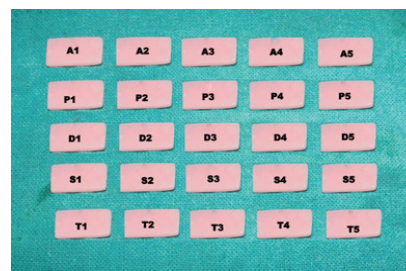


Fig-3. Heat polymerized acrylic specimens.

II. Preparation of testing solutions:

S.No	Testing solution	Preparation
1	Turmeric solution	1g/ltr boiling distilled water; simmer for 5 min & filtered.
2	Tea	30g/ltr boiling water; simmer for 5 min & filtered
3	Saffron Kehwa	30g/ltr boiling water; simmer for 5 min & filtered
4	Gurgur tea	30g/ltr boiling water; simmer for 30 min & filtered. It is then placed in a blender to churn after adding 10g of butter is added.
5	Namkeen tea	30g/ltr boiling water and pinch of baking soda; simmer for 30 min & filtered.

III. Grouping of Samples:

Five testing solutions used for the study were Turmeric solution, Tea, Saffron Kehwa, Namkeen tea and Gurgur tea. Each solution was prepared and divided into five parts so that 5 specimens of each brand of acrylic resin were immersed into the specific solutions. Specimens were designated according to the acrylic resin and solution (Figure 4). Total 25 closed containers were taken to accommodate the 25 groups of specimens[12]. The specimens were not placed together to avoid specimen to specimen contact. Each container with 5 specimens was kept in incubator at 37 ± 1 °C temperature. The solutions were changed on a weekly basis[13].

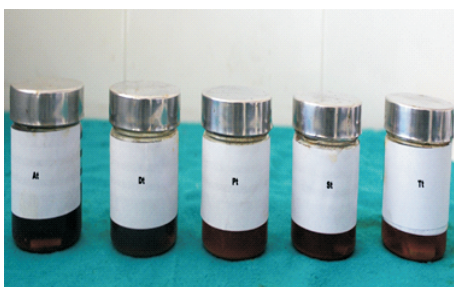


Fig-4. Sealable Jars of Tea for five heat cure denture base acrylic resins.

IV. Labelling of samples :

Labelling of samples is shown in Table I and II

Denture base resin	Beverage
(A): Ashvin	t: Tea
(D): DPI	G: Gurgur Tea
(P): Pyrax	N: Namkeen Tea
(S): SR Triplex	T: Turmeric Solution
(T): Trevalon	S: Saffron Kehwa

Table I: Labelling of denture base and beverages used.

AS	DS	PS	SS	TS
AG	DG	PG	SG	TG
AN	DN	PN	SN	TN
AT	DT	PT	ST	TT
At	Dt	Pt	St	Tt

Table II: Labelling of 25 samples

V. Testing of Samples:

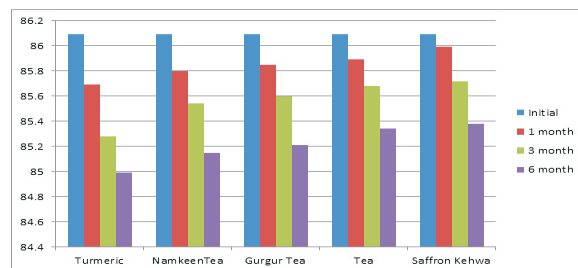
Experimental recordings were taken before immersion and after 1 month, 3 months and 6 months of exposure to staining solutions. Before any readings, the specimens were removed and rinsed in distilled water and excess water were removed with tissue paper and specimens allowed to dry 14. The effect of the solution on the acrylic resin was measured with the help of spectrophotometer (Perkin Elmer Lambda 35, USA) at

Central Institute of Temperate Horticulture (Indian Council of Agricultural Research), Srinagar, J&K. The readings were statistically analyzed[15].

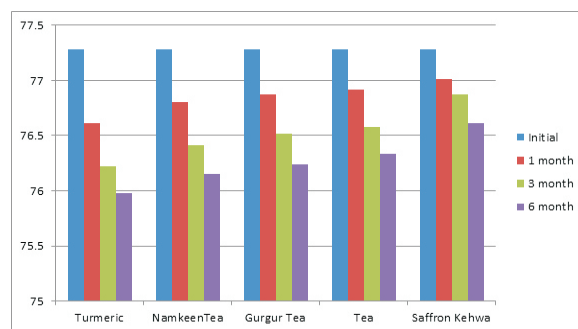
Randomly selected areas were used to determine color change by using a spectrophotometer. The average of the 3 readings was recorded and the mean of each material was calculated with the use of the CIE Lab uniform color scale 16.

RESULTS :

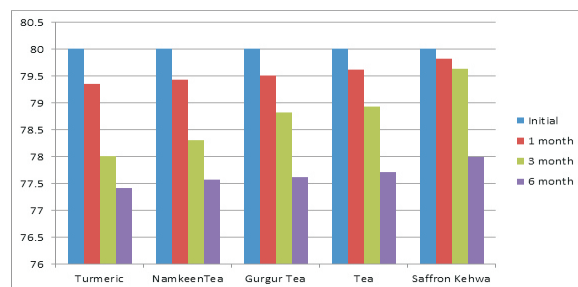
Graph I: Changes in ΔE values in SR Triplex



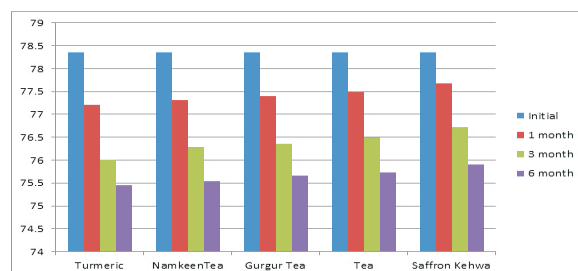
Graph II: Changes in ΔE values in Trevalon



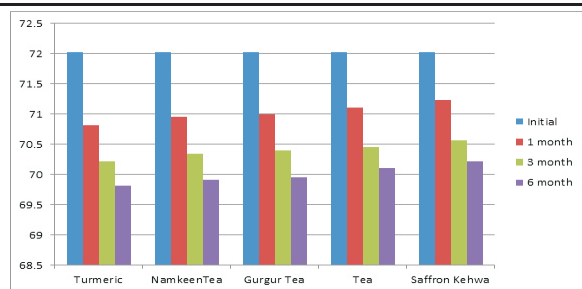
Graph III: Changes in ΔE values in DPI



Graph IV: Changes in ΔE values in Pyrex



Graph V: Changes in ΔE values in Ashvin



In the present study, there was statistically significant change in color for all the brands of heat cure denture base acrylic resins, during the 6 months of experimental exposure to common beverages used in Kashmir (Graph I, II, III, IV, V). The solution/specimen showing greatest change in ΔE produces maximum staining effect[17]. Amid all the tested solutions, turmeric solution showed the highest staining effect on the specimens (max change in ΔE) followed by Namkeen tea, Gurgur tea, tea and Saffron Kehwa. All the brands of heat cure denture base acrylic resins tested in this study showed statistically significant color changes in the testing solutions. Ashvin (Graph V) showed highest colour change variation in all the testing solutions followed by Pyrax, DPI, Trevalon and SR Triplex respectively. SR Triplex showed least discoloration in all the testing solutions (Graph I)[18]. All the 5 staining solutions showed more significant color change during the first 1 month of immersion in the respective solutions for all five heat cure denture base resins. The color change was not very appreciable between 3rd and 6th month of the experimental exposure for denture base acrylic resins[19].

DISCUSSION :

The color and translucency of the denture base acrylic resin should be steady during the processing and clinical use because color stability is an important property to decide the suitability of these materials[20]. Color evaluation by using a spectrophotometer and colorimeter, minimizes subjective mistakes in color determination and are more accurate than visual measurement. CIE Lab system is a uniform 3-dimensional system which is widely used in determining chromatic differences and is more advantageous than Munsell color system[21]. The value of ΔE^* represents relative color changes that an observer might report for the materials after immersion or between time periods. Thus ΔE^* is more meaningful than the individual L^* , a^* , b^* values. Um and Ruyter suggested that the ΔE value of 1 unit is “visually perceptible.” A ΔE colour alteration between 1 and 2 is clinically acceptable and above 3.3 is considered clinically

unacceptable[22].

With regular use denture base resins are subjected to discoloration, which can be attributed to either extrinsic factors like adsorption of substances or intrinsic factors like alteration of the matrix. Certain pigments in oral vicinity get absorbed in denture base resin through diffusion and leads to chromatic alterations[23]. Lower rate of diffusion in the in vivo environment can be justified by the reduction in diffusion coefficient of acrylic resin by one half as temperature is reduced from 37 to 23 degree Celsius.

In the present study, there was statistically significant color change for all the brands of heat cure denture base acrylic resins, during the 6 months of experimental exposure to test solutions. The solution/specimen showing greatest change in ΔE produces maximum staining effect. Among the solutions tested Turmeric solution showed the highest staining effect on the specimens (max change in ΔE) when compared to other beverage solutions, followed by Namkeen tea, Gurgur tea, tea and Saffron Kehwa[24].

Major constituents of turmeric are curcuminoids, the yellow colouring pigments that are responsible for staining denture base resins. Smaller molecular size of curcuminoids coupled with water absorbed characteristics of the denture base resins create a stronger staining effect as discussed by Ergun et al[25]. The effect of turmeric solution in terms of color change was maximum because the colorant of turmeric is more polar. Um and Ruyter[26] mentioned in their study that whenever the colorant is more polar and their by more hydrophilic, it stains more as denture base resins are hydrophilic attracting more soluble dyes on the surface.

Namkeen tea followed Gurgur tea and tea showed maximum discoloration for denture base resin next to turmeric solution. The discoloration in tea is mainly due to adsorption of polar colorants on the surface of denture base resins as reported by Crispin et al. Tannic acid, which is present in tea is the main cause of staining. Further fine tea particles get deposited in the pits of denture base resins. The pits may have formed due to polymerization shrinkage of denture base resins during curing[11]. Namkeen tea contains baking powder that has abrasive properties attacking the resin and making it more susceptible to staining[27].

One of the main ingredients of Gurgur tea is butter. Butter contains colorants and citric acid that are responsible for the staining characteristic of Gurgur tea. Saffron Kehwa contains a-crocin which is responsible for its staining characteristic. This a-crocin is trans-crocetin di-(β -D-gentiobiosyl) ester. Least discoloration was shown by Saffron Kehwa. This result

is attributed to minute quantity of saffron added to the beverage and the removal of accumulated layers. As the Saffron Kehwa layer on specimens reached a certain thickness, they tend to break away from the surface of the samples and return to the solution[28].

All the brands of heat cure denture base acrylic resins tested in this study showed statistically significant color changes in the testing solutions. Ashvin showed highest colour change variation in all the testing solutions followed by Pyrax, DPI, Trevalon and SR Triplex respectively. SR Triplex showed least discoloration in all the testing solutions[29]. Time of immersion was found to be a critical factor for colour stability of heat cure denture base acrylic resins. The staining became more intense with time i.e. ΔE value for colour change increased with time but the rate doesn't remain the same for 1 month, 3 months and 6 months. Rate of staining decreased with time due to saturation of colorant in the denture base acrylic resins. Other factors can also influence colour change of polymers, such as material contamination, porosity associated with technique, poor oral hygiene, diet, surface failures, and material polishing[30].

CONCLUSION : Within the limitations of this in vitro study, it was concluded that among the heat cure denture base resins, Ashvin showed least color stability in all testing solutions followed by Pyrax, DPI and Trevalon, while SR Triplex showed least discoloration in all the testing solutions. Among the beverages used Turmeric solution produced maximum discoloration followed by Namkeen tea, Gurgur tea, whereas Saffron Kehwa produced least discoloration in all test specimens. Discolorations of heat cure denture base resins is directly proportional to the duration of immersion in the beverages but the rate of staining decreased with time due to saturation of colorant in the denture base acrylic resins. Long term in vivo studies are required to evaluate the effect of these variables on the colour stability of the heat cure denture base acrylic resins used in clinical practice.

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