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Comparative Evaluation of Conventional Heat Cure and Commercially Available Hypoallergenic Denture Base Resins For Color Stability

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Conflicts of Interest: Nil

Abstract

Introduction: This in vitro study was undertaken to compare the colour stability of conventional denture base resin (PMMA) and hypoallergenic denture base resins (Alldent Sinomer; Valplast) when exposed to some common beverages (distilled water, tea, coffee, pan masala solution) by means of a spectrometer.

Materials and Methods: Three commonly used denture base resins were selected. 5 specimens from the selected test material were stored in each test solution at 370c in a dark environment. Subsequent colour measurements were taken at 1st, 7th and 30th day of immersion using spectrophotometer. Data was statistically analysed by repeated measures ANOVA and the pairwise comparisons by Benferroni corrections to find which groups differed from each other.

Results: Significant colour shifts occurred in PMMA, Alldent Sinomer, Valplast in all the test solutions (except distilled water). The colour shift of Valplast in Pan Masala solution was significantly greater than that of remaining test materials in Pan Masala solution. The colour shift of each material in coffee and tea solutions were not significantly different when compared among selected test materials.

Conclusion: All denture base resins showed significant colour change at the end of 30 days ($p<0.001$) though the maximum colour change was observed in Valplast. **Clinical Significance:** With respect to this study, minimizing the consumption of such beverages and cessation of Pan Masala particularly when Valplast is the denture base material of choice, may be advantageous for denture wearers for long-term colour stability of their dentures.

Keywords: hypoallergenic denture base resins, colour stability, spectrophotometer

Introduction

Among the denture base materials, PMMA denture base has dominated the market for more than 50 years due to its innumerable advantages.[1] However, due to its increased residual monomer content which has been proven allergenic to certain patients, hypoallergenic denture base resins have been introduced recently.[2]

Hypoallergenic denture base resins show no residual monomer content. These materials appear to represent an alternative to conventional PMMA by minimizing the risk of adverse reactions induced by residual monomer in denture-wearing patients with potential allergy susceptibility.[2]

Colour stability is the property of a material that allows colour to be maintained over a period of time in a specific environment. Colour change is an indicator of ageing or damage to dental materials and can be assessed by visual or instrumental methods.[3] In dental literature, no studies have been reported on the colour stability of hypoallergenic denture base materials to warrant their use clinically. Against this backdrop of information scarcity, this in vitro study was undertaken to analyse hypoallergenic denture base materials when exposed to some common beverages by means of a spectrophotometer.

Materials and Methods

Conventional heat polymerised resin-PMMA (control group), two hypoallergenic denture base resins (Alldent Sinomer; Valplast) were used in the study (Table 1).

20 specimens of 10mm x 2mm from each type were made according to the manufacturer's instructions (Fig. 1). The samples were then stored in distilled water at 37^0C for 24 hours. Four solutions were used (Distilled water; Tea solution; Coffee solution; Pan masala solution) (Table 2). The first solution served as control group. The specimens (n=20 for each type of material) of PMMA and two hypoallergenic denture base resins (Alldent Sinomer; Valplast) were then divided into four subgroups of five specimens of each material which were then immersed in each test solution (Fig. 2). Subsequent colour measurements were taken at 1st, 7th and 30th day of immersion. Solutions were freshened every seven days and stirred once a day to reduce the precipitation of particles in solutions.

Colour Measurements

Colours of the specimens were measured with a spectrophotometer (Greta Macbeth Sphectrolino) against a white background (Fig. 3) Colour samples from the three groups were tested by evaluating the light directed and reflected from the specimen surface (Fig. 4). All measurements were done according to CIE standards.

Before each measurement, samples were removed from the solutions and rinsed in distilled water. Excess water on the surfaces was removed with tissue paper and samples were allowed to dry. Three measurements were taken at a time from one point which corresponded to the central region of each specimen. Average value of these readings was automatically calculated by the spectrophotometer and recorded. Colour changes were characterised using the Commission Internationale d'Eclairge $L^*a^*b^*$ colour space (CIE $L^*a^*b^*$).[6] The colour systems are quantitative systems with regular coordinates, and they have a meaningful relation to the visual perception of colour differences. Total colour differences are expressed by formula:

$$E_{ab} = [(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]^{1/2}$$

Where L, Δ a, Δ b Δ

Are differences in L*, a*, and b* values before and after immersion at each time interval. Δ E results were calculated between specimens of each test material in the control group (distilled water) and the specimens of same material in different colorants.

The data obtained was fed in computer and subjected to statistical analysis using statistical software (SPSS version 15.0; SPSS Inc, Chicago, IL). Repeated measures ANOVA using SPSS 15 and the Pairwise comparisons by

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means of Bonferroni correction were conducted and results were expressed as mean difference and p value at or less than 0.05 was considered statistically significant.

Results

The present study was based on comparative evaluation of conventional heat cure and commercially available hypoallergenic denture base resins for colour stability in four different solutions over a period of 30 days.

Table 3 shows ΔE, means and standard deviations for all test materials after 1st, 7th, 30th day of immersion in the four solutions.

From the study, it was inferred that there is a statistically significant difference in the average colour change between the three groups in different solutions over a period of 30 days ($p<0.001$). There was statistically significant difference in colour between four subgroups (decision based on $p<0.001$). There was statistically significant colour change from baseline to day 30 in all the four solutions (Graph I, III).

Among the different brands of denture base resins, Valplast exhibited the greatest colour change whereas Polymethyl methacrylate demonstrated the least.

Among the two hypoallergenic denture base resins (i.e. Alldent sinomer and Valplast), Valplast showed greater color change than Alldent sinomer at the end of 30th day. Considering the different testing solutions, Pan masala solution had the maximum effect on the colour of different denture base resin material samples ($p=0.015$) (Graph II).

Discussion

Colour stability of a dental prosthesis is one of the most important factors for determining its long term success and patient acceptance.[7] Therefore it was important to evaluate the colour stability of the tested materials.

Discolouration seen in prosthesis may be related to patient's dietary habits, oral hygiene, and structural property of the material used.[8] The present study examined the changes in the colour of three different types of denture base resins caused by four different solutions over a period of 30 days.

Evident colour shifts occurred in each test group in each staining solution over time.

Compounds present in tea play an important role in the colour characteristics of acrylic teeth. Tea consists of flavonoids, phenolic compounds, caffeine, other xanthines, thiamines and other amino acids. However, caffeine forms complexes with the permeric constituents in tea and these complexes have poor stability and often precipitate under cold storage.[4]

Discoloration from tea was probably due to adsorption of polar colorants from tea at the surface of acrylic resin material. Other factors that may influence colour change includes tea precipitation and concentration of the staining solutions.[4]

Pan Masala mainly consists of Areca nut, slaked lime, catechu and condiments. The two most important constituents of Areca nut are tannins (11-26%) and alkaloids (0.15-0.67%). Arecoline is the major alkaloid. Staining by Pan masala is mainly caused by cathechu due to adsorption.

Coffee was chosen as a test solution as it has been shown to have strong staining effect on denture base resins. General composition of coffee consists of caffeine (2-5%), chlorogenic acid (3-9%), browning product and others (20-35%).[5]

The immersion duration of a material in a solution also affects the degree of colour change. In the present study, the immersion periods were 1 day, 7 days and 30 days. As such, colour changes in periods longer or shorter than the evaluation periods of this study cannot be speculated with the result of this study.

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Likewise, it would be erroneous to compare with different immersion durations as the degree of colour change varies with time.

One of the drawbacks in the present investigation might be related with methodology utilised for the staining procedure. Between the different immersion intervals, the experimental denture base specimens were not subjected to any clearing procedure, which might not accurately reflect clinical conditions. Thus, the results obtained herein might serve to reveal the consequences of a low quality denture care.

Conclusion

Within the limitations of this study, it can be concluded that;

- There was a significant colour change of the three denture base resins treated with four different testing solutions from baseline till the end of 30 days ($p<0.001$).
- Among the different brands of denture base resin materials, Valplast exhibited the greatest change in colour. Poly methyl methacrylate demonstrated least change in colour.
- Among the two hypoallergenic denture base resins (i.e. Alldent Sinomer and Valplast), Valplast showed greater colour change than Alldent Sinomer at the end of the 30th day.
- Considering the different testing solutions, pan masala solution had the maximum effect on the colour of different denture base resin material samples ($p=0.015$).

Acknowledgement

The contribution and efforts of the team from the Department of Prosthodontics, Department of Dental Materials, Manipal College of Dental Sciences, Manipal, Manipal is highly appreciated.

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Figure 1. Finished and polished denture base resin specimens

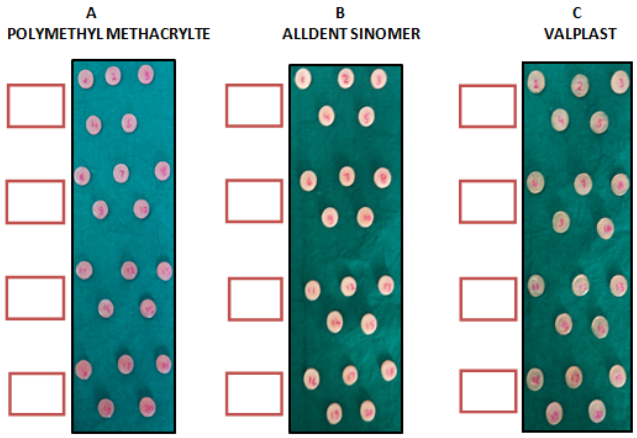

Figure 2. Prepared solutions with sample stored in incubator at 37°C.

Figure 3. Denture base resin sample kept on base and spot reader kept over it.

Figure 4. Color Measurement Done With Spectrophotometer

Table1: List of commercially available denture base resins used in the study.

S. No	Denture Base Product	Company
1.	Trevalon	Dentsply India Pvt. Ltd., Gurgaon
2.	Alldent Sinomer N	Novodent Ets. Industriestrasse 651
3.	Valplast Material	(Novoblast, USA)

Table 2: List of solutions used in the study

Type of solution	Trade name	Manufacturer	Ingadients
Distilled Water (SOLUTION 1)	NA	NA	NA
Tea (SOLUTION 2)	Tata tea	Tata Global Beverages	15. gm tea + 500ml boiled distilled water
Coffee (SOLUTION 3)	Bru Instant	Hindustan Unilever Limited	15. gm coffee + 500ml boiled distilled water
Pan masala (SOLUTION 3)	Rajnigandha	Dharampal Satyapal Limited	15. gm panmasala + 200ml boiled distilled water

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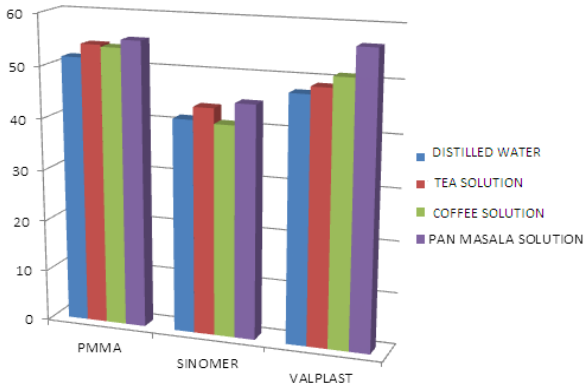
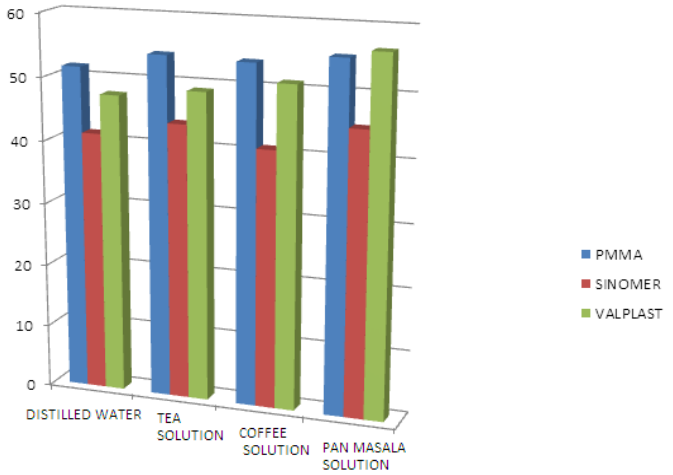
Table 3: Mean color change, standard deviation in different types of solution of the three groups

Solution	Duration	PMMA (Group I)		ALLDENT SINOMER (Group II)		VALPLAST (Group III)	
		Mean	SD	Mean	SD	Mean	SD
Tea	1st day	61.4000	1.97611	51.5800	3.02605	58.6800	1.79221
	7th day	51.1800	1.88335	41.2200	1.77679	44.8800	3.20266
	30th day	54.1800	2.24878	43.7600	1.91390	48.9400	4.10768
Coffee	1st day	63.0400	1.54855	51.6600	4.40204	60.3000	1.51162
	7th day	52.6000	.85732	39.8600	2.47750	47.8400	2.50559
	30th day	53.8200	1.73839	40.8600	3.09483	51.0000	2.36960
Pan Masala	1st day	63.6800	.73959	52.5000	2.99583	61.8200	2.56457
	7th day	53.3800	1.01341	45.1800	1.64833	52.5600	1.10363
	30th day	55.3400	1.44499	44.9000	1.42653	56.5200	2.91239

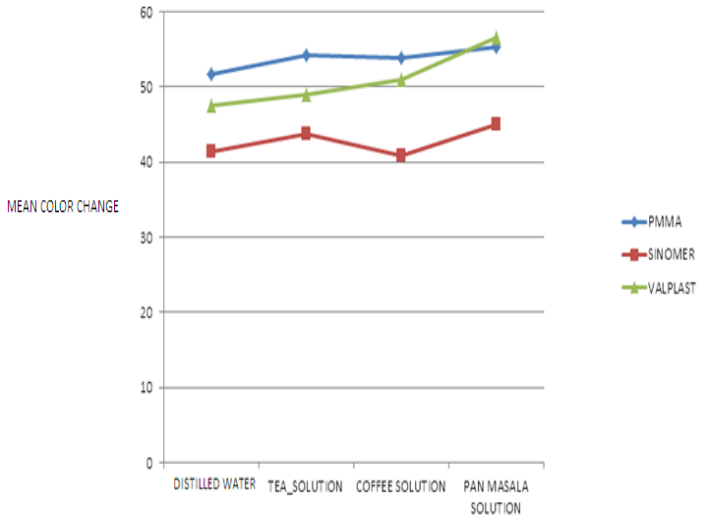
Graph I – Mean color change of different denture base resin samples in various testing solutions.



Graph II – Effect of various testing solutions on the denture base resin samples.



GRAPH III – Mean color change of the three denture base resin materials in four different testing solutions.



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