ORIGINAL RESEARCH

Evaluation of the Impact of Different Disinfectants on Color Stability of Denture Base Materials: A Comparative Study

Turki Almuraikhi

Abstract

Aim: Aim of the current research was to assess the effect of different disinfectant solutions on the color steadiness of denture base materials.

Materials and methods: Ninety samples were made employing the Meliodent and ProBase Hot heat cure denture base resin materials. Metallic disks measuring 3 mm thick as well as 20 mm in diameter were utilized to make the samples. Forty-five samples of every denture base material were immersed in three chemical disinfectants: 2% alkaline glutaraldehyde, 0.5% chlorhexidine gluconate, 0.5% sodium hypochlorite solution as well as distilled water that served as a control. Color scoring was performed at baseline and following first, 14th as well as 21 days. Color was calculated as per CIE *L*a*b** color scale as related to standard source C alongside a white background on a reflection spectrophotometer.

Results: Subsequent to the immersion of Meliodent heat-cured denture base resin materials within distilled water, the baseline color steadiness score was 6.16 ± 0.12, 6.12 ± 0.08 on the first day, 5.98 ± 0.06 on day 14 and 5.74 ± 0.14 on day 21. Within 2% alkaline glutaraldehyde the baseline color constancy mean value was 6.12 ± 0.28, 6.08 ± 0.04 on the first day, 5.04 ± 0.11 on day 14 and 4.22 ± 0.14 on day 21. Within 0.5% chlorhexidine gluconate the baseline color constancy mean value was 6.14 ± 0.09, 6.02 ± 0.12 on the first day, 5.38 ± 0.19 at 14th day and 4.84 ± 0.10 on day 21. In 0.5% sodium hypochlorite solution the baseline color steadiness mean value was 6.16 ± 0.18, 6.10 ± 0.06 on the first day, 4.98 ± 0.26 on 14th day and 3.14 ± 0.14 on day 21. ProBase Hot heat cure denture base resin materials after immersion in Distilled water delineated the baseline color constancy mean value was 6.48 ± 0.02, 6.34 ± 0.09 on the first day, 6.08 ± 0.14 on 14th day and 5.88 ± 0.07 on day 21. Within 2% alkaline glutaraldehyde the baseline color constancy mean value was 6.42 ± 0.16, 6.18 ± 0.11 on the first day, 5.12 ± 0.18 at 14th day and 4.24 ± 0.24 on day 21. Within 0.5% Chlorhexidine gluconate the baseline color steadiness mean value was 6.48 ± 0.10, 6.26 ± 0.08 on the first day, 5.48 ± 0.11 on 14th day and 4.88 ± 0.06 on day 21. In 0.5% sodium hypochlorite solution the baseline color steadiness mean value was 6.44 ± 0.12, 6.14 ± 0.08 on the first day, 4.98 ± 0.16 on 14th day, and 3.34 ± 0.06 on day 21. There was a statistically noteworthy difference amid the dissimilar time points in each of the three disinfectants.

Conclusion: In the confines of the inherent limitations of this research, it can be inferred that the color steadiness of either denture base resins was enhanced following immersion in 0.5% chlorhexidine gluconate in pursuit by 2% alkaline glutaraldehyde as well as 0.5% sodium hypochlorite solution. Distilled water exerted the smallest amount of influence on the color change of the samples of denture base resins.

Clinical significance: Techniques that help infection prevention influence denture disinfection. Currently, there is a dearth of commercially marketed agents that are specifically intended to disinfect dentures. Color constancy of the denture materials is an important parameter to be given due consideration while selecting a disinfectant. This would be a pivotal characteristic for practitioners to consider as they choose disinfectant solutions to disinfect dentures.

Keywords: Color stability, Denture base resin, Disinfection, Spectrophotometer.

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Introduction

In the dental profession, one of the key factors to be considered is the amount of exposure of the dentist to a large range of microbial organisms. Avoiding cross-infectivity amid the dental practitioner, employees in the dental clinic, dental technical staff as well as a patient is pivotal for efficient infection prevention within the dentist's office and work laboratory. Apprehension on the propagation of such disease-causing microorganisms has created new concerns for denture sterilization as well as disinfection.[1]

Complete dentures are subject to exposure to various bacterial, viral, and fungal organisms daily. Additionally, oral, non-regional, and systemic pathology causing agents have been detected in dentures that have been subject to contamination. Hence, such dentures may serve as a potential source of infection owing to the lack of surface smoothness and unevenness that promote the formation of microbial colonies as well as their entry within the denture resin.[2] Denture cleanliness is highly suggested for denture cleansing as well as to maintain their functionality. Denture cleansers are subject to extensive research for the identification of a perfect agent that can eradicate microbes. Potent chemical solutions could serve as a substitute, particularly for geriatrics as the dexterousness is usually reduced.[3]

Denture base agents that are subject to heat-curing depict appropriate color steadiness although the autopolymerizing agents delineate comparatively reduced color permanence.[4] The

Department of Prosthodontics, College of Dentistry, Majmaah University, AL-Majmaah, Kingdom of Saudi Arabia

Corresponding Author: Turki Almuraikhi, Department of Prosthodontics, College of Dentistry, Majmaah University, AL-Majmaah, Kingdom of Saudi Arabia; Phone: +966566552933, e-mail: t.almuraikhi@mu.edu.sa

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remaining monomer quantity can partly explain the ensuing color alterations. Denture base agents cured using the rapid-polymerize technique have established seven times the intensity of remaining monomer present in traditional heat-cure substances.[5]

A range of techniques to sterilize and disinfect the dental premises have been recommended. The course of action explains four key groups of disinfectants that are acknowledged by the Council on Dental Therapeutics. They include chlorine solutions, formaldehyde, glutaraldehyde plus iodophors.[6] Substitute techniques for disinfecting and sterilizing dental prosthetics include microwave irradiation[7] as well as Photodynamic Therapy (PDT).[8]

Two percent alkaline glutaraldehyde is non-polar molecules and an organic compound. Action of this disinfectant is more appropriate against *Mycobacterium* species; 0.5% sodium hypochlorite solution is an effective technique for elimination of adherent microorganism; 0.5% Chlorhexidine gluconate is very potent against various kinds of microorganisms and shows a broad-spectrum biocidal efficacy against both gram-negative and gram-positive bacteria.[9]

Meliodent is a super-fine polymer that gives a superb flow. Meliodent has a long working time up to 25 minutes plus, Meliodent has a unique copolymer formula, this gives smoothness characteristics and surface. Superior tissue compatibility and less plaque buildup.[5] ProBase Hot have high standard quality for the processing properties, accuracy of fit, and stability of shape.[10]

Immersing the prosthesis in disinfectants reveals that certain solutions thus employed may alter the physical/mechanical characteristics of dental base agents, among which the color stability is a key parameter to maintain esthetics and any significant changes in the color are characteristic of damaged or aging denture base resins. Consequently, the current research was performed to evaluate the impact of different disinfectant agents on the color steadiness of denture base materials.

Materials and Methods

Preparation of Specimens

Overall 90 samples were fabricated employing commercially available Meliodent (Heraeus Kulzer GMBh and Co., Hanau, Germany) as well as ProBase Hot (Ivoclar Vivadent, Liechtenstein) heat-cure denture base resin agents. Metallic disks that were 3 mm thick and 20 mm in diameter were subjected to investment in dental flasks by means of dental stone. The mold gap that was hence procured was utilized to prepare the test samples. The dental stone mold was subject to application of separating media. As per manufacturer recommendations, mixing of the powder plus liquid was carried out. As the mix entered the dough phase, it was subjected to effective kneading and packing into the space of the mold. Finally, closure was performed using the bench press. These flasks were then permitted a small duration polymerization within a water bath at 72°C for 90 minutes. Following this they were subject to boiling in water for half an hour at 100°C within a dental acrylizer.

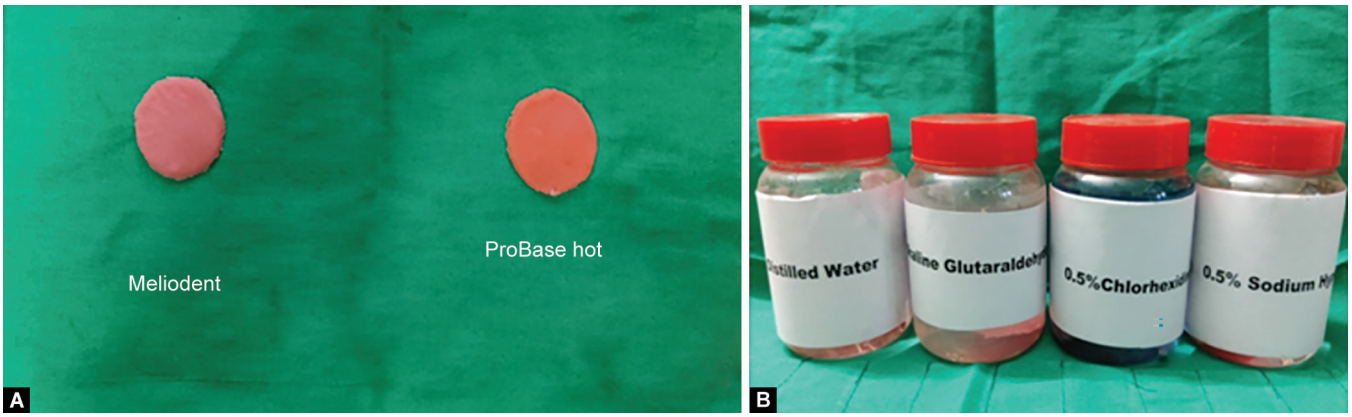
On closing the curing phase, the flasks were subjected to bench cooling until they attained room temperature. The samples were retrieved, and the flash was subjected to trimming. To finish the samples, the surplus resin was detached with a tungsten carbide bur, in pursuit of wet silicon carbide papers (600-grit, 800-grit, 1000-grit, and 1200-grit). To imitate lab measures, just a single surface was rendered wet and subjected to polishing with a cloth wheel and pumice. Each sample was visually inspected; and any specimen having intrinsic/extrinsic porosities, warpage, fractured edges, distorted proportions, or surface imperfection was subject to exclusion from this research.

Immersion of Denture Base Resins in Disinfectants

Forty-five samples of every denture base material were immersed in three chemical disinfectants: 2% alkaline glutaraldehyde, 0.5% Chlorhexidine gluconate, 0.5% sodium hypochlorite solution as well as distilled water (devoid of all disinfection ingredients) that served as a control. Each of the three disinfectants was positioned in three different glass containers with the distilled water in an additional glass container. Two samples each of different denture base substances were subjected to immersion in all 4 containers. Incubation of specimens with disinfectants was done in laboratory conditions (Figs 1A and B).

Denture Base Color Stability Measurement

Color steadiness was measured at baseline, following 1, 14 and 21 days. All disinfectant solutions were changed every day by same operator to minimize variances. After each sample was immersed for the particular time, it was subjected to water cleansing and drying with a tissue paper. Subsequent to recording the above color scores at the implicated time periods, the samples were again immersed in new solutions. Color was calculated as per CIE *L*a*b** color scale as related to standard source C alongside a white background on a reflection spectrophotometer. As per this method, all colors in nature are attained via merging of three primary colors, that is red,



Figs 1A and B: (A) Two different denture base resins prepared in the study; (B) Immersion of specimens into the experimental disinfectants

Table 1: Comparison of color stability Meliodent heat cure denture base resins after immersed in the different disinfectants at different points of time

Disinfectant solution	*Time points*	*Mean ± SD*	*F value*	*p value*
Distilled water	Baseline	6.16 ± 0.12	21.652	0.694
	1st day	6.12 ± 0.08		
	14th day	5.98 ± 0.06		
	21st day	5.74 ± 0.14		
2% alkaline glutaraldehyde	Baseline	6.12 ± 0.28	19.318	0.001
	1st day	6.08 ± 0.04		
	14th day	5.04 ± 0.11		
	21st day	4.22 ± 0.14		
0.5% chlorhexidine gluconate	Baseline	6.14 ± 0.09	18.046	0.001
	1st day	6.02 ± 0.12		
	14th day	5.38 ± 0.19		
	21st day	4.84 ± 0.10		
0.5% sodium hypochlorite solution	Baseline	6.16 ± 0.18	20.328	0.001
	1st day	6.10 ± 0.06		
	14th day	4.98 ± 0.26		
	21st day	3.14 ± 0.14		

blue and green, in definite amounts. The foundation of the CIE Lab system has been laid based on this system.

$$\text{Color differences } (\Delta E^*) = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$$

Color scoring was done in the middle of every specimen. The color of each specimen was calculated thrice and the mean scores were measured and documented.

Statistical Analysis

SPSS version 20.0 was used to analyze the data statistically. Samples were assessed prior to immersing and following the various immersion time-intervals. Data was statistically analyzed employing the two-way repeated measures analysis of variance (ANOVA). If noteworthy differences were established, Tukey's post hoc test at 95% probability level was used.

Results

Table 1 depicts the comparative assessment of color steadiness of Meliodent heat-cured denture base resin materials following immersion in the dissimilar disinfectants at the diverse time intervals. Within distilled water, the baseline color steadiness score was 6.16 ± 0.12, 6.12 ± 0.08 on the first day, 5.98 ± 0.06 on day 14, and 5.74 ± 0.14 on day 21. There were no statistically noteworthy differences amid the various time-points studied. Within 2% alkaline glutaraldehyde the baseline color constancy mean value was 6.12 ± 0.28, 6.08 ± 0.04 on the first day, 5.04 ± 0.11 on day 14 and 4.22 ± 0.14 on day 21. Within 0.5% chlorhexidine gluconate, the baseline color constancy mean value was 6.14 ± 0.09, 6.02 ± 0.12 on the first day, 5.38 ± 0.19 on 14th day, and 4.84 ± 0.10 on day 21. In 0.5% sodium hypochlorite solution, the baseline color steadiness mean value was 6.16 ± 0.18, 6.10 ± 0.06 on the first day, 4.98 ± 0.26 on 14th day, and 3.14 ± 0.14 on day 21. There was a statistically noteworthy disparity amid the diverse time-points in each of the three disinfectants (Fig. 2).

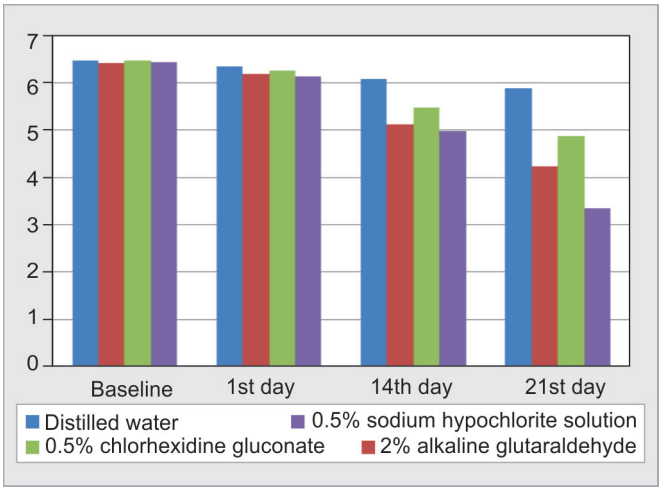


Fig. 2: Color stability of ProBase Hot heat cure denture base resins after immersed in the different disinfectants

Table 2 depicts the comparative assessment of color steadiness of ProBase Hot heat cure denture base resin materials following immersion in the dissimilar disinfectants at diverse time-intervals. In Distilled water the baseline color constancy mean value was 6.48 ± 0.02, 6.34 ± 0.09 on the first day, 6.08 ± 0.14 on 14th day, and 5.88 ± 0.07 on day 21. There were no statistically noteworthy differences amid the varying time-points. Within 2% alkaline glutaraldehyde the baseline color constancy mean value was 6.42 ± 0.16, 6.18 ± 0.11 on the first day, 5.12 ± 0.18 on 14th day, and 4.24 ± 0.24 on day 21. Within 0.5% Chlorhexidine gluconate the baseline color steadiness mean value was 6.48 ± 0.10, 6.26 ± 0.08 on the first day, 5.48 ± 0.11 on 14th day, and 4.88 ± 0.06 on day 21. In 0.5% sodium hypochlorite solution, the baseline color steadiness mean value was 6.44 ± 0.12, 6.14 ± 0.08 on the first day, 4.98 ± 0.16 on 14th day, and 3.34 ± 0.06 on day 21. There was a statistically

Table 2: Comparison of color stability ProBase Hot heat cure denture base resins after being immersed in the different disinfectants at different points of time

Disinfectant solution	*Time points*	*Mean ± SD*	*F value*	*p value*
Distilled water	Baseline	6.48 ± 0.02	22.036	0.742
	1st day	6.34 ± 0.09		
	14th day	6.08 ± 0.14		
	21st day	5.88 ± 0.07		
2% alkaline glutaraldehyde	Baseline	6.42 ± 0.16	20.210	0.001
	1st day	6.18 ± 0.11		
	14th day	5.12 ± 0.18		
	21st day	4.24 ± 0.24		
0.5% chlorhexidine gluconate	Baseline	6.48 ± 0.10	19.218	0.001
	1st day	6.26 ± 0.08		
	14th day	5.48 ± 0.11		
	21st day	4.88 ± 0.06		
0.5% sodium hypochlorite solution	Baseline	6.44 ± 0.12	19.246	0.001
	1st day	6.14 ± 0.08		
	14th day	4.98 ± 0.16		
	21st day	3.34 ± 0.06		

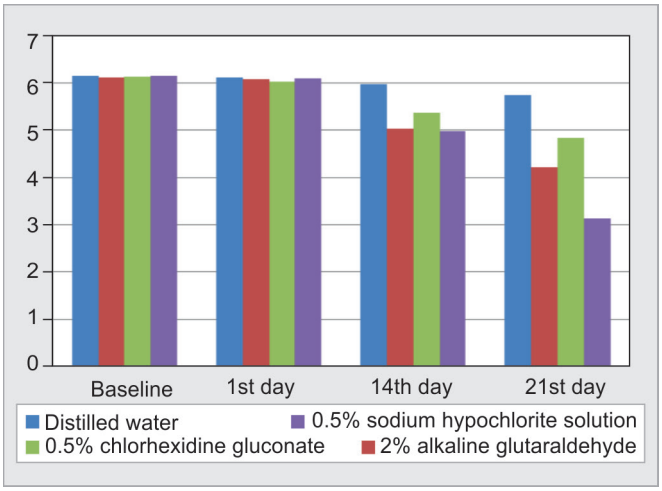


Fig. 3: Color stability of Meliodent heat cure denture base resins after immersed in the different disinfectants

noteworthy difference with *p* value <0.001 amid the dissimilar time-points in each of the three disinfectants (Fig. 3).

Discussion

Prosthetic appliances infected with disease-causing microbes provide a likely resource for infection spread among patients and dental workers. To stop cross-infectivity, prosthetic appliances must be entirely subjected to disinfection before sending to the laboratory as well as ahead of insertion. Numerous ways of disinfection have been suggested to make sure infection control during dental procedures. A secure, handy and economic technique of disinfecting dental prosthetic appliances is immersion in chemical disinfecting solutions.[11]

Alterations in color become esthetically problematic if enduring functionality of the prosthesis is required. Furthermore, this is influenced by numerous factors such as the resin-base type, technique of polymerization, use of denture cleansing agents, diet, as well as the hygiene of the oral cavity of patients. Assessment of color changes can be calculated either by visual inspection or by use of a particular armamentarium. Colorimeters as well as spectrophotometers are frequently utilized to assess color alterations of dental materials, as it eradicates subjective elucidation in addition to permitting recognition of trivial color changes. The Commission Internationale de l'Eclairage (CIE) *L**, *a**, *b** is a stable color scale that constitutes all the colors perceptible to the human eye. *us is appropriately means to judge color alterations in dental materials.[12] Johnston and Kao[13] reviewed appearance, harmonized by visual scrutiny as well as clinical colorimetry, and concluded that mean color dissimilarity amid compared teeth that were scored as a counterpart in the oral atmosphere was 3.7 Δ*E**. Um and Ruyter,[14] recommended that a detectable discoloration should be inferred as adequate till a value of Δ*E** = 3.3. In the current research, discoloration lesser than or more than Δ*E** = 3.3 was addressed as "acceptable" or "unacceptable" in that order. As per this research, the color alterations shown by all samples following 28 days were clinically acceptable.

In this research the color steadiness of the heat-polymerized acrylic resin was somewhat improved following immersion in 0.5% chlorhexidine gluconate, then the 2% alkaline glutaraldehyde and 0.5% sodium hypochlorite solution in pursuit. This finding is not in agreement with the research of Reis et al.[15] and Yiu et al.[16] who elucidate that sodium hypochlorite exhibits a whitening result through oxidation reaction at the surface of denture acrylic resins. Such an occurrence was not noted in the materials subjected to test in this research. The acrylic resin has basically the same chemical composition: high molecular weight polymethyl methacrylate, cross-linked resin plus IPN (Interpenetrating Polymer Network). The result is the formation of a polymer with high chemical and

physical resistance. Consequently, these superior characteristics also make these materials less prone to the oxidative effects of this disinfectant solution.

Similarly, studies conducted by Duymus and Yanikoglu,[17] and Zissis et al.[18] stated that processing of acrylic dentures may subject them to numerous possibilities for defects, which result in shape deviations, failures of surface structures and porosities. Void producing defects impair the downgrade and structure the physical and biological quality of denture base resins. Additionally, these defects have a negative influence on the hygienic characteristics and they compromise the esthetics (color changes) of the denture base resins.

In our research, no noteworthy color changes of heat cure acrylic resins following immersion in distilled water were seen. This can be attributed to a lack of coloring agents that may contribute to changes on the sample surface, and cause discoloration. Additionally, the pH of water may lead to a small amount of roughness on the surface owing to its neutral nature. This is in accordance with the research of Bensel et al.[19] who inferred that storage in distilled water causes color variation in the test samples from ΔE 0.66 ± 0.32 to ΔE 1.00 ± 1.14. The data assessment of the color measurements depict that the tested disinfectants did not cause any major color alteration.

This is also in agreement with the research by Keyf and Etikan.[20] The trivial color alteration in mineral water with time may take place owing to existence of water, that has a tendency to make softer the polymer by leading to swelling of the network and relaxing the frictional forces amid the polymer chains.

Infection control protocols command the disinfection of all dentures. There are no results available that are designed for the particular use of disinfecting dentures. Color stability of the denture materials is one varying to be considered when choosing disinfectant. This will be useful to clinicians when they are selecting disinfectant solutions for the disinfection of dentures.

Absence of human saliva and the biofilm over denture surfaces are limitations of our research, as these factors may also contribute to color alterations resulting in a not-so-precise estimation of the performance of the agents being tested in the clinical scenario. Thus, the outcomes of this study can only be a hopeful beginning for future research. In addition, we utilized a straightforward disc-shape sample that is not a true reflection of the real shape. Further studies ought to entail the polymerization method as well as other kinds of denture bases and nano-particles. Also, the polishing effects must be analyzed.

Conclusion

In the confines of the inherent limitations of this research, it can be inferred that the color steadiness of either denture base resins was enhanced following immersion in 0.5% chlorhexidine gluconate in pursuit by 2% alkaline glutaraldehyde as well as 0.5% sodium hypochlorite solution. Distilled water exerted the smallest amount of influence on the color change of the samples of denture base resins.

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