

# Comparative Evaluation of Colour Stability of Conventional Heat-Cured Acrylic Denture Base Resin After Using Natural and Chemical Denture Cleansers: An In-Vitro Study

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## ABSTRACT

**Background:** The long-term aesthetics and functionality of acrylic dentures depend significantly on the color stability of the denture base material. Commonly used chemical cleansers and natural products may impact the color of polymethyl methacrylate (PMMA), the most widely used denture base resin.

**Aim:** To compare and evaluate the effect of natural (Triphala, Neem, Aloe vera) and chemical (Soap, Chlorhexidine mouthwash, Denture cleansing tablet) cleansers on the color stability of conventional heat-cured PMMA resin.

**Materials and Methods:** A total of 105 standardized PMMA specimens were fabricated and divided into seven groups (n=15 per group). Group I (control) was immersed in distilled water; Group IIA [A1-A3] were immersed in natural cleansers

(Triphala, Neem, Aloe vera), and Group IIIB [B1-B3] in chemical cleansers (Soap, Mouthwash, Clinsodent tablet). Specimens were immersed daily for 1 hour and stored in distilled water between immersions. Color measurements were taken using a spectrophotometer (FRU, CIE Lab\*) at baseline, 1 month, 3 months, and 6 months.  $\Delta E$  values and NBS units were calculated and statistically analyzed using ANOVA.

**Results:** All groups showed an increase in  $\Delta E$  values over time. The least color change at 6 months was observed with Aloe vera ( $\Delta E=2.88$ ), while the highest was with distilled water ( $\Delta E=4.99$ ) and Clinsodent ( $\Delta E=4.67$ ). Natural cleansers, particularly Aloe vera and Triphala, showed better color stability compared to chemical agents. Statistically significant differences were observed between groups ( $p<0.001$ ).

**Conclusion:** Natural denture cleansers like Aloe vera and Triphala are viable alternatives to chemical cleansers for

maintaining denture hygiene without compromising color stability. Dentists should consider recommending them to improve long-term patient satisfaction.

**Keywords:** Acrylic resin, PMMA, color stability, denture cleansers, Triphala, Aloe vera, Clinsodent.

## INTRODUCTION

Polymethyl methacrylate (PMMA) is the most commonly used denture base material due to its favorable mechanical properties, acceptable aesthetics, ease of manipulation, and cost-effectiveness [1]. However, long-term usage, particularly with improper hygiene practices, may lead to color changes that compromise aesthetics and patient satisfaction [2].

Denture cleansers are widely used to ensure hygiene, yet their impact on the material properties of PMMA, especially color stability, is a growing concern [3]. While chemical cleansers such as chlorhexidine and sodium perborate tablets are effective against microbial biofilm, they may contribute to gradual discoloration of the prosthesis [4,5]. On the other hand, natural substances like Aloe vera, Triphala, and Neem—traditionally used in Indian medicine—offer antimicrobial effects with potentially less harm to material properties [6].

The present in-vitro study was undertaken to evaluate and compare the impact of selected natural and chemical denture cleansers on the color stability of heat-cured acrylic denture base resin over a six-month period.

## MATERIALS & METHODS

### Specimen Preparation

- 105 rectangular PMMA samples ( $64 \times 10 \times 3.3$  mm) were fabricated using DPI heat-cure resin [7].



Fig 1: PMMA samples

Samples were divided into 3 groups and 6 sub-groups (n=15):

**Group I (Control):** Distilled water

**Group IIA (Natural Cleansers):**

- A1: Triphala
- A2: Neem
- A3: Aloe vera

**Group IIIB (Chemical Cleansers):**

- B1: Soap
- B2: Chlorhexidine mouthwash
- B3: Clinsodent tablet

### Preparation of Cleansing Solutions

In this study, three natural (Triphala, Neem, Aloe vera) and three chemical (Soap, Chlorhexidine Mouthwash, Denture Cleansing Tablet) denture cleansers were used. All solutions were freshly prepared daily in 200 ml of distilled water and stirred every 10 seconds for 2 minutes at room temperature.

- **Triphala:** 20 g of Triphala powder dissolved, stirred, and filtered.
- **Neem:** 2 Neem tablets dissolved, stirred, and filtered.
- **Aloe Vera:** 20 ml of aloe vera gel mixed, stirred, and filtered.
- **Soap:** 20 ml of liquid soap mixed and stirred.
- **Mouthwash:** 20 ml of 0.2% Chlorhexidine mouthwash diluted and stirred.

- **Denture Cleansing Tablet:** 1 Clinsodent tablet dissolved as per manufacturer’s instructions and stirred.

Color measurements were performed using a spectrophotometer based on the CIE L\*a\*b\* system under standard illuminant A, with calibration done before each session [8].

- L\* represents lightness (0 = black, 100 = white),
- a\* indicates red (+) to green (-),
- b\* indicates yellow (+) to blue (-).

Color change ( $\Delta E$ ) was calculated using:

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

To assess clinical relevance,  $\Delta E$  was converted into NBS units using:

$$\text{NBS Unit} = \Delta E \times 0.92$$

**Statistical Analysis** Statistical analysis was performed using One-Way Analysis of Variance (ANOVA) to compare the color stability ( $\Delta E$  values) and corresponding NBS (National Bureau of Standards) units of conventional heat-cured acrylic dentures immersed in different denture cleansing solutions at four-time intervals: baseline, 1 month, 3 months, and 6 months.

All statistical analyses were interpreted at a significance level of  $p \leq 0.05$ .

## RESULT

The table 1 presents titled "Critical Marks of Color Difference According to the NBS provides a scale to measure color differences based on National Bureau of Standards (NBS) units

Critical marks of color difference	Textile terms (NBS UNITS)
Trace	0.0-0.05
Slight	0.5-1.5
Noticeable	1.5-3.0
Appreciable	3.0-6.0
Much	6.0-12.0
Very much	$\geq 12.0$

TABLE 1: CRITICAL MARKS OF COLOR DIFFERENCE ACCORDING TO THE NBS

### Baseline (0 Months)

At baseline, the NBS values across all groups ranged from 0.01 to 0.04, indicating “trace” or imperceptible color changes in all groups. This confirms that the initial fabrication of the denture base resin had uniform color properties and no noticeable discoloration due to storage media at this stage.

### After 1 Month

NBS units increased to a range of 1.42 (Aloe Vera) to 2.37 (Distilled Water). These values fall within the “slight” to “noticeable” range, indicating early but perceptible color changes, especially in distilled water. Aloe Vera, Soap, and Neem showed lesser changes, suggesting milder interaction with the acrylic resin surface.

### After 3 Months

NBS values ranged from 2.54 (Chlorhexidine) to 3.96 (Distilled Water). These values enter the “noticeable” to “appreciable” category. Distilled water

again resulted in higher color change, likely due to water sorption and lack of active cleansing properties. In contrast, Chlorhexidine and Aloe Vera maintained better color stability, supporting their efficacy in minimizing pigment absorption or surface degradation.

### After 6 Months

At the 6-month interval, the NBS values were highest, ranging from 2.51 (Aloe Vera) to 4.87 (Distilled Water). Distilled water again caused the greatest discoloration, falling into the “appreciable” range. This highlights that passive soaking without cleansing action may promote discoloration over time. Aloe Vera, Soap, and Neem remained within the “noticeable” range, suggesting relatively stable long-term color preservation. The antimicrobial and antioxidant properties of Aloe Vera and Neem may contribute to their protective effects against staining.

**TABLE 2: COLOR DIFFERENCE AFTER IMMERSION IN DIFFERENT DISINFECTANT SOLUTIONS**

Solutions		Baseline	1 month	3 months	6 months
Control	Distilled Water	Trace	Noticeable	Appreciable	Appreciable
Natural	Triphala (A1)	Trace	Noticeable	Noticeable	Noticeable
	Neem (A2)	Trace	Noticeable	Appreciable	Appreciable
	Aloe-Vera (A3)	Trace	Slight	Noticeable	Noticeable
Commercial	Soap (B1)	Trace	Noticeable	Noticeable	Appreciable
	Chlorhexidine (B2)	Trace	Noticeable	Noticeable	Appreciable
	Clinsodent (B3)	Trace	Noticeable	Appreciable	Appreciable

Table 2 presents the qualitative assessment of color differences in conventional heat-cured acrylic dentures following immersion in various disinfectant solutions at four-time intervals: baseline, 1 month, 3 months, and 6 months

Overall, natural cleansers like Aloe Vera and Triphala maintained better color stability over time, whereas distilled water, commercial soap, and Clinsodent led to greater discoloration

## DISCUSSION

Heat-cured PMMA is the most commonly used denture base material due to its excellent aesthetics, biocompatibility, and ease of processing, though it is susceptible to color changes over time from chemical exposure and water sorption.

**Triphala:** A traditional Ayurvedic formulation with antifungal and antioxidant properties, particularly effective against *Candida* due to its gallic acid content [6]

Prakhar Khurana et al [9]. found that Triphala and Aloe vera, when combined with denture cleansers, did not significantly affect the color stability of heat-cured PMMA resin, aligning with the present study's findings that natural cleansers like Triphala maintain better color stability than chemical agents.

**Neem (Azadirachta indica):** Known for its broad-spectrum antimicrobial and anti-adhesive properties, especially effective against *Candida albicans* and plaque-forming bacteria.

**Aloe Vera (Barbadensis miller):** Exhibits antibacterial, antifungal, and anti-inflammatory effects due to bioactive compounds like lupeol and salicylic acid [6].

**Soap:** Acts as a mechanical and chemical cleanser, commonly used for denture hygiene, with proven antimicrobial efficacy and low cytotoxicity [10].

**Mouthwash (Chlorhexidine 0.2%):** A broad-spectrum disinfectant effective against bacteria and fungi, though long-term use may cause bleaching or staining [11].

**Denture Cleansing Tablet (Clinsodent):** Contains sodium perborate, releasing active oxygen for chemical and mechanical cleaning, but may cause color fading with prolonged use [12].

Amanda Peracini et al [13]. studied the effect of denture cleansers (Corega Tabs, Bony Plus) on heat-polymerized acrylic resin over 180 days. Color changes measured with a colorimeter were clinically insignificant, supporting the current study's finding that while discoloration occurs over time, it remains within acceptable limits.

Anand Porwal et al [12]. evaluated the impact of denture cleansers (sodium perborate, sodium hypochlorite) on color stability, surface hardness, and roughness of three denture base resins. All color changes remained within clinically acceptable ranges, aligning with the current study's observation of time-related discoloration.

Turki Almuraikhi et al [14]. assessed the effect of chemical disinfectants on denture base resin color. Distilled water caused the least color change, while disinfectants showed some influence. These results support the present study's conclusion that discoloration occurs over time, even with controlled immersion.

**Distilled Water:** Used as a control, it lacks active cleaning agents but causes discoloration over time due to water sorption and polymer degradation [15].

This study evaluated the color stability of conventional heat-cured acrylic denture base resin when immersed in various natural (Triphala, Neem, Aloe Vera) and chemical (Soap, Chlorhexidine mouthwash, Clinsodent tablet) denture cleansers. Specimens were immersed daily for 1 hour and stored in distilled water between immersions. Color measurements were taken using a spectrophotometer (FRU, CIE Lab\*) at baseline, 1 month, 3 months, and 6 months.

Among natural cleansers, Aloe Vera consistently demonstrated the highest color stability, followed by Triphala and Neem. In the chemical group, Chlorhexidine showed better color stability than Soap and Clinsodent. Distilled water, used as control, surprisingly caused the most significant discoloration over time.

The  $\Delta E$  values increased progressively across all groups, with the most prominent changes occurring at 6 months. These results align with previous studies suggesting that prolonged immersion, even in distilled water, can degrade acrylic resin through hydrolytic and oxidative processes. Natural agents like Aloe Vera and Triphala were found to be effective, non-toxic, and economical alternatives to chemical cleansers. However, Neem, while beneficial for its antimicrobial properties, showed greater discoloration, possibly due to its strong phytochemical content.

Although chemical cleansers like Clinsodent and Chlorhexidine are effective in microbial control, they may compromise color stability over time, emphasizing the need for a balance between antimicrobial efficacy and esthetic longevity.

This in-vitro study indicates that natural denture cleansers can be safe and effective for long-term use, with minimal impact on the esthetics of denture base materials. However, further in-vivo research is

necessary to validate these findings under clinical conditions.

## CONCLUSION

Within the limitations of this in vitro study, the following conclusions can be drawn:

1. All tested denture cleansers—both natural and chemical—caused a progressive change in color of conventional heat-cured acrylic denture base resin over time.
2. Aloe Vera showed the highest color stability among natural denture cleansers, followed by Triphala and Neem.
3. Among chemical cleansers, Chlorhexidine mouthwash demonstrated the least color change, followed by Soap, while Clinsodent denture cleansing tablet showed the highest discoloration.
4. Distilled water, despite being a neutral control solution, exhibited the most significant discoloration, likely due to long-term water sorption and polymer degradation.
5. Natural agents, particularly Aloe Vera and Triphala, appear to be safe, cost-effective, and esthetically favorable alternatives to chemical cleansers for denture hygiene.

**Clinical relevance:** The choice of denture cleanser significantly affects the long-term color stability of denture base resins. Clinicians should consider recommending natural cleansers like Aloe Vera to patients concerned about esthetics, especially for prolonged use.

Further in-vivo studies are recommended to validate these results and assess the combined effects of oral environment and patient factors on denture color stability.

### Declaration by Authors

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## REFERENCES

1. Prosthodontic Applications of Polymethyl Methacrylate (PMMA): An Update Muhammad Sohail Zafar
2. Shah VR, Shah DN, Chauhan CJ, Doshi PJ, Kumar A. Evaluation of flexural strength and color stability of different denture base materials including flexible material after using different denture cleansers. *The Journal of Indian Prosthodontic Society*. 2015 Oct 1;15(4):367-73.
3. Hong G, Murata H, Li Y, Sadamori S, Hamada T. Influence of denture cleansers on the color stability of three types of denture base acrylic resin. *The Journal of prosthetic dentistry*. 2009 Mar 1;101(3):205-13.
4. Uludamar A, Ozkan YK, Kadir T, Ceyhan I. In vivo efficacy of alkaline peroxide tablets and mouthwashes on *Candida albicans* in patients with denture stomatitis. *Journal of Applied Oral Science*. 2010;18:291-6.
5. Kumar P, Patel N, Patel N. Effects of denture cleansers on denture material properties—An observational Case—Control Study. *Journal of Oral Research*. 2020;9(1):72-80.
6. Ojah P, Luniyal C, Nair C, Astekar M, Pal A, Chopra M. Anti candidal efficacy of commercially available triphala, neem, denture cleanser and natural aloe vera leaf on heat polymerized acrylic resin. *The Journal of Indian Prosthodontic Society*. 2021 Apr 1;21(2):167-72.
7. De Andrade IM, Cruz PC, da Silva CH, de Souza RF, de Freitas Oliveira Paranhos H, Candido RC, Marin JM, de Souza-Gugelmin MC. Effervescent tablets and ultrasonic devices against *Candida* and mutans streptococci in denture biofilm. *Gerodontology*. 2011 Dec;28(4):264-70.
8. Westland S. Review of the CIE system of colorimetry and its use in dentistry. *Journal of Esthetic and Restorative Dentistry*. 2003 Dec;15:S5-12.
9. Khurana P, Singhal R, Agarwal SK, Kalpana K. Comparative evaluation of the effect of two plant extract and denture cleanser on the staining and anti-fungal efficacy of denture base resin: An in vitro study. *Journal of Dentistry and Oral Biology*. 2022;7(3):1-7.
10. Zoccolotti JD, Tasso CO, Arbeláez MI, Malavolta IF, Pereira EC, Esteves CS, Jorge JH. Properties of an acrylic resin after immersion in antiseptic soaps: Low-cost, easy-access procedure for the prevention of denture stomatitis. *PloS one*. 2018 Aug 30;13(8):e0203187.
11. Zulkarnain M, Angelyna P. The Effect of Immersed Heat Cured Acrylic Resin Denture Base in Chlorhexidin and Extract of Roselle Flower towards Color Stability. In International Dental Conference of Sumatera Utara 2017 (IDCSU 2017) 2018 Feb (pp. 177-179). Atlantis Press.
12. Porwal A, Khandelwal M, Punia V, Sharma V. Effect of denture cleansers on color stability, surface roughness, and hardness of different denture base resins. *The Journal of Indian Prosthodontic Society*. 2017 Jan 1;17(1):61-7.
13. Peracini A, Davi LR, de Queiroz Ribeiro N, de Souza RF, da Silva CH, Paranhos HD. Effect of denture cleansers on physical properties of heat-polymerized acrylic resin. *Journal of prosthodontic research*. 2010 Apr 1;54(2):78-83.
14. Almuraikhi T. Evaluation of the impact of different disinfectants on color stability of denture base materials: A comparative study. *The Journal of Contemporary Dental Practice*. 2022 Aug 10;23(5):543-7.
15. Amin F, Iqbal S, Azizuddin S, Afridi FI. Effect of denture cleansers on the color stability of heat cure acrylic resin. *J Coll Physicians Surg Pak*. 2014 Nov

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