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A Comparative Evaluation of Stain Removal Efficacy of Commercially Available Chemical Denture Cleansers with Natural Denture Cleansers on Different Acrylic Teeth: An *in vitro* Study

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ABSTRACT

Background: Staining of dentures undermines both appearance and oral cleanliness. Although chemical cleansing agents dominate current practice, plant-derived alternatives are drawing increasing interest because they are well tolerated and easy to obtain.
Aim: To assess and contrast how effectively marketed chemical denture cleansers and natural cleansing agents remove stains from different types of acrylic denture teeth.
Materials and Methods: Two hundred acrylic denture teeth comprising Premadent and Acryrock brands were prepared and kept immersed in coffee and tea staining solutions over a three-month period. The specimens were allocated to five groups according to the cleansing agent applied, namely distilled water serving as the control, Densive, Clinsodent, Aloe vera, and Neem. A spectrophotometer was used to capture colour readings, from which colour-difference (ΔE) values were derived. The data were examined with a paired t-test together with one-way ANOVA.
Results: The degree of staining was more pronounced with coffee than with tea. The chemical cleansers Clinsodent and Densive removed stains far more effectively than the natural agents did. Within the natural group, Neem outperformed Aloe vera.
Conclusion: Chemical denture cleansers continue to be the most efficient option for eliminating stains, whereas natural cleansers, given their biocompatibility and ready availability, are better suited to a supporting role.

Keywords: *Denture cleansers, Color stability, Aloe vera, Neem, Clinsodent, Densive*

INTRODUCTION

Patient expectations regarding appearance have risen steadily throughout every branch of modern dentistry.[1] Because of this, the choice of artificial teeth contributes substantially to how esthetic a denture ultimately appears.[2] Both the artificial teeth and the acrylic resin bases of complete dentures come into repeated contact with foods and drinks, together with the acidic pH and pigments this carry. Over time such repeated exposure compromises colour, surface smoothness, esthetics, physico-mechanical performance, and longevity.[3] When prosthetic materials are being selected, both the patient and the clinician need to weigh how well the denture teeth and bases withstand colour change.[4] To improve their mechanical behaviour, artificial teeth are manufactured from polymethyl methacrylate polymers or from highly cross-linked acrylic resins, while porcelain teeth provide the greatest resistance to wear and to discolouration.

Keeping dentures clean is fundamental to oral health, since heavy plaque build-up can give rise to periodontal disease or caries.[5] Everyday cleaning is achieved through mechanical or chemical means.[4] The mechanical category covers brushes, microwave treatment, and ultrasonic devices, whereas the chemical category relies on denture cleansers, antimicrobial rinses, and denture creams that are used to remove bacteria and stains.[6]

Agents employed as denture cleaners include alkaline hypochlorites, dilute organic and inorganic acids, disinfectants, and enzymes. Such agents are convenient to apply, work with every type of denture base material, possess antimicrobial activity, and help preserve the colour stability of both the denture base and the teeth.[4]

Natural cleansing agents, notably aloe vera and neem, have attracted attention on account of their antimicrobial action and their limited unwanted effects. In dentistry aloe vera serves as a disinfectant that carries no adverse consequences,[7] while neem acts effectively against the oral bacterial flora and periodontal organisms.[8] These natural agents are also inexpensive, easy to obtain, and fully biodegradable.[7]

MATERIALS & METHODS

Study Design: An in vitro experimental study was conducted.

Materials used

1. Dental modelling wax (Dental products of India Ltd.)
2. Polyvinyl Chloride Cylinder (Supreme Industries Ltd.)
3. Cold mould seal (Dental Products of India Ltd.)
4. Self-Cure Clear Acrylic Resin (Dental Products of India Ltd.)
5. Monomer (Dental Products of India Ltd.)
6. Premadent Acrylic teeth set (Premadent Dental Products Pvt. Ltd.)
7. Acryrock teeth set (Ruthinium Group, Italy)
8. Staining agents:

A. Bru Instant Coffee (Hindustan Unilever Ltd)

B. Brooke Bond Red Label Tea (Hindustan Unilever Ltd)

9. Commercially available chemical denture cleansers:

A. Densive denture cleanser (Group Pharmaceuticals Ltd.)

B. Clinsodent powder (ICPA Health Products Ltd., Ankleshwar)

10. Natural based cleansers:

A. Aloe vera

B. Neem (Himalaya Wellness Company)

11. Distilled water (HI – TECH, Hyderabad)
12. Pumice (Neelkanth Healthcare Private Ltd)

Equipment used:

Spectrophotometer: FRU WR10 (Shenzhen Wave Optoelectronics Technology Co., Ltd.). Fig :1

Fig: 1 Spectrophotometer

Fabrication of acrylic denture teeth (ADT) samples: Two hundred acrylic denture teeth (ADT) specimens, each measuring 53 mm × 14 mm, were prepared in the following manner. Conforming to ADA specification no. 15 (ISO 22112:2017), every ADT specimen was seated in a purpose-made acrylic holder that fitted exactly into the recess of the spectrophotometer. Each specimen was oriented with its palatal surface facing downward and its buccal surface facing upward. The specimens were trimmed and polished while the stated dimensions were carefully retained. This procedure yielded the complete set of 200 samples, as depicted in figure 2.

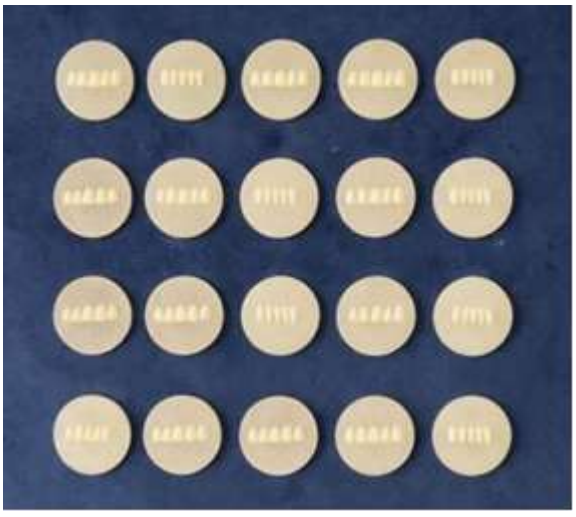

Fig: 2 ADT samples

Baseline Color Measurement Before the specimens were placed in the staining solutions, their colour was recorded with an FRU spectrophotometer operating on the CIE L*a*b* colour system. The recorded parameters were L* representing lightness, a* denoting the red–green axis, and b* denoting the yellow–blue axis.

The colour difference (ΔE) separating the pre- and post-immersion readings was obtained from the equation $\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$.

Preparation of Staining Solutions

Coffee solution — 100 grams of coffee powder was added to 1800 ml of boiling water and stirred at 20-second intervals for 2 minutes before being allowed to cool to room temperature. Tea solution — 100 grams of tea powder was combined with 2000 ml of boiling water, stirred at 20-second intervals for 2 minutes, and left to reach room temperature; any undissolved residue was then removed by passing the liquid through filter paper.

Subgrouping of Samples The full set of 200 samples was distributed among four subgroups, each containing 50 specimens:

- Subgroup 1: Premadent teeth immersed in coffee solution
- Subgroup 2: Premadent teeth immersed in tea solution
- Subgroup 3: Acryrock teeth immersed in coffee solution
- Subgroup 4: Acryrock teeth immersed in tea solution

Each subgroup was left immersed in its assigned staining solution and kept for three months so as to reproduce the effects of prolonged staining.

Color Evaluation of Stained Samples Once the staining interval had elapsed, the specimens were washed under distilled water and dried. The colour values obtained at this stage were treated as the post-staining measurements and later compared against the baseline readings.

Grouping of ADT samples

- Group A: 40 samples with Distilled water (Control group)
- Group B: 40 samples with Densive denture cleanser tablets
- Group C: 40 samples with Clinsodent denture cleaning powder
- Group D: 40 samples with Aloe vera
- Group E: 40 samples with Neem

Preparation of denture cleanser solutions

The cleansing solutions were made up as described below:

1. Addition of two tablets of Densive denture cleanser (Group Pharmaceuticals Ltd., Palghar) to 200ml of water.
2. Addition of two teaspoon full powder of Clinsodent (Peroxide cleanser, ICPA Health Products, India) to 200ml of water.
3. Addition of 20 ml Aloe vera gel to 200 ml of water.
4. Addition of 2 Neem tablets (Himalaya Neem tablet) in 200 ml water
5. Distilled water (control group) 100 ml.

Color Stability Evaluation After Immersion in Cleansers The stained specimens were placed in their designated cleansing solutions. When the cleansing interval was complete, each specimen was rinsed with distilled water and dried, after which its ΔE value was compared with both the baseline and the post-staining figures in order to gauge how effectively the stain had been removed.

Statistical Analysis

The collected data were processed in IBM SPSS. Within-group differences were examined with the paired t-test, while comparisons between groups relied on one-way ANOVA. A p-value below 0.05 was taken to indicate statistical significance.

RESULT

TABLE 1: COMPARISON OF MEAN COLOR CHANGE VALUES BEFORE IMMERSION AND AFTER 3 MONTHS OF IMMERSION AMONG THE DIFFERENT STUDY GROUPS

Group	Before immersion		After immersion		P value
	Before Mean	Standard deviation(SD)	After Mean	Standard deviation(SD)	
Premadent Coffee	3.3876	1.45214	7.1944	2.11881	.000
Premadent Tea	3.3338	1.20668	6.2842	1.87343	.000
Acryrock Coffee	11.3884	3.36619	7.0988	2.03951	o.000
Acryrock Tea	10.8714	3.42328	6.5624	2.41730	.000

Paired t test; ANOVA; p-value < 0.001 is statistically significant

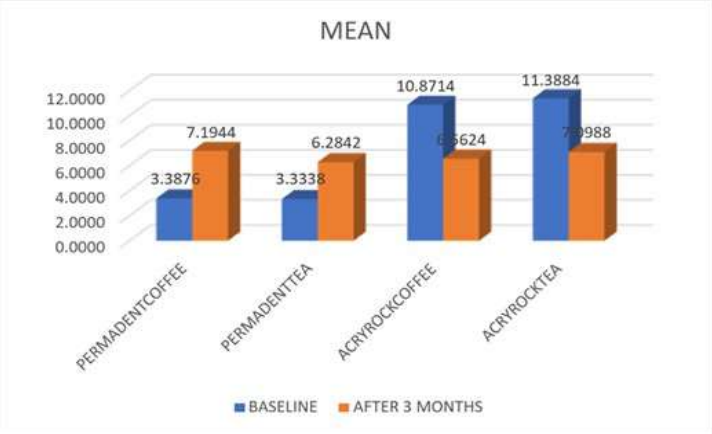

Fig: 3

TABLE 2: EFFICACY OF CLEANSING AGENTS IN STAIN REMOVAL OF PREMADENT TEETH IMMERSED IN COFFEE

	Before immersion		After immersion		
Cleansing agent	Before Mean	Standard deviation	After Mean	Standard deviation	P value
Control group (Distilled Water)	6.6020	2.17943	6.4600	2.18778	.033
Chemical cleanser Densive	6.6800	1.98496	3.9360	1.17561	.000
Clinsodent	7.4900	2.30708	3.6870	1.10651	o.000
Natural cleanser Aloe vera	8.0400	1.81737	7.0450	1.72602	.000
Neem	7.1600	2.35578	5.5950	1.84481	o.000

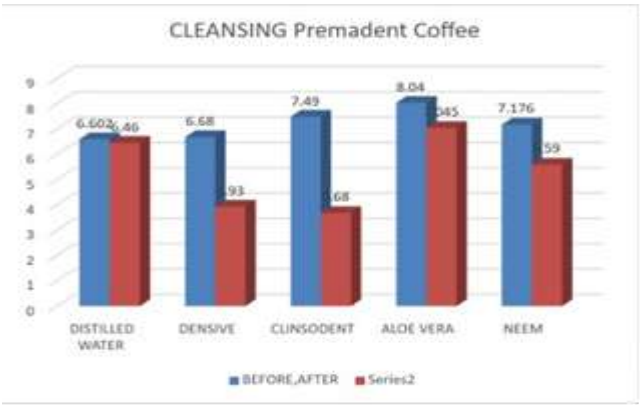

Fig: 4

TABLE 3: EFFICACY OF CLEANSING AGENTS IN STAIN REMOVAL OF PREMADENT TEETH IMMERSED IN TEA

	Before immersion		After immersion		
Cleansing agent	Before Mean	Standard deviation	After Mean	Standard deviation	P value
Control group (Distilled Water)	5.6670	1.73335	5.2160	1.67627	.000
Chemical cleanser Densive	7.4660	2.04194	3.6380	0.88516	.000
Clinsodent	6.1060	2.05565	4.6740	1.60032	o.000
Natural cleanser Aloe vera	5.8840	1.96711	4.6740	1.60032	.000
Neem	6.2980	1.28482	4.2010	.85542	0

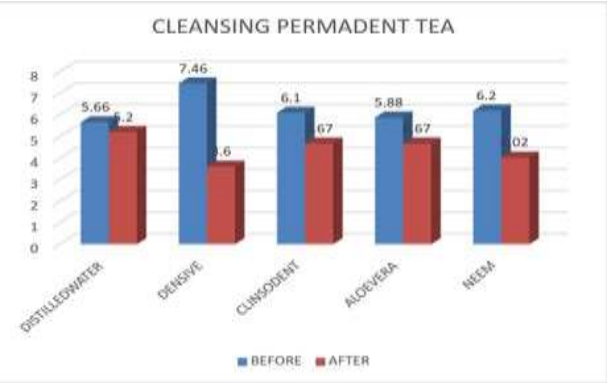

Fig: 5

TABLE 4: EFFICACY OF CLEANSING AGENTS IN STAIN REMOVAL OF ACRYROCK TEETH IMMERSED IN COFFEE

	Before immersion		After immersion		
Cleansing agent	Mean	Standard deviation	Mean	Standard deviation	P value
Control group (Distilled Water)	7.5300	1.94583	7.5130	1.91090	.818
Chemical cleanser Densive	6.7160	2.16140	4.1520	1.28295	.000
Clinsodent	6.5230	1.52167	3.4220	.88089	o.000
Natural cleanser Aloe vera	6.8450	2.20736	6.4380	2.17351	.000
Neem	7.8800	2.34806	6.5480	2.00548	o.000

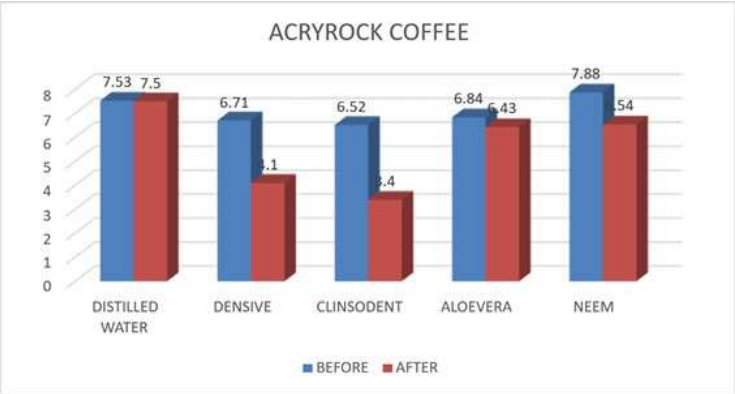

Fig: 6

TABLE 5: EFFICACY OF CLEANSING AGENTS IN STAIN REMOVAL OF ACRYROCK TEETH IMMERSED IN TEA

	Before immersion		After immersion		
Cleansing agent	Before Mean	Standard deviation	After Mean	Standard deviation	P value
Control group (Distilled Water)	6.2170	2.21907	5.8500	2.27198	.001
Chemical cleanser Densive	6.2600	2.15107	3.3750	1.18948	.000
Clinsodent	6.1670	2.93431	2.7950	1.38809	o.000
Natural cleanser Aloe vera	6.3070	2.12859	5.3260	1.78420	.000
Neem	7.8610	2.60137	5.6450	1.96403	o.000

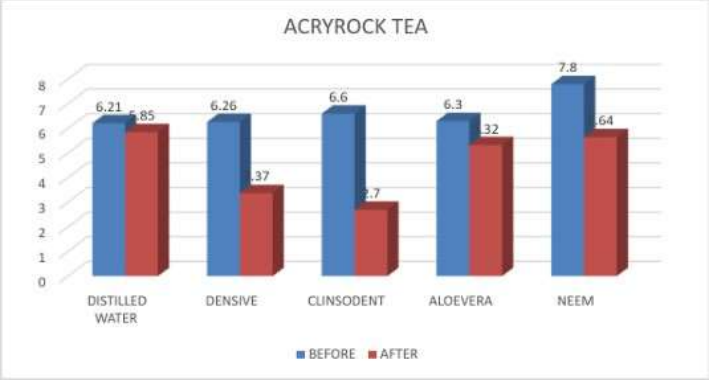

Fig: 7

Staining Intensity:

- Coffee > Tea

Cleansing efficacy:

- Premadent (Coffee): Clinsodent > Densive > Neem > Aloe vera > Control
- Premadent (Tea): Clinsodent > Densive > Neem > Aloe vera > Control
- Acryrock (Coffee): Clinsodent > Densive > Neem > Aloe vera > Control
- Acryrock (Tea): Clinsodent > Densive > Neem > Aloe vera > Control

DISCUSSION

Because it bears so heavily on a patient's confidence and self-esteem, esthetics occupies a central place in prosthodontic

rehabilitation. Even with the progress made in dental materials and methods, the discolouration of denture teeth persists as a familiar clinical problem that undermines the long-term success of the prosthesis.[9]

Dietary chromogens like coffee and tea act on acrylic denture teeth continuously, and their discolouring effect accumulates as time passes.[3] Such staining stems from a combination of intrinsic and extrinsic causes. The intrinsic component can develop when residual monomers or catalysts such as benzoyl peroxide undergo oxidation, whereas the extrinsic component originates from the deposition of plaque and dietary pigments. Eriksen and Nordbö attributed extrinsic staining to three mechanisms: chromogenic bacteria, pigments from the diet, and chemical alteration of pellicle constituents.[10]

When acrylic denture teeth meet staining drinks such as coffee, tea, and cola, discolouration develops through both adsorption of pigment at the surface and its absorption into the interior. The chromogenic molecules first settle on the surface and then move into the polymer matrix by way of water sorption, an inherent trait of methacrylate-based resins. This uptake of moisture produces a slight swelling and widens the gaps between polymer chains, which allows the staining molecules to diffuse more deeply and creates intrinsic discolouration. The extent of discolouration therefore depends not only on which staining agent is involved but also on material characteristics such as water sorption and polymer make-up.[11]

Kurtulmus-Yilmaz and Deniz examined how readily artificial teeth stained after immersion in coffee, red wine, and tea, and found the largest colour shift with red wine, followed in order by coffee and then tea. The present investigation used coffee and tea, both being among the most widely consumed beverages, and coffee was seen to stain the specimens more heavily than tea, as shown in figure 3.[12]

Ceramic and methacrylate-based resins are the materials most often used for denture teeth. Relative to ceramic versions, resin teeth offer several benefits, among them stronger bonding to the denture base, lower weight, and a diminished likelihood of fracture.[1]

Chitragar et al assessed the colour stability of several denture teeth, Acryrock and Cosmo HXL among them. Acryrock recorded smaller colour-change values than Cosmo HXL, signalling stronger resistance to staining. The authors ascribed this to its highly cross-linked acrylic resin matrix, which limits water sorption and pigment ingress, as reflected in figures 6 and 7, and in turn supports lasting esthetic stability for patients exposed to chromogenic substances.[13]

For edentulous patients, looking after both the dentures and the oral tissues is vital to overall health.[14] Harvinder Singh et al surveyed the oral conditions seen in denture wearers and reported angular cheilitis, secondary infections, mucosal lesions, and stomatitis or burning mouth syndrome arising from the difficulty of keeping dentures hygienic.[15]

The discolouration of acrylic denture teeth is governed by several factors at once, including the staining agents themselves, the length of use, functional wear, and ageing.[2] Mechanical wear plays a part by degrading the surface and raising its roughness, which encourages plaque to gather and chromogenic substances to adsorb, and this produces extrinsic discolouration. Regular consumption of beverages hastens staining because of their tannins and polyphenols, and tobacco smoke leaves deposits of tar and pigment on the denture surface.[16]

Acrylic resins withstand extended brushing provided that soft, long-bristled brushes and non-abrasive dentifrices are chosen. Cleaning pastes and powders for dentures include abrasive constituents such as calcium carbonate, whereas formulations based on sodium bicarbonate are gentler. Budtz-Jørgensen advocated a denture-cleaning paste incorporating zirconium compounds (the $ZrSiO_2$–ZrO system) as it polishes effectively while abrading very

little; by contrast, toothpastes that contain chloroform have been reported to cause pronounced denture wear.[17]

Ultrasonic cleaning works within a frequency range of 20–60 kHz and dislodges debris by cavitation, though its high price restricts everyday use.[6] Microwave irradiation has been shown to kill microorganisms, yet it is not advised for routine cleaning.[18] Denture wipes, meanwhile, were effective in lifting food particles and improving the cleanliness of dentures.[19]

The addition of chelating agents such as EDTA and of enzymes including papain, lipase, amylase, and trypsin improves the capacity to remove plaque.[20] Alkaline peroxide cleansers liberate oxygen bubbles that generate a cleansing action, although routine long-term immersion can bleach the acrylic. Alkaline hypochlorites readily break down the organic components of plaque and display strong bactericidal and fungicidal activity, but they may corrode the metal parts of a denture.[17]

Alkaline peroxide products such as Densive and Clinsodent are in widespread use. Sharma examined their anticandidal behaviour and found that Densive, which contains sodium perborate monohydrate, acted against microbes rapidly, while Clinsodent, formulated with potassium persulfate, trisodium phosphate, EDTA, and tetrapotassium pyrophosphate, brought about the largest fall in Candida albicans counts after eight hours of immersion.[21]

Kumar et al noted marked drops in microbial counts after specimens were immersed in alkaline peroxide cleansers. Their assessment of antimicrobial performance was made directly after cleansing, so evidence for any lasting antimicrobial effect beyond that immediate period remains scarce.[22]

Extended immersion of PMMA resins raised their surface roughness and lowered their surface hardness as the resin matrix degraded chemically, a process that produced microfractures and invited microbial colonisation.[23]

Since chemical cleansers can provoke unwanted reactions such as tissue irritation or allergy, natural denture cleansers have been investigated as substitutes.[21] Natural products including green tea (Camellia sinensis), bay leaf (Eugenia polyantha), and lime (Citrus aurantifolia) carry bioactive compounds that help remove stains; their epigallocatechin-3-gallate, eugenol, and naringin function as hydrogen donors and disrupt the chromogenic tannin compounds behind staining.[24]

Aloe vera is a natural cleansing agent recognised for its antibacterial and antifungal action, and its saponins behave as natural surfactants.[20] Shetty et al compared the anticandidal efficacy of triphala, aloe vera, cashew leaf, and denture cleansing tablets, reporting that triphala achieved the greatest reduction in Candida counts, with aloe vera coming next.[25]

Mahboub studied how aloe vera influenced the colour stability of acrylic resin and found no meaningful discolouration once the resin had been immersed for 36 hours.[7] Kumar et al showed that Candida colony counts stayed suppressed throughout a continuous 30-day course of aloe vera use.[22]

Neem (*Azadirachta indica*) possesses strong antibacterial activity and finds use in oral healthcare. Sharma showed that neem markedly curbed *Candida albicans* colonisation and ranked as the second most effective cleanser after the chemical agents,[21] and Nimbulkar recorded a sustained drop in plaque when neem was used regularly across a three-month span.[26]

Kanchan et al contrasted the surface roughness generated by chemical and natural denture cleansers and derived a damage ratio of roughly 1.27:1, meaning the chemical cleansers produced about 27% more surface alteration than the natural ones.[27] Double cross-linked PMMA denture teeth resist chemical alteration better because they take up less water and permit less solvent diffusion.[28]

In the present work, Clinsodent proved the most effective cleanser for lifting coffee

and tea stains from both Premadent and Acryrock teeth. Within the natural group, neem removed stains more successfully than aloe vera, and aloe vera was the least effective of all, as figures 4, 5, 6, and 7 illustrate. Taken together, these findings indicate that commercially marketed chemical denture cleansers clean stains more efficiently than natural cleansing agents do.

CONCLUSION

Exposure to the staining agents left both Premadent and Acryrock denture teeth discoloured. In removing that staining, the chemical denture cleansers were considerably more effective than the natural cleansers.

Clinsodent and Densive stood out as the most effective agents overall, whereas among the natural cleansers Neem gave the better outcome and Aloe vera the poorest.

On balance, chemical denture cleansers stay the preferred means of effective stain removal, while natural agents, valued for their biocompatibility and easy availability, are best regarded as adjunctive alternatives.

Declaration by Authors

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