



# Comparative analysis of the anti-fungal efficacy of herbal denture cleansing agents – an experimental study

Vaibhavi R. Shetty<sup>1</sup>, Manoj Varma<sup>2</sup>, Pavan Chand Attavar<sup>3</sup>, Kelvin Peter Pais<sup>4</sup>, Sanjana Bhat<sup>5</sup>, Sreevidya Bhat<sup>6</sup>

<sup>1</sup>Department of Public Health Dentistry, AB Shetty Memorial Institute of Dental Sciences, Nitte (Deemed to be University), Deralakatte, Mangalore, India

<sup>2</sup>Srinivas Institute of Dental Sciences, Mangalore, India

<sup>3</sup>Department of Microbiology, Srinivas Institute of Medical Sciences and Research Centre, Mangalore, India

<sup>4</sup>Father Muller Charitable Institutions, Mangalore, India

<sup>5</sup>Department of Conservative Dentistry and Endodontics, College of Dental Sciences, Davangere, India

<sup>6</sup>Department of Public Health Dentistry, Srinivas Institute of Dental Sciences, Mangalore, India

\*Corresponding Author: Vaibhavi R. Shetty, Email: [vaibhavishetty@gmail.com](mailto:vaibhavishetty@gmail.com)

## Abstract

**Background:** This study aims to assess and compare the antimicrobial effects of 0.3% chlorhexidine, Neem, Tulsi, and Indian borage solutions against *Candida albicans* found on dentures.

**Methods:** The present experimental study was conducted at a dental institution's Department of Prosthodontics. Fifty edentulous patients currently wearing dentures participated in this study, and their dentures were randomly assigned to one of five treatment groups: Neem solution, Tulsi solution, Indian borage solution, distilled water, or 0.3% chlorhexidine gluconate. To assess the antimicrobial effects of the test solutions, culture swabs were obtained from the dentures both prior to and following treatment, and were subsequently cultured on blood agar medium. The presence or absence of *Candida albicans* growth was then observed and compared to determine the solutions' antimicrobial effects. Statistical analysis included both univariate and bivariate methods. A 95% confidence interval was applied, and a *p*-value of  $\leq 0.05$  was established as the threshold for statistical significance.

**Results:** In this study, 32 patients participated, resulting in a response rate of 64%. Notably, over 59% of these participants presented with *Candida albicans* colonization on their dentures. Following treatment, it was observed that the majority of dentures treated with Neem, Indian borage, and chlorhexidine demonstrated the absence of *Candida albicans* growth when compared to those treated with distilled water.

**Conclusion:** Research has demonstrated that Neem, Tulsi, and Indian borage solutions exhibit antimicrobial properties. These findings suggest their potential utility as natural denture disinfecting agents, particularly against *Candida albicans*.

**Keywords:** Neem, Tulsi, Indian borage, Antifungal, Denture cleansing, Denture stomatitis

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## Introduction

The oral cavity provides an ideal environment for diverse microbial activities. This microflora also colonizes complete dentures worn by edentulous individuals.<sup>1</sup> Proper cleansing and maintenance of dentures are crucial for ensuring the patient's overall oral health and well-being, and failure to do so can culminate in various denture-related inflammations and other associated problems.<sup>2,3</sup> *Candida albicans* is a microorganism that has garnered significant research interest due to its substantial impact on denture-related conditions. This yeast is recognized as a primary etiological agent in denture stomatitis among individuals who wear dentures.<sup>4</sup> Epidemiological studies indicate that the prevalence of *Candida albicans* in denture wearers ranges from approximately 11% to 67%.<sup>5</sup> Beyond the presence of *Candida* species, the irregular

surfaces and concavities of acrylic denture bases create an ideal environment for dental plaque accumulation.<sup>6</sup> Consequently, maintaining dentures free of such pathogenic microflora is crucial for preserving good oral health. Maintaining optimal oral hygiene and effective denture cleansing is crucial. However, for elderly patients facing challenges, such as reduced dexterity or systemic illnesses, relying solely on water and mechanical cleaning methods is often insufficient. In these situations, the incorporation of denture cleansers has shown considerable benefits in improving denture hygiene.<sup>7</sup>

An effective denture cleansing agent must exhibit biocompatibility and possess fungicidal and bactericidal properties. Furthermore, it should preserve the integrity of denture materials, efficiently eliminate both organic and inorganic deposits, and be both user-friendly and



economical.<sup>8</sup> Chlorhexidine has historically been a prevalent denture cleansing agent due to its potent antibacterial properties. Its common use as a mouthwash further underscores its efficacy, making it a dependable option for denture disinfection.<sup>9</sup> However, this approach presents several disadvantages, including the possibility of oral irritation, dry mouth, and the propensity to cause discoloration of acrylic dentures with extended application.<sup>10,11</sup> Consequently, there is a clear demand for natural alternatives for denture cleansing to replace chemical agents and mitigate these issues.

Herbal compounds with antimicrobial properties could be effective denture cleansing agents if they are safe, efficient, affordable, and readily accessible. The Indian borage (*Plectranthus amboinicus*), known locally as 'Sambrani', is one such candidate, which is widely utilized in traditional Indian medicine and recognized for its potent antimicrobial and antioxidant characteristics.<sup>12</sup> Neem (*Azadirachta indica*) and its derivatives are recognized by healthcare professionals for their antifungal, antibacterial, and antiviral characteristics.<sup>13</sup> Similarly, Tulsi (*Ocimum tenuiflorum*) and its essential oils have a long history of use in traditional medicine due to their notable antimicrobial, antioxidant, and anti-inflammatory properties.<sup>14</sup> Its effectiveness against *Streptococcus mutans* has been shown to be comparable to that of chlorhexidine mouthwash.<sup>15</sup> Given that these plants are common perennials found in many Indian homes, they present a promising alternative for denture cleansing. Consequently, this study aimed to assess and compare the antifungal effect of 0.3% chlorhexidine, Neem, Tulsi, and Indian borage solutions against *Candida albicans* on dentures.

## Method

This experimental study, conducted between February and April 2020, received ethical approval from the Institutional Ethics Committee (No: 2020/02/24/1). All participants provided written informed consent.

A sample size of 50 participants was determined for this study. The participants were then randomized into five distinct groups, with ten individuals allocated to each group.

## Participants

This study recruited 50 completely edentulous patients from the Department of Prosthodontics at a private dental institution in Dakshina Kannada, Karnataka. Participants were included if they were over 50 years of age and had been wearing well-fitting dentures for a minimum of one year. Exclusion criteria included partially edentulous patients, those with maxillary and mandibular defects, and individuals exhibiting a lack of dexterity. Participants were randomly assigned to one of five solutions: Neem solution, Tulsi solution, Indian borage solution, distilled

water (negative control), and 0.3% chlorhexidine gluconate (positive control).

Prior to treatment, a pre-treatment swab sample was collected from the palatal surface of the upper denture and the alveolar surface of the lower denture (Figure 1). This swab was then cultured to detect the presence of *Candida albicans*. Following this initial collection, the dentures were immersed for six hours in their assigned solutions within a sterile container.

Following treatment with the test solutions, the dentures underwent a distilled water rinse, and post-treatment swabs were collected (Figure 1).

Swabs collected both before and after treatment with the test solutions were incubated and cultured on blood agar medium to assess the presence or absence of *Candida albicans* growth. The antimicrobial effect was determined by comparing the growth of *Candida albicans* pre- and post-treatment.

## Preparation of Solution

For the purpose of evaluating antimicrobial efficacy, commercially available 0.3% chlorhexidine, distilled water, and aqueous extracts of Indian borage, Neem, and Tulsi were obtained.

## Statistical Analysis

Data were initially recorded in MS Excel and subsequently imported into SPSS for analysis. Univariate and bivariate analyses were conducted, including comparisons of means and proportions using the chi-square test, analysis of variance (ANOVA), and the paired t-test. A 95% confidence interval was applied, and a *P* value of  $\leq 0.05$  was established as the threshold for statistical significance.

## Results

A total of 50 participants were initially selected and randomly assigned to one of five groups, with ten participants in each group. Of these, 32 participants completed the study, resulting in a 64% response rate.



Figure 1. Collecting swab sample for culture (original figure)

Table 1 presents a comparative analysis of participants' mean age, gender, and prevalence of systemic conditions across different groups. A statistically significant difference in the mean age was observed among the groups ( $P=0.001$ ), with the distilled water group exhibiting the lowest mean age, while the Indian borage group had the highest. In all five groups, female participants constituted a larger proportion than males, with the distilled water group containing no male participants. However, this gender distribution was not statistically significant ( $P=0.362$ ). Across all groups, a higher proportion of participants did not have diabetes, and this difference was also not statistically significant ( $P=0.689$ ). A greater proportion of participants in the Tulsi, Indian borage, and chlorhexidine groups presented with systemic conditions when compared to those in the Neem and distilled water groups. However, this difference was not statistically significant ( $P=0.120$ ).

Table 2 illustrates the prevalence of *Candida albicans* on participants' dentures, revealing that over 59% of individuals harbored the fungus. While a higher proportion of participants in the Neem, Tulsi, Indian borage, and distilled water groups exhibited *Candida albicans* on their dentures compared to the chlorhexidine group, this difference was not statistically significant ( $P=0.153$ ).

Table 3 illustrates the post-treatment comparison of *Candida albicans* growth. The majority of dentures treated with Neem, Indian borage, and chlorhexidine demonstrated an absence of *Candida albicans* growth when compared to those treated with distilled water. This

observed difference was statistically significant ( $P<0.001$ ).

Table 4 indicates that Neem, Indian borage, Tulsi, and chlorhexidine all demonstrated a statistically significant improvement in inhibiting *Candida albicans* growth when compared to distilled water ( $P=0.045$ ).

## Discussion

Denture stomatitis is a common condition among individuals who wear dentures.<sup>16</sup> Research indicates that most *Candida albicans* species tend to colonize the surfaces of dentures rather than the palatal mucosa.<sup>17</sup> This highlights the importance of effectively removing biofilms from denture surfaces through either physical or chemical methods. Chemical denture cleansing agents are highly effective at combating denture biofilm. However, a shift toward natural, plant-based alternatives for denture cleansing offers several benefits, including ready availability at low cost, reduced toxicity, decreased environmental impacts, and consequently, safer therapeutic outcomes. The increasing adoption of natural alternatives could enhance their widespread integration into daily routines.<sup>18</sup> Furthermore, the presence of *Candida albicans* within denture plaque is a significant factor in the development of denture stomatitis, highlighting the critical need for effective cleaning protocols and preventative strategies.<sup>19</sup>

Lal et al demonstrated that conventional denture cleansers, such as chlorhexidine, significantly reduced palatal inflammation and chlorhexidine solutions completely eradicated *Candida albicans* from denture surfaces.<sup>20</sup> Additionally, Liu et al's study proposed that antifungal plant extracts and food preservative agents

**Table 1.** Comparison of distribution of participants by age, gender, and systemic conditions in the five groups

Parameters	Groups					P
	Neem	Tulsi	Indian borage	Chlorhexidine	Distilled water	
Age in years mean (SD)	63.7 (10.1)	75.0 (12.6)	82.3 (4.7)	73.4 (13.6)	56.8 (2.1)	0.001*
Gender	Female n (%)	5 (71.4)	4 (57.1)	4 (50.0)	4 (80.0)	0.362
	Male n (%)	2 (28.6)	3 (42.9)	4 (50.0)	1 (20.0)	
Diabetes	Yes n (%)	1 (14.3)	3 (42.9)	4 (50.0)	2 (40.0)	0.689
	No n (%)	6 (85.7)	4 (57.1)	4 (50.0)	3 (60.0)	
Systemic conditions	Yes n (%)	2 (28.6)	6 (85.7)	6 (75.0)	4 (80.0)	0.120
	No n (%)	5 (71.4)	1 (14.3)	2 (25.0)	1 (20.0)	

\* $P\leq 0.05$  is statistically significant; SD: Standard deviation

**Table 2.** Group-wise distribution of study participants according to the presence/absence of *Candida albicans* in the dentures before intervention

Groups	n	Pre-treatment <i>Candida</i> growth n (%)		P
		Absent	Present	
Neem	7	3 (42.9)	4 (57.1)	0.153
Tulsi	7	3 (42.9)	4 (57.1)	
Indian borage	8	3 (37.5)	5 (62.5)	
Chlorhexidine	5	4 (80.0)	1 (20.0)	
Distilled water	5	0 (0.0)	5 (100.0)	

**Table 3.** Group-wise distribution of study participants according to the presence/absence of *Candida albicans* post-treatment with the test solutions

Groups	n	Post-Treatment <i>Candida albicans</i> Growth		P
		Absent n (%)	Present n (%)	
Neem	7	7 (100.0)	0 (0.0)	<0.001*
Tulsi	7	5 (71.4)	2 (28.6)	
Indian borage	8	8 (100.0)	0 (0.0)	
Chlorhexidine	5	5 (100.0)	0 (0.0)	
Distilled water	5	0 (0.0)	5 (100.0)	

\* $P\leq 0.05$  is statistically significant

**Table 4.** Participants showing improvement (absence) in the non-growth of *Candida albicans* organisms in the second culture following dipping in the test solutions compared to the first culture

Groups	Improvement Present	P
Neem	4 (100.0)	0.045*
Tulsi	2 (50.0)	
Indian borage	5 (100.0)	
Chlorhexidine	1 (100.0)	
Distilled water	0 (0.0)	

\* $P \leq 0.05$  is statistically significant

exhibited strong efficacy against *Candida albicans*, suggesting their potential use as effective denture cleansers.<sup>21</sup> This study demonstrated the significant efficacy of the Neem solution in inhibiting *Candida albicans*. Specifically, dentures previously exhibiting *Candida* growth showed complete absence of the fungus after treatment with the Neem solution. According to Ojah et al's study, Neem possesses superior antifungal efficacy compared to Aloe vera and Triphala churna.<sup>22</sup> Furthermore, Polaquini et al's research demonstrated that Neem leaf extracts exerted an anti-adhesive effect by influencing biofilm formation, *Candida albicans* colonization, cell surface hydrophobicity, and cellular adhesion.<sup>23</sup> As shown by Singhania et al's study, the combined application of Neem and Tea tree oil significantly reduces *Candida albicans* colony formation on acrylic surfaces, exhibiting a more pronounced effect than either substance used alone.<sup>24</sup> Additionally, the incorporation of Neem powder into polymethyl methacrylate denture base material was found to decrease *Candida albicans* adhesion to the denture surface.<sup>25</sup>

In this study, Tulsi effectively reduced *Candida albicans* growth by 50% when used as a denture cleansing agent. Future research could explore longer treatment durations or stronger Tulsi solutions to enhance its efficacy against *Candida albicans*. The application of Tulsi as a denture cleanser has also been investigated by Mahajan et al. Tulsi demonstrated antifungal effects against *Candida albicans*; however, chlorhexidine proved to be more effective.<sup>26</sup> The antimicrobial properties of Tulsi are attributed to its essential oils, including eugenol, clemene, germacrene-A, caryophyllene oxide, and caryophyllene.<sup>27</sup> In an in vitro comparative study, Sivareddy et al demonstrated that both ethyl acetate and ethanolic extracts of Tulsi (1000 µg/mL) exhibited a 13 mm zone of inhibition against *Candida albicans* species, a result comparable to that observed with fluconazole.<sup>28</sup> Beyond its efficacy against *Candida albicans*, Tulsi has demonstrated effectiveness against the periodontal pathogen *Actinobacillus actinomycetemcomitans*, exhibiting its peak antimicrobial effect at a 6% concentration.<sup>29</sup> This finding further supports Tulsi's

potential in maintaining periodontal health.

*Plectranthus amboinicus*, often referred to as Indian borage or Sambrani, is a widely utilized medicinal plant known for its diverse health benefits. This plant demonstrates a range of pharmacological activities, including anti-inflammatory, antimicrobial, antioxidant, analgesic, anti-tumor, anti-epileptic, wound healing, and anti-larvicidal properties.<sup>30</sup> In this study, a *Plectranthus amboinicus* solution demonstrated high efficacy in inhibiting *Candida albicans* growth, achieving a 100% reduction of *Candida albicans* on treated dentures. This finding aligns with a previous study by Aparna and Gayathri, which reported an 8 mm zone of inhibition against *Candida albicans* using a crude extract of *Plectranthus amboinicus*, further supporting its antifungal effectiveness.<sup>31</sup>

### Strengths and Limitations

This study demonstrates the potent antimicrobial effects of aqueous extracts derived from Tulsi, Neem, and Indian borage, comparing their efficacy to that of 0.3% chlorhexidine. However, the study was not without its limitations. Despite the observed antimicrobial effects of the herbal agents, the limited sample size, primarily due to participant non-response, precludes a definitive recommendation regarding their efficacy as herbal disinfecting agents. A prospective study with a larger sample size is necessary to accurately evaluate the effectiveness and efficacy of these herbal extracts. Sufficient supporting evidence could then lead to the use of these extracts for disinfecting dentures post-use, thereby reducing oral *Candida albicans* infections.

### Conclusion

Extracts from Tulsi, Neem, and Indian borage demonstrated comparable efficacy to 0.3% chlorhexidine in inhibiting the proliferation of *Candida albicans* organisms, and they significantly outperformed distilled water. These natural extracts exhibited promising cleansing and antimicrobial properties, suggesting their potential utility as natural denture disinfecting agents against *Candida albicans* species.

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### Authors' Contribution

**Conceptualization:** Vaibhavi R. Shetty, Manoj Varma, Kelvin Peter Pais, Sanjana Bhat.

**Data curation and compilation:** Vaibhavi R Shetty, Sanjana Bhat,

Sreevidya Bhat.

**Investigations:** Pavan Chand Attavar.

**Formal analysis:** Sreevidya Bhat.

**Methodology:** Vaibhavi R Shetty, Manoj Varma, Kelvin Peter Pais.

**Supervision:** Manoj Varma and Sreevidya Bhat.

**Writing-original draft:** Vaibhavi R Shetty, Sreevidya Bhat.

### Competing Interests

Nil.

### Data Availability Statement

The available data will be shared upon request.

### Ethical Approval

An ethical approval was obtained on 24/02/2020 (reference number: 2020/02/24/1) from the Institutional Ethics Committee.

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### References

- Shi B, Wu T, McLean J, Edlund A, Young Y, He X, et al. The denture-associated oral microbiome in health and stomatitis. *mSphere*. 2016;1(6):e00215-16. doi: [10.1128/mSphere.00215-16](https://doi.org/10.1128/mSphere.00215-16).
- Emami E, Taraf H, de Grandmont P, Gauthier G, de Koninck L, Lamarche C, et al. The association of denture stomatitis and partial removable dental prostheses: a systematic review. *Int J Prosthodont*. 2012;25(2):113-9.
- Arendorf TM, Walker DM. Denture stomatitis: a review. *J Oral Rehabil*. 1987;14(3):217-27. doi: [10.1111/j.1365-2842.1987.tb00713.x](https://doi.org/10.1111/j.1365-2842.1987.tb00713.x).
- Campos MS, Marchini L, Bernardes LA, Paulino LC, Nobrega FG. Biofilm microbial communities of denture stomatitis. *Oral Microbiol Immunol*. 2008;23(5):419-24. doi: [10.1111/j.1399-302X.2008.00445.x](https://doi.org/10.1111/j.1399-302X.2008.00445.x).
- Huh JB, Lim Y, Youn HI, Chang BM, Lee JY, Shin SW. Effect of denture cleansers on *Candida albicans* biofilm formation over resilient liners. *J Adv Prosthodont*. 2014;6(2):109-14. doi: [10.4047/jap.2014.6.2.109](https://doi.org/10.4047/jap.2014.6.2.109).
- Kumar B, Sandhu PK, Kumar AN, Patil CP. A comparative study for plaque removing efficacy between commonly used denture cleansers in India. *J Indian Prosthodont Soc*. 2017;17(3):295-300. doi: [10.4103/jips.jips\\_2\\_17](https://doi.org/10.4103/jips.jips_2_17).
- Gornitsky M, Paradis I, Landaverde G, Malo AM, Velly AM. A clinical and microbiological evaluation of denture cleansers for geriatric patients in long-term care institutions. *J Can Dent Assoc*. 2002;68(1):39-45.
- Jagger DC, Harrison A. Denture cleansing--the best approach. *Br Dent J*. 1995;178(11):413-7. doi: [10.1038/sj.bdj.4808788](https://doi.org/10.1038/sj.bdj.4808788).
- Mylonas P, Milward P, McAndrew R. Denture cleanliness and hygiene: an overview. *Br Dent J*. 2022;233(1):20-6. doi: [10.1038/s41415-022-4397-1](https://doi.org/10.1038/s41415-022-4397-1).
- McCoy LC, Wehler CJ, Rich SE, Garcia RI, Miller DR, Jones JA. Adverse events associated with chlorhexidine use: results from the Department of Veterans Affairs Dental Diabetes Study. *J Am Dent Assoc*. 2008;139(2):178-83. doi: [10.14219/jada.archive.2008.0134](https://doi.org/10.14219/jada.archive.2008.0134).
- Al-Jammali ZM, Al Murshidy HA, Al-Yasiry AM. Causes and treatment of complete denture staining: a review. *Med J Babylon*. 2021;18(3):151-4. doi: [10.4103/mjbl.mjbl\\_53\\_20](https://doi.org/10.4103/mjbl.mjbl_53_20).
- Bhatt P, Negi PS. Antioxidant and antibacterial activities in the leaf extracts of Indian borage (*Plectranthus amboinicus*). *Food Nutr Sci*. 2012;3(2):146-52. doi: [10.4236/fns.2012.32022](https://doi.org/10.4236/fns.2012.32022).
- Subapriya R, Nagini S. Medicinal properties of neem leaves: a review. *Curr Med Chem Anticancer Agents*. 2005;5(2):149-6. doi: [10.2174/1568011053174828](https://doi.org/10.2174/1568011053174828).
- Cohen MM. Tulsi-*Ocimum sanctum*: a herb for all reasons. *J Ayurveda Integr Med*. 2014;5(4):251-9. doi: [10.4103/0975-9476.146554](https://doi.org/10.4103/0975-9476.146554).
- Agarwal P, Nagesh L. Comparative evaluation of efficacy of 0.2% chlorhexidine, Listerine and tulsi extract mouth rinses on salivary *Streptococcus mutans* count of high school children-RCT. *Contemp Clin Trials*. 2011;32(6):802-8. doi: [10.1016/j.cct.2011.06.007](https://doi.org/10.1016/j.cct.2011.06.007).
- Baillie GS, Douglas LJ. Effect of growth rate on resistance of *Candida albicans* biofilms to antifungal agents. *Antimicrob Agents Chemother*. 1998;42(8):1900-5. doi: [10.1128/aac.42.8.1900](https://doi.org/10.1128/aac.42.8.1900).
- Prakash B, Shekar M, Maiti B, Karunasagar I, Padiyath S. Prevalence of *Candida* spp. among healthy denture and nondenture wearers with respect to hygiene and age. *J Indian Prosthodont Soc*. 2015;15(1):29-32. doi: [10.4103/0972-4052.155041](https://doi.org/10.4103/0972-4052.155041).
- Haloci E, Manfredini S, Toska V, Vertuani S, Ziosi P, Topi I, et al. Antibacterial and antifungal activity assessment of *Nigella sativa* essential oils. *World Acad Sci Eng Technol*. 2012;6(6):270-2.
- Drake D, Wells J, Ettinger R. Efficacy of denture cleansing agents in an in vitro bacteria-yeast colonization model. *Int J Prosthodont*. 1992;5(3):214-20.
- Lal K, Santarpia RP 3rd, Pollock JJ, Renner RP. Assessment of antimicrobial treatment of denture stomatitis using an in vivo replica model system: therapeutic efficacy of an oral rinse. *J Prosthet Dent*. 1992;67(1):72-7. doi: [10.1016/0022-3913\(92\)90053-d](https://doi.org/10.1016/0022-3913(92)90053-d).
- Liu X, Zheng X, Fang W, Zhang Y. Screening of food additives and plant extracts against *Candida albicans* in vitro for prevention of denture stomatitis. *Procedia Environ Sci*. 2012;12(Pt B):1361-6. doi: [10.1016/j.proenv.2012.01.435](https://doi.org/10.1016/j.proenv.2012.01.435).
- 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. *J Indian Prosthodont Soc*. 2021;21(2):167-72. doi: [10.4103/jips.jips\\_599\\_20](https://doi.org/10.4103/jips.jips_599_20).
- Polaquini SR, Svidzinski TI, Kemmelmeier C, Gasparetto A. Effect of aqueous extract from neem (*Azadirachta indica* A. Juss) on hydrophobicity, biofilm formation and adhesion in composite resin by *Candida albicans*. *Arch Oral Biol*. 2006;51(6):482-90. doi: [10.1016/j.archoralbio.2005.11.007](https://doi.org/10.1016/j.archoralbio.2005.11.007).
- Singhania A, Sathe S, Ranka R, Godbole S. Individual and synergistic effects of tea tree oil and neem extract on *Candida albicans* adhesion to denture soft liner. *Cureus*. 2022;14(8):e27869. doi: [10.7759/cureus.27869](https://doi.org/10.7759/cureus.27869).
- Hamid SK, Al-Dubayan AH, Al-Awami H, Khan SQ, Gad MM. In vitro assessment of the antifungal effects of neem powder added to polymethyl methacrylate denture base material. *J Clin Exp Dent*. 2019;11(2):e170-8. doi: [10.4317/jced.55458](https://doi.org/10.4317/jced.55458).
- Mahajan R, Khinda PK, Gill AS, Kaur J, Saravanan SP, Sahewal A, et al. Comparison of efficacy of 0.2% chlorhexidine gluconate and herbal mouthrinses on dental plaque: an in vitro comparative study. *European J Med Plants*. 2016;13(2):1-11. doi: [10.9734/ejmp/2016/23318](https://doi.org/10.9734/ejmp/2016/23318).
- Vinod KS, Sunil KS, Sethi P, Bandla RC, Singh S, Patel D. A

- novel herbal formulation versus chlorhexidine mouthwash in efficacy against oral microflora. *J Int Soc Prev Community Dent.* 2018;8(2):184-90. doi: [10.4103/jispcd.JISPCD\\_59\\_18](https://doi.org/10.4103/jispcd.JISPCD_59_18).
28. Sivareddy B, Reginald BA, Sireesha D, Samatha M, Reddy KH, Subrahmanyam G. Antifungal activity of solvent extracts of *Piper betle* and *Ocimum sanctum* Linn on *Candida albicans*: an in vitro comparative study. *J Oral Maxillofac Pathol.* 2019;23(3):333-7. doi: [10.4103/jomfp.JOMFP\\_167\\_19](https://doi.org/10.4103/jomfp.JOMFP_167_19).
29. Eswar P, Devaraj CG, Agarwal P. Anti-microbial activity of tulsi [*Ocimum sanctum* (Linn.)] extract on a periodontal pathogen in human dental plaque: an invitro study. *J Clin Diagn Res.* 2016;10(3):ZC53-6. doi: [10.7860/jcdr/2016/16214.7468](https://doi.org/10.7860/jcdr/2016/16214.7468).
30. Kumar P, Sangam, Kumar N. *Plectranthus amboinicus*: a review on its pharmacological and pharmacognostical studies. *Am J Physiol Biochem Pharmacol.* 2020;10(2):55-62. doi: [10.5455/ajpbp.20190928091007](https://doi.org/10.5455/ajpbp.20190928091007).
31. Aparna M, Gayathri V. Preparation of a common herbal medicine with culinary plants for skin infections caused by *Candida albicans* AND *Propionibacterium acnes*. *Glob J Biosci Biotechnol.* 2019;8(2):235-40.