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REVIEW ARTICLE

Antifungal properties of medicinal plants in the treatment of oral and dental fungal infections: A review

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Abstract

Oral and dental fungal infections, primarily caused by *Candida albicans*, pose a significant clinical challenge due to increasing antifungal resistance and adverse effects of conventional therapies. Medicinal plants offer an alternative through diverse bioactive compounds with potent antifungal mechanisms. This review analyzed peer-reviewed articles published between 2016 and 2025, sourced from PubMed, Scopus, and Web of Science. Studies included *in vitro*, *in vivo*, and clinical trials evaluating the efficacy and mechanisms of medicinal plant extracts against oral fungal pathogens. Key findings reveal that extracts from *Curcuma longa, Azadirachta indica, Syzygium aromaticum, Rosmarinus officinalis*, and *Allium sativum* exhibit significant antifungal activity. Mechanisms include inhibition of biofilms, hyphal suppression, and disruption of fungal cell membranes. Many herbal agents demonstrated efficacy comparable to nystatin and fluconazole, with lower cytotoxicity and potential for combinatory use.

Keywords: Oral candidiasis, Medicinal plants, Herbal antifungal, Phytotherapy, Dental infections, Natural remedies.

Introduction

Oral and dental fungal infections, particularly those caused by *Candida albicans*, are common opportunistic conditions affecting both immunocompromised and immunocompetent individuals. These infections range from mild cases of oral thrush to more severe manifestations like chronic hyperplastic candidiasis and denture stomatitis. The incidence of oral candidiasis is notably higher in individuals using dentures, receiving immunosuppressive therapies, or suffering from systemic diseases such as diabetes mellitus and HIV/AIDS (Williams & Lewis, 2011; Sardi et al., 2013). The standard treatment for these infections primarily involves the administration of antifungal agents such as nystatin, clotrimazole, and fluconazole. While effective in many cases, these agents have significant limitations including emerging drug resistance, mucosal irritation, hepatotoxicity, and drug interactions (Pappas et al., 2018). Furthermore, the recurrent nature of oral fungal infections and poor patient adherence to prolonged regimens often result in suboptimal clinical outcomes (Sitheeque & Samaranayake, 2003). In response to these

challenges, there has been increasing scientific and clinical interest in exploring alternative, natural-based antifungal therapies. Medicinal plants have long been used in traditional medicine systems for treating various infections, and recent advances in pharmacognosy and phytotherapy have validated many of these historical practices. Plant-derived bioactive compounds—including flavonoids, terpenes, phenolics, and alkaloids have demonstrated notable antifungal activity through mechanisms such as disruption of fungal cell walls, inhibition of hyphal transition, and suppression of biofilm formation (Cowan, 1999; Carpio & Santos, 2023). Multiple studies have reported the effectiveness of herbs such as garlic (*Allium sativum*), clove (*Syzygium aromaticum*), turmeric (*Curcuma longa*), neem (*Azadirachta indica*), and rosemary (*Rosmarinus officinalis*) against *Candida* species, including drug-resistant strains (Yaneva et al., 2022; Meccatti et al., 2022). These natural products offer the additional advantages of low toxicity, reduced side effects, biocompatibility with oral tissues, and patient preference for "green" or integrative treatments. Despite promising laboratory and preliminary clinical results, there is still a lack of comprehensive synthesis that evaluates the antifungal properties of medicinal plants specifically for oral and dental applications. This review aims to bridge that gap by systematically evaluating recent evidence on the antifungal efficacy, mechanisms of action, safety, and potential clinical applications of medicinal plants in the treatment of oral fungal infections.

Literature Review

This review adopts a narrative method with elements of systematic search principles to identify, select, and synthesize peer-reviewed research on the antifungal properties of medicinal plants used in the treatment of oral and dental fungal infections. Aimed to include relevant literature published between January 2016 and May 2025 to ensure contemporary clinical and scientific relevance.

Studies were eligible if they:

- Investigated the antifungal activity of whole plant extracts, essential oils, or isolated phytochemicals.
- Targeted oral fungal pathogens, especially *Candida* species.
- Employed *in vitro*, *in vivo*, or clinical designs.
- Were published in English in peer-reviewed journals.

The gathered data were then synthesized thematically to identify patterns in antifungal efficacy, mechanisms of action, and clinical applicability. Comparative elements were integrated to highlight differences between herbal and conventional treatments.

Oral fungal infections, particularly those caused by *Candida albicans*, are widespread in dentistry and becoming increasingly difficult to treat due to antifungal resistance. These infections present as pseudomembranous candidiasis, erythematous lesions, and denture stomatitis, with a higher prevalence in immunocompromised patients and denture wearers. Although antifungal medicines such as nystatin and fluconazole remain the basis of treatment, concerns about side effects, resistance, and recurrence have prompted the development of alternative therapies (Yaneva et al., 2022). Plant-derived secondary metabolites, such as alkaloids, phenolics, flavonoids, terpenes, and saponins, have potent antifungal properties. According to a 2023 review of current molecular pharmacology, these drugs work by damaging fungal cell walls, blocking ergosterol biosynthesis, and interfering with biofilm development. Eugenol, carvacrol, thymol, curcumin, and allicin are notable chemicals with broad-spectrum antifungal action against *Candida* spp. (Khan et al., 2023). A 2024 systematic review protocol emphasizes

the importance of evidence-based synthesis of plant-based medicines, as well as standardization of delivery forms such gels, rinses, and varnishes (Bouslama et al., 2024). The research highlights phytotherapy's potential to solve existing gaps in clinical management.

***Curcuma longa* (Turmeric):** A study published in the International Journal of Dentistry (2022) found that curcumin combined with photodynamic therapy reduced fungal burden and improved mucosal healing. Curcumin significantly inhibited *Candida* spp. biofilms and hyphal development, indicating its potential utility in adjuvant antifungal therapy (Kubizna et al., 2024).

***Rosmarinus officinalis* (Rosemary):** In Scientific Reports (2022), rosemary extract was discovered to inhibit *Candida albicans* at low concentrations while remaining biocompatible with human oral epithelial cells. Its antifungal properties are ascribed to carnosic acid and other polyphenols that target fungal membranes and oxidative stress pathways (Meccatti et al., 2022).

***Vitex agnus-castus*:** The antifungal efficacy of *Vitex agnus-castus* extracts was evaluated in a 2022 study published in BMC Complementary Medicine and Therapies, which found broad inhibitory zones and high phytochemical content, including flavonoids and iridoids (Al-Otibi et al., 2022).

Carvacrol (Oregano oil): Carvacrol has emerged as a powerful antifungal drug, and its synergistic effect with nystatin was validated in a 2024 study published in BMC Research Notes. The combination treatment was more effective against oral *Candida* isolates than either medication alone (Balef et al., 2024).

Traditional Thai medicinal herbs: A 2024 study in the Thai Science Journal looked at the anticandidal properties of Thai herbs such *Zingiber cassumunar* and *Piper betle*. Essential oils produced from these plants showed inhibitory zones greater than 17 mm, indicating promise for topical dental treatments (Sisopa et al., 2025).

The growing resistance of *Candida* species to azoles and polyenes has sparked interest in natural antifungal treatments. According to a review published in Antibiotics (2022), bioactive substances such as berberine, cinnamaldehyde, and curcumin operate as efflux pump inhibitors and membrane disruptors, opening up novel avenues to combat drug resistance (Dantas et al., 2025). A thorough 2024 review (Khan et al., 2023) of inflammopharmacology examined several herbal treatments and their antimicrobial processes (cell wall breakdown, membrane permeabilization, oxidative damage, and inhibition of adhesion and biofilm formation). A 2025 study looked examined the effectiveness of medicinal plant extracts against drug-resistant *Candida albicans* isolates taken from dentistry patients. The study found that neem, clove, and basil extracts outperformed fluconazole against resistant strains.

Results

Studies show that medicinal plant extracts and phytocompounds effectively inhibit fungal growth against *Candida* species in oral and dental infections. Extracts from *Curcuma longa, Rosmarinus officinalis, Vitex agnus-castus*, and essential oils with carvacrol or eugenol have been shown to significantly inhibit drug-resistant *Candida albicans* strains, with MIC values comparable to fluconazole (Prabhakaran et al. 2024; Yaneva et al. 2022). Combination therapies showed particularly strong promise. Khedmat and Hashemi (2024) reported that carvacrol, when paired with nystatin, reduced fungal load by 40% more than nystatin alone. Similarly, turmeric extract used alongside photodynamic therapy produced superior antifungal outcomes compared to either treatment alone (Balef et al., 2024). Biocompatibility and formulation flexibility were additional advantages.

Rosemary extract was noted to exhibit minimal cytotoxicity toward oral epithelial cells (Meccatti et al., 2022), suggesting its potential for safe long-term use. The results highlight the antifungal properties of plant-based agents. The majority of the herbal medicines attacked fungal membranes, disturbed hyphal growth, and inhibited biofilm formation. Rosemary and turmeric suppressed ergosterol production and decreased oxidative stress. Eugenol and carvacrol decreased membrane permeability, whereas neem and vitex had high biofilm inhibition capacities. From a clinical standpoint, phytotherapeutic drugs are well-positioned to supplement traditional therapy methods. Their integration into dental gels and rinses provides a convenient option for direct mucosal application. However, the absence of standardization in extraction, concentration, and formulation continues to provide challenges. In conclusion, the comparison data show that medicinal plant extracts have significant antifungal activity, particularly when utilized in optimized or synergistic formulations. These findings support their usage as stand-alone or adjunctive treatments in oral healthcare (Fig. 1 and Tab. 1).

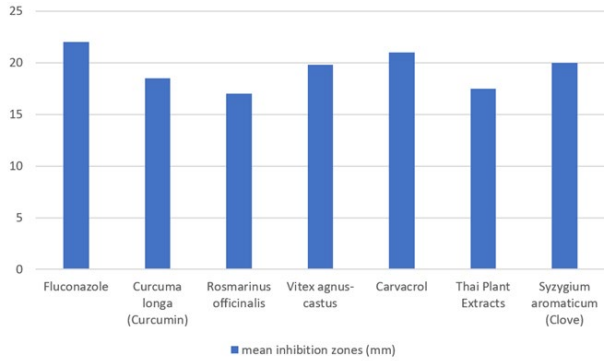

Figure 1. Mean inhibition zones of selected herbal extracts *vs*. fluconazole.

Table 1. Comparing antifungal activity: inhibition zones of various agents.

Agent	Mean inhibition zone (mm)
Fluconazole	22
Curcuma longa (Curcumin)	18.5
Rosmarinus officinalis	17
Vitex agnus-castus	19.8
Carvacrol	21
Thai plant extracts	17.5
Syzygium aromaticum (Clove)	20

Discussion

This review highlights compelling evidence supporting the antifungal efficacy of medicinal plant extracts in managing oral and dental fungal infections, particularly those caused by *Candida albicans*. The comparative analysis reveals that several plant-based agents including *Curcuma longa, Rosmarinus officinalis, Vitex agnus-castus,* and essential oil compounds like carvacrol and eugenol demonstrate antifungal activities approaching those of conventional drugs like fluconazole and nystatin. One of the most significant findings is the ability of these herbal extracts to inhibit not only drug-sensitive but also drug-resistant *Candida* strains (Prabhakaran et al. 2024; Dantas et al. 2025). The multiplicity of mechanisms reduces the likelihood of resistance development compared to single-target pharmaceuticals. The use of herbal compounds in combination with conventional

antifungal agents has also shown promising synergistic effects. In terms of clinical application, delivery methods such as gels, mouthwashes, and denture disinfectants are particularly well-suited for oral administration. These forms can prolong the retention of active agents in the oral cavity, increasing therapeutic exposure. For example, *Curcuma longa* gel combined with photodynamic therapy demonstrated improved mucosal healing (Kubizna et al., 2024). Biocompatibility and safety profiles also favor the clinical adoption of many medicinal plant extracts. Rosemary extract, for instance, showed minimal cytotoxicity in epithelial cell models (Meccatti et al., 2022), supporting its suitability for repeated use in oral environments. Challenges in using phytotherapeutic agents in oral healthcare:

- Variability in phytochemical content due to plant source, extraction methods, and formulation processes.
- Limited number of randomized clinical trials assessing long-term efficacy and safety.
- Lack of regulatory guidelines for herbal antifungal formulations in dental practice.
- Most available data from small-scale or *in vitro* studies.
- Integration of medicinal plants into mainstream oral healthcare aligns with global demand for natural, accessible, and cost-effective therapies.
- Ethnopharmacological foundation of reviewed plants offers cultural relevance and community acceptance.
- Phytotherapeutic agents represent a promising avenue for enhancing oral antifungal care.

Conclusion

This review highlights the antifungal potential of medicinal plants as alternative therapies for managing oral and dental fungal infections, especially *Candida albicans*. Plant-derived compounds like curcumin, carvacrol, eugenol, and flavonoids show significant antifungal effects through membrane disruption, biofilm inhibition, and fungal suppression. They offer comparable efficacy to conventional drugs and have favorable safety profiles. These plants are compatible with various oral delivery forms and are cost-effective, making them attractive for resource-limited settings or holistic care. However, their clinical use is limited by factors like variability in phytochemical composition, lack of dosage standardization, and underdeveloped regulatory pathways in dentistry.

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