Review Article

Anticariogenic potential of *Ocimum sanctum*: A narrative review

Siva Shankkari[1], Anil V. Ankola[2], Roopali M. Sankeshwari[3], Yuvarani Kandasamy Parimala[1], Kavitha Ragu[1]

From, [1]Postgraduate student, [2]Professor, [3]Professor and Head, Department of Public Health Dentistry, KLE Vishwanath Katti Institute of Dental Sciences, KLE Academy of Higher Education and Research, Belagavi-590010 Karnataka, India.

ABSTRACT

Dental caries is an oral disease that is prevalent globally. It is determined by diet, saliva composition, and oral flora, with *Streptococcus mutans* being the major contributor. Conventionally, prevention of dental caries is targeted at the control of cariogenic bacteria and maintaining the optimum pH of the oral cavity. However, adverse reactions like allergic reactions, toxicity, and antimicrobial resistance linked with synthetic compounds have prompted research into plant-based products. This review proposes to investigate the anticarcinogenic potential of *Ocimum sanctum*, whose multifaceted therapeutic properties in traditional medicine are well documented. The present narrative review was done comparing numerous in vitro and in vivo studies that investigated the antibacterial, anti-plaque, and salivary pH modulation actions of *Ocimum sanctum.* The review further investigated studies on dental products formulated from *Ocimum sanctum.* Several in vitro studies showed that ethanolic and aqueous extracts of *Ocimum sanctum* strongly inhibited cariogenic bacteria, particularly *Streptococcus mutans*, with zones of inhibition and low Minimum Inhibitory Concentration (MIC) values. Its use in mouthwashes, dentifrices, and restorative materials has yielded encouraging results equivalent to chlorhexidine. Considering the antibacterial and anticariogenic potential of *Ocimum sanctum*, it can be used be an alternative which is biocompatible and cost effective.

Key words: Ocimum sanctum, Dental Caries, Herbal, Complementary Therapies

Oral diseases affect approximately half of the global population. Dental caries of both primary and permanent dentition contributes significantly to oral disease burden [1]. The etiopathogenesis of dental caries is multifaceted as it is influenced by factors such as diet, salivary composition and oral microbiota. Dental caries occurs when the bacteria, especially *Streptococcus mutans*, in the oral cavity ferment the dietary carbohydrates and produce acid, thereby causing demineralisation of the tooth surface [2].

Management of dental caries relies upon detection of carious lesions at an early stage, treatment of the existing lesions and prevention of further development of caries. Conventionally, restorations are done for both enamel and dentinal caries, while pulpal therapy is performed for caries involving pulp [3]. Topical fluorides and pit and fissure sealants are the cornerstone in the prevention of dental caries [4]. Although various dental materials have been widely used for the prevention and treatment of dental caries, it has some limitations, such as allergic reaction, toxicity and development of antimicrobial resistance, necessitating upon development of alternative products of plant origin that are biocompatible and also cost-effective [5].

Access this article online

Quick response code

Received – 07th May 2025
Initial Review – 8th May 2025
Accepted – 10th May 2025

Recently, plant-based products have gained popularity due to their therapeutic potential, fewer side effects and the less cost of production. One of the commonly used plants in traditional medicine is *Ocimum (O.) sanctum,* commonly known as holy basil or tulsi. It is an aromatic shrub belonging to the family Lamiaceae and originating from north central India. [6] Evidences show that *O. sanctum* possesses anti-inflammatory, antibacterial, antifungal, antiemetic, antispasmodic, and antioxidant properties [7]. The phytochemical analysis of *O. sanctum* has revealed the presence of alkaloids, flavonoids and tannins. These components are found to be responsible for the medicinal properties of the herb [8]. Although, the therapeutical potential of *O. sanctum* is widely researched, there is a paucity in literature on the anticariogenic potential of *O. sanctum*. This review aims to narrate the anticariogenic potential of *O. sanctum*

Antibacterial properties of *O. sanctum*

An invitro study conducted by Chanthaboury et al. [9] reported that the ethanolic extract of O. sanctum inhibited the growth of the cariogenic bacteria. Similar study conducted using methonolic extract of *O. sanctum* revealed the

Correspondence to: Dr. Anil V. Ankola, Department of Public Health Dentistry, KLE Vishwanath Katti Institute of Dental Sciences, KLE Academy of Higher Education and Research, Belagavi-590010 Karnataka, India.

Email: dranilankola@kledental-bgm.edu.in

antibacterial activity of *O. sanctum* against S. *mutans, Enterococcus faecalis* and *Staphylococcus aureus (S. aureus).* The highest zone of inhibition of the extract against *Streptococcus mutans* (*S. mutans*) was observed at a concentration of 3 mg/ml. The minimum inhibitory concentration (MIC) and minimum bacterial concentration (MBC) was found to be 125 µg/ml and 250 µg/ml, respectively [10]. Another *in vitro* study conducted to assess the antimicrobial activity of ethanolic extract of *O. sanctum* against *S. mutans* at different concentrations revealed that 4% ethanolic extract had a zone of inhibition of 22 mm [11]. The antibacterial and cytotoxic activity of *O. sanctum* was evaluated by Varghese et al., who reported a bacteriostatic effect of *O. sanctum* extract against *S. mutans, Enterococcus faecalis, Candida albicans, Lactobacillus species,* and *S. aureus* at a concentration of 100µL [12].

A similar *in vitro* study by Pai et al. assessing the antimicrobial activity of aqueous extract of *O. sanctum* on cariogenic bacteria demonstrated maximum antimicrobial activity at a concentration of 4% against *S. mutans* and *Streptococcus sanguis*. However, lower concentrations were also effective [13]. Rai et al. [14] conducted an *in vitro* study to compare the antimicrobial efficacy of four different plant extracts on cariogenic bacteria and found that the zone of inhibition of *O. sanctum* was higher when compared to *Terminalia chebula* (Harad), and *Tinospora cordifolia* (Guduchi), but lesser than that of *Glycyrrhiza glabra* (Liquorice). A systematic review by Shekar et al. [15] on herbal extracts used in oral health care reported that *O. sanctum* have been found to inhibit the growth of some cariogenic bacteria. All these findings sum up that *O. sanctum* has antibacterial activity against most of the cariogenic bacteria insisting upon the use of this extract for prevention of dental caries.

Effect on salivary pH

Salivary pH is an important factor contributing to the development of dental caries. As the pH of the saliva decreases, usually after the consumption of fermentable carbohydrates, the oral environment becomes acidic. This acid production can lead to the demineralisation of inorganic components and dissolution of organic components of the tooth structure causing dental caries [16]. Considering this forementioned mechanism of caries development, dentifrices are usually formulated in such a way it does not increase the salivary pH for the prevention of dental caries. A study conducted by Loyayekar et al. estimated the salivary pH and *S. mutans* viability after chewing *O. sanctum* leaves among 30 children. It was demonstrated that salivary pH was not affected by chewing *O. sanctum* leaves. However, the *S. mutans* viability had significantly reduced.

Dental applications of *O. sanctum*

Owing to the antibacterial potential of *O. sanctum*, it has been widely used in prevention and treatment of caries. A study by Ahdal et al. [17] to assess the survival *of S. mutans* and shear bond strength of restoration after disinfection with various agents found that the highest shear bond strength of the restoration was found in the *O. sanctum* group, and the bacterial viability was comparable with chlorhexidine. These findings suggest that *O. sanctum* can be incorporated into restorative material with antibacterial properties. Also, it has been claimed that this antibacterial effect was due to the presence of tannins in *O. sanctum* [17]. A randomised controlled trial by Jain et al. [18] to compare the antibacterial efficacy of mouthwash formulated from *O. sanctum*, manuka honey and curcuma longa with chlorhexidine reported that *O. sanctum* mouthwash was as effective as chlorhexidine against *S. mutans* and *Lactobacillus acidophilus*.

Also, it was found to be effective in improving the oral hygiene status after 2 weeks. Megalaa et al. [19] conducted a randomised controlled trial to compare the anticaries efficacy of *O. sanctum* mouthrinse with sodium fluoride among high caries risk children. 4% *O. sanctum* mouthrinse was administered to the participants for 7 days and they were assessed for *S. mutans* count. It was found that the reduction of *S. mutans* was maximum in the *O. sanctum* group, suggesting that the mouthrinse formulated from *O. sanctum* extract can be used as an adjunct in caries prevention and management. Joycharat et al. conducted a study to estimate the antibacterial efficacy of a Thai formula on *S. mutans in vitro*. The ethanolic extract of the Thai formula (THF-DC), which contains *O. sanctum*, was prepared and evaluated. The MIC of the formula revealed the highest activity of a few herbal extracts, including *O. sanctum*, with the zone of inhibition varying from 7 to 22.5 mm.

Also, it has been suggested that the antimicrobial properties of the Thai formula can be attributed to the components of the plant extracts such as tannins, alkaloids, flavonoids and terpenoids [20]. Dental plaque is the biofilm found on the surface of the tooth. The formation of dental plaque is initiated by the adhesion of bacteria to the salivary pellicle. This acts as a harbour for pathogens, which are primarily responsible for dental caries and other oral diseases [21]. Various studies focus on the control of plaque for preventing and managing dental caries. A study conducted by Kamran et al. [22] assessed the effect of a mouthwash formulated from *O. santum* and *Morinda citrifolia* on the inflammatory medicators present in the gingival crevicular fluid and plaque scores of orthodontic patients.

It reported that the herbal mouthwash reduced the inflammatory mediators significantly and suggested that the herbal mouthwash in conjunction with fluoridated toothpaste can be used for the control of plaque. Similarly, another randomised controlled trial compared *O. sanctum* mouthwash with chlorhexidine mouthwash for the control of dental plaque and inflammation of gingiva. It was found that the *O. sanctum* mouthwash was as effective as chlorhexidine

in reducing the plaque scores [23]. Penmetsa et al. compared the effect of two herbal mouthwashes formulated from *O. sanctum* and aloe vera with chlorhexidine and found that both *O. sanctum* and aloe vera were equally effective as chlorhexidine in reducing the plaque scores [24]. Nadar et al. conducted a trial among 14 to 15-year-old school children to compare the efficacy of 4% *O. sanctum* extract with fluoridate dentifrices. It concluded that *O. sanctum* showed significant reduction in the plaque scores after 21 days of intervention [25]. All the above findings corroborate the effectiveness of *O. sanctum* in reducing the plaque scores, suggesting the anti-plaque effect of *O. sanctum*.

Role in the management of antimicrobial resistance

Antimicrobial resistance is a growing concern in health. Evidences show that a lot of microbes involved in dental caries are associated with antibiotic resistance [26]. This antimicrobial resistance is augmented by persistent use or misuse of antibiotics. These findings insist on the development of alternative agents that help to avoid antimicrobial resistance and effectively cease the activity of harmful pathogens [27]. *O. sanctum* can help act as an adjunct to overcome antimicrobial resistance, as it has been found to have antibacterial properties against bacteria responsible for the initiation and progression of caries. Formulation prepared from *O. sanctum* could also be effective in the management of bacterial strains that were resistant to commonly used synthetic antibiotics.

Limitations

Most of the studies evaluating anticariogenic potential of *O. sanctum* extract were performed invitro implying on the lack of in vivo studies. There could be a discrepancy in applying the findings of invitro studies as the environment in which invitro studies were conducted is different from the oral environment which contains all the biochemical components and oral microbiota. Also, there is paucity in literature demonstrating the antibacterial efficacy of *O. sanctum* with long follow up period. This fails to evaluate the long-term effects of the extract on oral tissues. Another limitation of herbal extract is lack of standardisation of the component. The geographical variation of the *O. sanctum* can have impact on its phytochemical composition. This discrepancy in the content of the extract obtained from different regions can affect its therapeutic properties.

This corroborates on the need for standardisation of the plant based on its biochemical composition. The preparation of the extract and formulation of dental products can lead to variability in the phytochemical properties. Also, there is no evidence on the bioavailability of the active components of the plant extract. The remanent concentration of the extract in the serum, saliva and gingival crevicular fluid was not accounted which is essential for formulation of any dental products for topical use such as mouthwash, gels, gum paints, varnish, etc. Studies comparing the *O. sanctum* with commercially available dental products are few suggesting there is lack of evidence supporting the use of *O. sanctum*-based formulation as an alternative dental product.

Future recommendations

Clinical trials involving human participants should be conducted in a large scale to compare *O. sanctum* with the commercially available mouthwash, varnish and other topical formulations. Studies with a longer follow up should be carried out to assess the long-term effect of *O. sanctum* on oral cavity. Standardisation of protocol for extract preparation should be done and the active components should be identified to ensure consistency of the findings for its application in further research. Future research should be directed towards the development of novel formulations like mouthwash and varnish or gel for topical application on tooth structure for prevention of dental caries.

The antibacterial activity of *O. sanctum* against *Enterococcus faecalis* suggests the formulation of intracanal medicament from *O. sanctum* as this particular species of bacteria is more commonly found seen of the root canal and is responsible for majority of the root canal failures [28]. Combination of *O. sanctum* with other herbal extracts or reinforcement of the extract with nano particles of Zinc can be done to study the synergistic effect of the formulation on cariogenic bacteria. Studies can be conducted to incorporate *O. sanctum* in local drug delivery agents for specific and targeted delivery for caries prevention and plaque control. Furthermore, long-term safety of *O. sanctum* should be studies by assessing its bioavailability, demonstrating its metabolism in the body and its concentration in serum, saliva and gingival crevicular fluid after administration.

CONCLUSION

Ocimum sanctum exhibits significant anticariogenic properties which can be attributed to the phytochemical components such as tannins, alkaloids and flavonoids. The extract of *O. sanctum* has been demonstrated to possess antibacterial efficacy against a wide range of microorganisms especially *S. mutans* which is a significant causative agent of dental caries. These findings highlight that incorporation of *O. sanctum* in dental products could be an effective method for prevention of dental caries. This could emerge as a valuable adjunct to the commercially available products which is biocompatible and cost-effective.

REFERENCE

1. Jain N, Dutt U, Radenkov I, *et al*. WHO's global oral health status report 2022: Actions, discussion and implementation. Oral Dis. 2024; 30:73–9.
2. Meyer F, Schulze zur Wiesche E, Amaechi BT, *et al*. Caries Etiology and Preventive Measures. Eur J Dent. 2024; 18:766–76.
3. Rathee M, Sapra A. Dental Caries. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2025.

4. Kashbour W, Gupta P, Worthington HV, *et al*. Pit and fissure sealants versus fluoride varnishes for preventing dental decay in the permanent teeth of children and adolescents. Cochrane Database Syst Rev. 2020; 11(11):CD003067.
5. Gocmen GB, Yanikoglu F, Tagtekin D, *et al*. Effectiveness of some herbals on initial enamel caries lesion. Asian Pac J Trop Biomed. 2016; 10:846–50.
6. Bast F, Rani P, Meena D. Chloroplast DNA Phylogeography of Holy Basil (Ocimum tenuiflorum) in Indian Subcontinent. Sci World J. 2014; 2014:847482.
7. Prakash P, Gupta N. Therapeutic uses of Ocimum sanctum Linn (Tulsi) with a note on eugenol and its pharmacological actions: a short review. Indian J Physiol Pharmacol. 2005; 49(2):125–31.
8. Panchal P, Parvez N. Phytochemical analysis of medicinal herb (*Ocimum sanctum*). Int J Nanomater Nanotechnol Nanomedicine. 2019; 5(2):008–11.
9. Chanthaboury M, Choonharuangdej S, Shrestha B, Srithavaj T. Antimicrobial Properties of Ocimum Species: An In Vitro Study. J Int Soc Prev Community Dent. 2022; 12(6):596–602.
10. Mistry KS, Sanghvi Z, Parmar G, *et al*. The antimicrobial activity of Azadirachta indica, Mimusops elengi, Tinospora cardifolia, Ocimum sanctum and 2% chlorhexidine gluconate on common endodontic pathogens: An in vitro study. Eur J Dent. 2014; 8(2):172–7.
11. Agarwal P, Nagesh L, Murlikrishnan. Evaluation of the antimicrobial activity of various concentrations of Tulsi (*Ocimum sanctum*) extract against Streptococcus mutans: an in vitro study. Indian J Dent Res Off Publ Indian Soc Dent Res. 2010; 21(3):357–9.
12. Varghese AS, Sankeshwari RM, Nagamoti MB, *et al*. Cariogram-based Comparison of Caries Risk Profile in Preschoolers Before and After Giving Parent-oriented Educational Mobile Messages: A Randomized Controlled Trial. Int J Clin Pediatr Dent. 2025; 18(1):45–52.
13. Pai KR, Pallavi LK, Bhat SS, *et al*. Evaluation of Antimicrobial Activity of Aqueous Extract of "Ocimum Sanctum-Queen of Herb" on Dental Caries Microorganisms: An In Vitro Study. Int J Clin Pediatr Dent. 2022; 15(Suppl 2):S176–9.
14. Rai A, Tripathi AM, Saha S, *et al*. Comparison of Antimicrobial Efficacy of Four Different Plant Extracts against Cariogenic Bacteria: An In Vitro Study. Int J Clin Pediatr Dent. 2020; 13(4):361–7.
15. Chandra Shekar BR, Nagarajappa R, Suma S, *et al*. Herbal extracts in oral health care - A review of the current scenario and its future needs. Pharmacogn Rev. 2015; 9(18):87–92.
16. Joshi A, Gupta A, Lihala R, Vaid P. Association of salivary pH in patients with dental caries and periodontal disease. Int J Res Med Sci. 2022; 10(1):240–4.
17. Al Ahdal K, Maawadh AM, Al Deeb L, *et al*. Effect of malachite green, ocimum sanctum, and Er, Cr: YSGG laser on antimicrobial activity against S.mutans and CAD disinfection bonded to resin restoration. Photodiagnosis Photodyn Ther. 2023; 42:103571.
18. Jain A, Singh V, Lukram A, *et al*. Antibacterial efficacy of manuka honey, ocimum sanctum, curcuma longa and 0.2% chlorhexidine mouthwash on the level of streptococcus mutans and lactobacillus acidophilus - A randomized controlled trial. Indian J Dent Res Off Publ Indian Soc Dent Res. 2022; 33(2):169–73.
19. Megalaa N, Thirumurugan K, Kayalvizhi G, *et al*. A comparative evaluation of the anticaries efficacy of herbal extracts (Tulsi and Black myrobalans) and sodium fluoride as mouthrinses in children: A randomized controlled trial. Indian J Dent Res Off Publ Indian Soc Dent Res. 2018; 29(6):760–7.
20. Joycharat N, Limsuwan S, Subhadhirasakul S, *et al*. Anti-Streptococcus mutans efficacy of Thai herbal formula used as a remedy for dental caries. Pharm Biol. 2012; 50(8):941–7.
21. Bernimoulin JP. Recent concepts in plaque formation. J Clin Periodontol. 2003; 30 Suppl 5:7–9.
22. Kamran MA, Alnazeh AA, Almoammar S, *et al*. Effect of Plant-Based Mouthwash (Morinda citrifolia and Ocimum sanctum) on TNF-α, IL-α, IL-β, IL-2, and IL-6 in Gingival Crevicular Fluid and Plaque Scores of Patients Undergoing Fixed Orthodontic Treatment. Med Kaunas Lith. 2023; 59(11):1968.
23. Gupta D, Bhaskar DJ, Gupta RK, *et al*. A randomized controlled clinical trial of Ocimum sanctum and chlorhexidine mouthwash on dental plaque and gingival inflammation. J Ayurveda Integr Med. 2014; 5(2):109–16.
24. Penmetsa GS, Pitta SR. Efficacy of Ocimum sanctum, Aloe vera and chlorhexidine mouthwash on gingivitis: A randomized controlled comparative clinical study. Ayu. 2019; 40(1):23–6.
25. Nadar BG, Usha GV, Lakshminarayan N. Comparative Evaluation of Efficacy of 4% Tulsi Extract (Ocimum sanctum), Fluoridated and Placebo Dentifrices against Gingivitis and Plaque among 14-15 years School Children in Davangere City, India - A Triple Blinded Randomized Clinical Trial. Contemp Clin Dent. 2020; 11(1):67–75.
26. Jaffar S, Taj MK, Khan MI, *et al*. Antimicrobial resistance patterns and bacterial profiling among dental caries patients. J Pak Med Assoc. 2025; 75(1):41–7.
27. Izah SC, Joshua MT, Torru KE, *et al*. Antimicrobial Resistance and the Role of Herbal Medicine: Challenges, Opportunities, and Future Prospects. In: Izah SC, Ogwu MC, Akram M, editors. Herbal Medicine Phytochemistry: Applications and Trend; 2024 p. 2127–52.
28. Alghamdi F, Shakir M. The Influence of Enterococcus faecalis as a Dental Root Canal Pathogen on Endodontic Treatment: A Systematic Review. Cureus. 12(3):e7257.

How to cite this article: Shankkari S, Ankola AV, Sankeshwari RM, Parimala YK, Ragu K. Anticariogenic potential of *Ocimum sanctum*: A narrative review. Indian J Integr Med. 2025; Online First.

Funding: None; *Conflicts of Interest: None Stated*