

Review Article

Synergistic Power: Multi-Herb Formulations and Nanotechnology in Modern Dental Care

Kavitha Ragu¹, Sagar Jalihal², Anil V. Ankola³, Roopali M. Sankeshwari⁴, Siva Shankkari¹, Yuvarani Kandasamy Parimala¹

From, ¹Postgraduate student, ²Reader, ³Professor, ⁴Professor 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

Herbal medicine has traditionally found its way in varying degrees into the field of oral healthcare, with many plant extracts demonstrating antimicrobial, anti-inflammatory, and antioxidant properties. With advances in dental research, the therapeutic emphasis has slowly been shifting toward multi-herb formulations rather than single-herb applications, so as to harness the synergistic effects of different phytochemicals and thereby improve therapeutic efficacy. At the same time, the advent of herbal nanotechnology has led to the improvement in the bioavailability, stability, and target delivery of difficult herbal compounds. This review focuses on the changing landscape of multi-herb and nano-herbal formulations in dental care, along with their working mechanisms, clinical applications, and potential advantages over conventional treatment. A comprehensive literature search was undertaken to identify all available data on multi-herb and nano-herbal dental products, concentrating on their antimicrobial, anti-inflammatory, and remineralizing benefits. Discussion of some important medicinal plants widely used in dentistry, viz. neem, turmeric, clove, and aloe vera, is provided along with their properties and specific applications in dentistry. The review also considers how novel delivery systems like nanoparticles and nanoemulsions can significantly enhance the therapeutic efficacy of the herbal actives. Though very promising evidence is obtained from the preliminary studies, further studies are needed to put these formulations on a firm basis.

Key words: Herbal Medicine, Nanotechnology, Multiherbal, Traditional Medicine

Herbal remedies are historically reputed as cosmetic treatments for oral health, with native traditions around the world using plant extracts for oral hygiene and treatment of common dental ailments [1-3]. The edifice of all these old treatments rests on the deep knowledge of the therapeutic effects contributed by the plant world: plants like neem (*Azadirachta indica*), clove (*Syzygium aromaticum*), and guava (*Psidium guajava*) with are some of those well-recognized for antimicrobial, anti-inflammatory, and antioxidant properties [4-6]. With the amalgamation of these properties, which could prevent dental caries, gingivitis, and periodontitis, these approaches offer complete care for oral health [6].

Traditional medicine, which is an age-old system of treatment, has mostly harnessed single-herb preparation methods. This methodology may, in fact, not use the vast varieties of phytochemicals present in different plants and thereby may limit the scope and power of their therapeutic effects. Hence, most of these applications have been rather

ineffective in a more comprehensive approach, considering the complex nature of oral biofilms and the multifactorial nature of dental diseases. Modern trends in medicine have taken note of this shortcoming and have set forth research on multi-herb formulations to harness synergistic effects that can further therapeutic potency [7, 8].

Several authors have recently investigated the possibility of multi-herb formulations that incorporate various medicinal plants' extracts to favour synergism. Based on this dual-action, the presence of different phytochemicals can serve to enhance antimicrobial, anti-inflammatory, and remineralizing activities; hence, it can provide a wide spectrum of defence against oral pathogens and lessen the chance for resistance development [7, 8]. For instance, the new herbal chewable tablet consisting of *Murraya koenigii* (curry leaves), *Acacia catechu* (black catechu), *Punica granatum* (pomegranate peel), and *Psidium guajava* (guava leaves) was found to be superior in inhibiting the growth of *Streptococcus mutans* and other cariogenic bacteria and promoting enamel remineralization. Such polyherbal formulations open new

Access this article online

Received – 06th May 2025
Initial Review – 07th May 2025
Accepted – 07th May 2025

Quick response code

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

Email: drsagarjalihal@kledental-bgm.edu.in

vistas in natural dental care and promise a more comprehensive and sustainable alternative to modern chemical products [8, 9].

Meanwhile, the manufacture of nanotechnology and herbalism has become one of the hot fronts in contemporary science. Nanoherbal formulations-nanoparticles, nanogels, nanoemulsions carrying plant extracts-now have several benefits above conventional herbal preparations vis-a-vis enhanced bioavailability, stability, and targeted delivery to specified oral tissues. These sorts of inventions allow better utilisation of herbal actives by ensuring sustained release and deeper penetration of herbal actives into dental biofilms or periodontal pockets. Therefore, pharmaceutically synergistic multi-herb preparations in tandem with technological advancement in nanotechnology are the next frontier in oral caregiving, offering a safer, more efficacious, and ecologically friendly option for managing oral ailments [10, 11]. This review intends to walk through the present status, recent advances, and prospects of multi-herb and nano-herbal formulations in dentistry.

METHODS

Literature Search Strategy

A literature search was conducted to find relevant studies on multi-herb formulations and nanotechnological approaches in dental care. Articles were systematically searched in four major electronic databases: PubMed, Scopus, Web of Science, and Google Scholar--from January 2010 to April 2025. Keywords as well as Medical Subject Headings (MeSH) terms used included "herbal dentistry," "multi-herb formulation," "polyherbal," "nanotechnology," "nano-herbal," "oral health," "dental caries," "periodontal disease," and "antimicrobial." Boolean operators (AND, OR) helped narrow down the search and filter studies relevant to the interface between herbal medicine and nanotechnology in dental applications.

Inclusion and Exclusion Criteria

Studies were selected based on the following criteria:

Inclusion criteria

1. Investigated the effects of multi-herb or polyherbal formulations in any aspect of dental care, such as caries prevention, periodontal therapy, or antimicrobial activity.
2. Explored the application of nanotechnology in the delivery, enhancement, or formulation of herbal compounds for oral health management.
3. Original research articles, systematic reviews, or meta-analyses published in peer-reviewed journals.
4. Published in English.

Exclusion criteria

1. Focused solely on single-herb extracts without exploring combinations or synergistic effects.
2. Did not pertain to dental or oral health applications.

3. Were conference abstracts, editorials, letters to the editor, or articles not peer-reviewed.

Study Selection and Data Extraction

Title and abstract screening were carried out by two reviewers independently to determine relevance based on inclusion and exclusion criteria for each record retrieved. The full texts of potentially eligible articles were obtained for more extensive review. When instances of disagreement emerged between reviewers, these were resolved either by consensus or through consultation with a third reviewer. Data extracted from included studies included the type of study, dispersing herbal or nano-herbal formulations, targeted oral health conditions, major findings, and stated advantages or drawbacks of the study. This ensured that all relevant information was extracted in support of the narrative synthesis.

Data Synthesis

A narrative synthesis was conducted on the results of the chosen studies. The narrative synthesis explores two thematic streams: the synergistic action of multi-herb formulations and the nanotechnological approach toward boosted efficacy, safety, and clinical outcome of herbal dental therapeutics. Key themes, trends, and gaps were identified and discussed in order to provide an integrated picture of an evolving field.

DISCUSSION

Herbal medicines have a long tradition in oral healthcare, being used for centuries by many cultures for oral hygiene and the treatment of dental diseases. Neem (*Azadirachta indica*), clove (*Syzygium aromaticum*), and guava (*Psidium guajava*) possess considerable antimicrobial, anti-inflammatory, and antioxidant activities and thus can be used in the treatment of dental caries, gingivitis, and periodontitis. Most traditional therapies, however, were single-herb based and hence may not draw on the full potential of the multiple phytochemicals presented by plants. It is an important limitation, especially considering the complicated nature of oral biofilms and the multifactorial causes of dental disease.

Role of Key medicinal herbs

Medicinal plants utilized in dental care and therapy are a great variety, with each imparting unique bioactive chemicals and different therapeutic applications as listed in Table 1. Widely known in Ayurvedic medicine for its antimicrobial and anti-inflammatory properties, neem finds prominent use in herbal toothpaste and mouthwash formulations meant for plaque control and gingival health [12]. Turmeric, loaded with curcumin, endowed with potent anti-inflammatory and antioxidant properties, provides an excellent cure for gingivitis, periodontitis, and oral ulcers. Cloves provide analgesic and antimicrobial properties widely used in the treatment of toothache and oral infections [12, 13]. Other herbs, guava, liquorice, aloe vera, and pomegranate, provide further wound-healing, anti-inflammatory, and antioxidant

effects useful in oral ulcer treatment and gum health. The inclusion of miswak (*Salvadora persica*) and peppermint (*Mentha piperita*) increases the antimicrobial activity and adds the refreshing effects, which improves patient compliance [14, 15].

Table 1: Common Medicinal Herbs in Dentistry [16, 17]

Herb (Scientific Name)	Common Name	Plant Part Used	Main Properties	Dental Uses
<i>Azadirachta indica</i>	Neem	Leaves, bark	Antibacterial, anti-inflammatory, antioxidant	Treats gum infections, reduces plaque, used in mouthwashes
<i>Curcuma longa</i>	Turmeric	Rhizome	Anti-inflammatory, antimicrobial, antioxidant	Treats gingivitis, periodontitis, and oral ulcers
<i>Glycyrrhiza glabra</i>	Licorice	Root	Antibacterial, anti-inflammatory	Reduces plaque, treats oral ulcers, and gum disease
<i>Punica granatum</i>	Pomegranate	Fruit peel	Antioxidant, antimicrobial, anti-inflammatory	Treats bleeding gums, gingivitis, and oral ulcers
<i>Psidium guajava</i>	Guava	Leaves	Antibacterial, anti-inflammatory, antioxidant	Treats swollen gums, oral ulcers, and as mouthwash
<i>Aloe barbadensis Miller</i>	Aloe Vera	Leaf gel	Anti-inflammatory, wound healing, antifungal	Treats gum disorders, promotes healing, soothes oral lesions
<i>Matricaria chamomilla</i>	Chamomile	Flower	Anti-inflammatory, antibacterial, healing	Reduces periodontal inflammation, aids in healing
<i>Mentha piperita</i>	Peppermint	Leaves	Antimicrobial, anti-inflammatory, refreshing	Reduces bad breath, soothes gingivitis
<i>Salvadora persica</i>	Miswak	Stem	Antibacterial, anti-inflammatory, abrasive	Used as natural toothbrush, prevents plaque
<i>Syzygium aromaticum</i>	Clove	Buds	Analgesic, antibacterial, anti-inflammatory	Relieves toothache, treats oral infections
<i>Acacia arabica</i>	Babul	Leaves, bark	Antibacterial, astringent	Mouthwash, treats spongy gums
<i>Mangifera indica</i>	Mango	Leaves, twigs	Antibacterial	Used for cleaning teeth
<i>Persea americana</i>	Avocado	Fruit	Anti-inflammatory, antioxidant	Treats gingivitis, canker sores, periodontal disease
<i>Carica papaya</i>	Papaya	Leaf, fruit	Anti-inflammatory, healing	Treats canker sores

Multi-Herb Formulations: Synergy and Efficacy

The rationale for combining herbs in one formulation rests on the principle of phytochemical synergy, meaning that the combined effect of different plant compounds produces a stronger therapeutic effect than the action of any one herb. As shown in Table 2, many multi-herb formulations, such as toothpaste and mouthwash, contain a mixture of neem, clove, turmeric, and peppermint, whose complementary properties offer a wider spectrum of antimicrobial activity, greater anti-inflammatory action, and stronger inhibition of plaque. Such polyherbal products have been clinically found to reduce dental plaque, gingival inflammation, and oral microbial load

far more strongly than single-herb or allopathic counterparts in clinical situations.

For instance, a randomized controlled trial done by Patil et al. (2021) showed that the multi-herbal mouthwash comprising neem, clove, and turmeric was a more efficacious cleanser of plaque and gingivitis than the chlorhexidine mouthwash, with fewer side effects, in particular staining or taste changes. Likewise, polyherbal gels and pastes are increasingly used to treat oral ulcers and assist in gum healing, which offers antimicrobial as well as tissue-regenerative properties [16, 17].

Table 2: Multi-Herb Formulations and Advanced Delivery Systems in Dentistry

Formulation/Delivery System	Key Herbal Ingredients	Main Properties	Dental Uses/Applications
Multi-herb Toothpaste	Neem, Clove, Turmeric, Peppermint, Betel	Antibacterial, anti-inflammatory, plaque control	Reduces dental plaque, freshens breath, prevents caries [16, 17]
Herbal Mouthwash	Aloe vera, Green tea, Tea tree oil, Peppermint	Antimicrobial, anti-inflammatory, soothing	Plaque reduction, gingivitis prevention [16, 17]
Polyherbal Gel	Aloe vera, Clove, Turmeric	Healing, analgesic, antimicrobial	Oral ulcers, gum healing [16, 17]
Nano-herbal Formulations	Curcumin, Green tea polyphenols, Neem extract	Enhanced bioavailability, targeted delivery, sustained release	Improved antimicrobial effect, deeper penetration, prolonged action
Nanoparticle-based Herbal Delivery	Curcumin, Andrographolide, Herbal phytoconstituents	Improved solubility, stability, targeted action	Periodontal therapy, caries prevention, controlled release

Nanotechnology: Advancing Herbal Dentistry

A breakthrough in herbal dentistry is using nanotechnology to create tiny delivery systems for herbal medicines. These include nanoparticles, nanogels, and nanoemulsions that help solve common problems with traditional herbal products, like poor dissolving, instability, and limited absorption in the body. By packaging herbal ingredients such as curcumin, green tea polyphenols, or neem extract into nanoparticles, they can better penetrate dental plaque and gum tissues, release their benefits slowly over time, and target infection or inflammation more precisely [18].

Studies show that nano-curcumin has stronger antimicrobial and anti-inflammatory effects than regular curcumin, making it especially useful for treating gum disease and preventing cavities. Nano-herbal gels and mouthwashes also offer longer-lasting effects, while reducing irritation and minimizing side effects elsewhere in the body [19, 20].

Nanotechnology Applications in Dentistry

Table 3: Nanotechnology Applications in Dentistry

Nanomaterial/Technology	Main Properties/Advantages	Dental Applications	Example Herbal Actives/Uses
Nano-hydroxyapatite (nHAp)	Biocompatible, remineralizing, seals dentinal tubules	Enamel remineralization, dentin hypersensitivity, toothpaste [25]	--
Silver nanoparticles (AgNPs)	Potent antimicrobial, anti-biofilm, low toxicity	Mouthwashes, restorative materials, implant coatings	Green tea, neem, clove [21, 22]
Gold nanoparticles (AuNPs)	Biocompatible, drug delivery, anti-inflammatory	Targeted drug delivery, diagnostics, anti-cancer therapies	Turmeric, pomegranate [23, 24]
Nano-calcium phosphate	Biomimetic, enhances remineralization	Toothpastes, varnishes, restorative materials [28]	--
Nano-zirconia/alumina composites	High strength, toughness, anti-biofilm	Dental implants, crowns, polishing agents [28]	--
Casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) nanoparticles	Promotes remineralization, stabilizes calcium and phosphate ions	Preventive care, enamel repair, sensitivity treatment [28]	--
Titanium dioxide nanoparticles	Antimicrobial, whitening, UV protection	Mouthwashes, coatings for dental materials [28, 29]	--
Liposomes/nanomicelles	Enhance solubility, stability, targeted and sustained release	Herbal mouthwashes, gels, drug delivery systems [27, 29]	Curcumin, aloe vera, resveratrol
Nanoemulsions	Improved penetration, increased bioavailability	Herbal mouth paints, gels, oral sprays [27, 29]	Tea tree oil, aloe vera
Nanocapsules/nanogels	Protect actives, control release, enhance mucosal adhesion	Periodontal therapy, caries prevention [29]	Curcumin, green tea polyphenols
Nanostructured implant surfaces	Improved osseointegration, stability	Dental implants [29]	--
Nanocarriers for herbal actives	Enhanced bioavailability, targeted delivery, sustained release	Herbal mouthwashes, gels, drug delivery systems [27, 29]	Curcumin, green tea, neem, others

Table 3 provides an overview of different nanomaterials and technologies currently used in dentistry, focusing on their unique properties and how they’re applied. For example, nano-hydroxyapatite (nHAp) mimics the mineral content of natural enamel, helping to rebuild it and reduce tooth sensitivity. Silver nanoparticles (AgNPs) are known for their strong antimicrobial and anti-biofilm abilities, making them useful in mouthwashes and coatings for dental implants. Gold nanoparticles (AuNPs) are used for targeted drug delivery and reducing inflammation. Other nanomaterials, like nano-calcium phosphate and casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) nanoparticles, help repair enamel and treat sensitivity. Nanocarriers such as liposomes, nanomicelles, and nanoemulsions assist in increasing the solubility and stability of herbal ingredients like curcumin and aloe vera, making these natural remedies more effective. Table 3 sums up key nanomaterials and technologies in herbal dentistry, showing their features, how they’re used in dental care, and examples of herbal substances involved.

Silver Nanoparticles (AgNPs)

Silver nanoparticles, or AgNPs, are some of the most studied nanomaterials in dentistry because they are very effective at fighting bacteria and preventing biofilms, all while being relatively safe. They work against a wide range of oral germs, like Streptococcus mutans and Candida albicans, which are major players in cavities and mouth infections. Scientists have found that adding AgNPs to things like mouthwashes, dental

fillings, and implants has greatly improved their ability to kill bacteria and reduce infections. Interestingly, when AgNPs are made using natural extracts like green tea, neem, or clove, they get an extra boost from these plants antimicrobial properties, making them even more powerful [21, 22].

Gold nanoparticles (AuNPs)

Gold nanoparticles, or AuNPs, are highly valued because they are safe for our bodies and can do many different jobs.

They're often used to carry medicines directly to affected areas or to help with diagnoses. In herbal dentistry, AuNPs combined with herbal compounds like turmeric and pomegranate, which are known for their anti-inflammatory and antioxidant effects, are showing promise for treating oral inflammation and possibly even oral cancers. Because they can deliver these helpful compounds exactly where they are needed, they help minimise side effects and improve treatment results [23, 24].

Nano-Hydroxyapatite (nHAp)

Nano-hydroxyapatite is very similar to the mineral makeup of natural tooth enamel and bones, which makes it biocompatible and really good at helping repair enamel and reduce tooth sensitivity. Because these nanoscale particles are tiny, they can get inside the tiny tubes in dentin, sealing them off and lowering sensitivity. They also form a protective coat over the enamel surface, find nHAp in toothpastes, varnishes, and treatments for sensitive teeth, offering a natural-like way to repair enamel that works better than traditional fluoride methods [25].

Titanium Dioxide Nanoparticles

Titanium Dioxide Nanoparticles are known for their ability to fight microbes, whiten teeth, and protect against UV rays. When added to mouthwashes and dental coatings, they help keep your mouth cleaner and looking brighter while also blocking germs from sticking around [26].

Liposomes and Nanomicelles

Liposomes and Nanomicelles are tiny carriers that improve how herbal compounds like curcumin, aloe vera, and resveratrol dissolve and stay stable. They help deliver these ingredients right where they're needed and make them last longer, improving their sticking power to the mucous membranes. That makes them useful in herbal mouthwashes, gels, and other delivery systems [27].

Nanoemulsions

Nanoemulsions are small oil-in-water mixtures that help herbal ingredients penetrate better and work more effectively. For example, mouth gels containing tea tree oil and aloe vera with nanoemulsions show stronger antimicrobial and anti-inflammatory effects, making them better at treating mouth infections and mouth sores [27].

Nanocapsules and nanogels

Nanocapsules and nanogels help protect sensitive herbal ingredients from breaking down. They allow for controlled release and help these ingredients stick to the mouth's mucous membranes longer. This is especially helpful in treatments for gum disease and cavity prevention, where delivering ingredients like curcumin and green tea polyphenols over time is important for success [27, 28].

FUTURE RECOMMENDATIONS

Looking ahead, developing nano-herbal dental products will depend on several important factors. First, standardizing herbal extracts and nanoformulations is important to make sure that each batch is consistent in quality, reproducibility, and biological activity. This involves creating validated methods for extraction and clear protocols for characterizing both the herbal ingredients and their nano-delivery systems. Second, large-scale clinical trials with many participants and long-term follow-up are necessary to accurately assess how well these products work, how safe they are, and how patients experience them. Third, working closely with regulatory agencies is key to establishing clear guidelines and standards specific to nano-herbal products.

This will help address challenges related to manufacturing, safety testing, and labelling that are unique for nanomedicines. Fourth, thorough toxicological and biocompatibility studies, both in laboratory settings and in live subjects, must evaluate the long-term safety and environmental impact of the nanomaterials used. Plus, it's important to analyse whether these products are affordable and accessible, especially in areas with limited resources. Finally, research focused on patients' acceptance, compliance, and overall quality of life will help improve formulations and delivery methods. Collaboration between dentists, pharmacologists, nanotechnologists, and industry experts will speed up innovation and make it easier to bring these products into everyday clinical use. By working together on these fronts, we can turn promising lab results into widely available treatments that are safe, effective, and accessible, finally helping improve dental health around the world.

CONCLUSION

The merging of herbal remedies with nanotechnology is opening up exciting new possibilities in dental care. It offers natural, effective, and eco-friendly options that might even replace some traditional treatments. When herbal ingredients are delivered through advanced nano-systems, they get past many limitations of standard medicines. This means they can be absorbed better, work more precisely where needed, and last longer in the body. Studies show that nano-herbal products like nano-curcumin and nano-hydroxyapatite are promising for treating gum infections, cavities, and sensitive teeth. Of course, there are still obstacles like how to mass-produce these solutions safely, get regulatory approval, and prove they're effective in real-world settings. But ongoing research and technological innovations are quickly overcoming these challenges. With more collaboration between different scientific fields and thorough clinical testing, nano-herbal dental products could change how we take care of our teeth, combining traditional herbal wisdom with the precision of nanotech.

REFERENCE

1. Anwar MA, Sayed GA, Hal DM, *et al.* Herbal remedies for oral and dental health: a comprehensive review of their multifaceted mechanisms including antimicrobial, anti-inflammatory, and antioxidant pathways. *Inflammopharmacology*. 2025;1-76.
2. Abu Tamam A, Kukreja B, Ramachandra S, *et al.* Herbal Medicine as an Adjunct in the Treatment of Periodontal Diseases - A Systematic Review . *Open Dent J*, 2024; 18: e18742106295311. <http://dx.doi.org/10.2174/0118742106295311240419074231>
3. Mane, Dipali & Ramdas, Khuspe & Kharmate, *et al.* The impact of herbal and natural products in managing oral health: A pharmacological perspective. *IP International Journal of Comprehensive and Advanced Pharmacology*. 10. 22-33. 10.18231/j.ijcaap.2025.004.
4. Duggal S, Chandrika PS, Nasyam FA, *et al.* Herbal Dentistry: Nurturing Oral Health with Natural Remedies. *J Pharm Bioallied Sci*. 2024; 16(Suppl 3):S1932-4.
5. Kumar G, Jalaluddin MD, Rout P, *et al.* Emerging trends of herbal care in dentistry. *J Clin Diagn Res*. 2013; 7(8):1827.
6. Shekar BR, Nagarajappa R, Suma S, *et al.* Herbal extracts in oral health care-A review of the current scenario and its future needs. *Phcog Rev*. 2015; 9(18):87.
7. Karygianni L, Al-Ahmad A, Argyropoulou A, *et al.* Natural antimicrobials and oral microorganisms: a systematic review on herbal interventions for the eradication of multispecies oral biofilms. *Front. microbiol*. 2016; 6:1529.
8. Kalkundri TA, Dinnimath BM. Design, development and evaluation of a new polyherbal mouth wash for antibacterial potency against oral bacteria. *Int. J. Pharm. Sci. Res*. 2018; 9:5301-7.
9. Saraya S, Kanta J, Sarisuta N, *et al.* Development of guava extract chewable tablets for anticariogenic activity against *Streptococcus mutans*. *Mah Univer Jou of Pharma Sci*. 2008; 35:18-23.
10. Budama-Kilinc Y, Kurtur OB, Gok B, *et al.* Production of Prophylactic Nanoformulation for Dental Caries and Investigation of Its Effectiveness by In Vitro and In Silico Methods. *Pharmaceutics*. 2025; 17(2):167.
11. Butler J, Handy RD, Upton M, *et al.* Review of antimicrobial nanocoatings in medicine and dentistry: mechanisms of action, biocompatibility performance, safety, and benefits compared to antibiotics. *ACS nano*. 2023; 17(8):7064-92.
12. Rani N, Singla RK, Narwal S, *et al.* Medicinal plants used as an alternative to treat gingivitis and periodontitis. *Evidence-Based Complementary and Alternative Medicine*. 2022; 2022(1):2327641.
13. Joseph RA, Sabarish R, Muthukumar S, *et al.* Comparative Evaluation on the effect of Herbal mouthwash on Putative Periodontal Pathogens–In vitro study. *Res J Pharm Technol*. 2023; 16(1):97-102. <https://10.52711/0974-360X.2023.00017>.
14. Malcangi G, Inchingolo AM, Casamassima L, *et al.* Effectiveness of Herbal Medicines with Anti-Inflammatory, Antimicrobial, and Antioxidant Properties in Improving Oral Health and Treating Gingivitis and Periodontitis: A Systematic Review. *Nutrients*. 2025; 17(5):762.
15. Aljarbou F, Almobarak A, Binrayes A, *et al.* *Salvadora Persica's* Biological Properties and Applications in different Dental specialties: a narrative review. *Evidence-Based Complementary and Alternative Medicine*. 2022; 2022(1):8667687.
16. Dwivedi SD, Yadav M, Singh D, *et al.* Herbal Alternatives for Oral Health: Mechanistic Exploration with their Market Potential. *Journal of Ravishankar University*. 2024; 37(1):1-21. <https://doi.org/10.52228/JRUB.2024-37-1-1>
17. Mane DV, Khuspe PR, Kharmate P, *et al.* The impact of herbal and natural products in managing oral health: A pharmacological perspective. *IP Int J Compr Adv Pharmacol*. 2025; 10(1):22–33
18. Yazdani M, Rostamzadeh P, Rahbar M, *et al.* The potential application of green-synthesized metal nanoparticles in dentistry: A comprehensive review. *Bioinorg. Chem*. 2022; 2022(1):2311910.
19. Malekzadeh M, Kia SJ, Mashaei L, *et al.* Oral nano-curcumin on gingival inflammation in patients with gingivitis and mild periodontitis. *Clinical and experimental dental research*. 2021; 7(1):78-84.
20. Zakria HM, Ebtesam AE, Maged AE, *et al.* A comparative evaluation of nano curcumin gel versus nano doxycycline gel in treatment of chronic periodontitis stage II grade B. *Tanta dent. j*. 2024; 21(2):250-8.
21. Fernandez CC, Sokolonski AR, Fonseca MS, *et al.* Applications of silver nanoparticles in dentistry: advances and technological innovation. *Int. J. Mol. Sci*. 2021; 22(5):2485.
22. Mallineni SK, Sakhamuri S, Kotha SL, *et al.* Silver nanoparticles in dental applications: A descriptive review. *Bioengineering*. 2023; 10(3):327.
23. de Lima MHDCT, Avelino MEL, Cavalcanti MRN, *et al.* Unraveling applications of gold nanoparticles in dentistry: A scoping review. *J Dent*. 2025; 156:105685. <https://10.1016/j.jdent.2025.105685>.
24. Dharman S, Maragathavalli G, Shanmugam R, *et al.* Curcumin mediated gold nanoparticles and analysis of its antioxidant, anti-inflammatory, antimicrobial activity against oral pathogens. *Pesqui Bras Odontopediatria Clin Integr*. 2023; 23:e220068.
25. Browning WD, Cho SD, Deschepper EJ. Effect of a nano-hydroxyapatite paste on bleaching-related tooth sensitivity. *J Esthet Restor Dent*. 2012; 24(4):268-76.
26. Ali R, Alwan AH. Titanium Dioxide nanoparticles in Dentistry: multifaceted applications and innovations. *future dent. j*. 2023; 1(1):12-25.
27. Sabuj MZ, Islam N. Nanophytomedicine: An Effective Way for Improving Drug Delivery and Bioavailability of Herbal Medicines. *Nanophytomedicine: Concept to Clinic*. 2020:55-70.
28. Mansoor A, Khurshid Z, Khan MT, *et al.* Medical and dental applications of titania nanoparticles: an overview. *Nanomaterials*. 2022; 12(20):3670.
29. Gronwald B, Kozłowska L, Kijak K, *et al.* Nanoparticles in dentistry—current literature review. *Coatings*. 2023; 13(1):102

How to cite this article: Ragu K, Jalihal S, Anil V. Ankola, Roopali M. Sankeshwari, Shankkari S, Parimala YK. Synergistic Power: Multi-Herb Formulations and Nanotechnology in Modern Dental Care. *Indian J Integr Med*. 2025; Online First.

Funding: None;

Conflicts of Interest: None Stated