RESEARCH PAPER

Evaluation of Herbal Medicines Against Microbial Dental Caries in Primary and Permanent Dentition

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ABSTRACT

Dental caries and periodontal disorders are the leading causes of tooth loss worldwide, affecting the whole population. Dental decay is a major public oral health issue in the Middle East, Africa's sub-Saharan regions, and Asia. The microbiome of the oral cavity is diverse, containing bacteria, archaea, fungus, protozoa, and viruses. The patient appeared with a toothache problem; observations were performed on the diseased patient's oral cavity, which is divided into four parts: upper right first quadrant, second left quadrant, lower left third quadrant, and lower right fourth quadrant. The upper right is infected with bacteria, whereas the bottom left has already had root canal therapy and is full of gum. Lower regions patient has already had root canal treatment and has secondary infections, higher regions noticed bacterial infections in both teeth, depth of infections examined under X-ray, and deep bacterial infections inside were discovered. Toothache is a significant global health condition, and medicinal plants are frequently used to treat pain and inflammation. There are 21 medicinal plant species used to treat toothaches in America, 29 in Europe, 192 in Africa, 112 in Asia, and ten in Oceania. The most common species were *Allium sativum*, *Acmella oleracea*, *A. cepa*, *Jatropha curcas*, *Syzygium aromaticum* and *Jatropha gossypiifolia*. Asteraceae was the most common family of medicinal plants, followed by Solanaceae, Lamiaceae, Fabaceae, Euphorbiaceae, Myrtaceae, and Rutaceae, we focused under SDG; number 3 good health well-being.

Keywords: Biofilm, Dental caries, Medicinal plants, Microorganisms, Quadrant, X-ray

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INTRODUCTION

The penicillin, the first antibacterial antibiotic, was discovered in 1928 and initially used to treat patients in the year of 1942 [1]. The medicinal possible remained quickly documented. During Ecosphere War II, the United States and Great Britain collaborated to produce penicillin in large quantities by 1943 [2]. After World War II, Dutch scientists devised a new way to produce penicillin, which was introduced in 1946. This resulted in mass production and lower treatment costs [3]. Antibiotics have saved millions of lives and revolutionized medicine. The invention of antibiotics revolutionized medical science and improved healthcare quality. Unfortunately, the usage of antibiotics has led to the speedy formation of unaffected strains outstanding to the inexorable blowout of confrontation genes in the bacteriological population [4].

Periodontal disorders and Dental caries are the foremost foundations of tooth damage worldwide; affecting 20-50% of the global population [5], the disease of periodontal is prominent source of tooth damage amongst patients in Indian over 30 years old, accounting for about 80% [6]. Dental caries is a chief community oral healthiness problem throughout Asia, Middle East, Africa's sub-Saharan areas, according to multiple researches [7]. Some studies suggest that dental caries have decreased internationally, particularly in modern countries, whereas others claim a considerable increase in caries incidence [8].

Dental caries and periodontal disease are greatest common protracted infections produced by bacteria in the mouth. The human oral flora contains around 700 bacteria; with 50% being uncultivable [9], the mouth cavity has a diverse microbiome of archaea, bacteria, fungus, viruses and protozoa. Oral micro-biomes often exist as free-floating microbes in saliva, forming a diverse biofilm community that attaches to various mouth surfaces [10].

Diet also has an important effect in enamel erosion and dental caries [11], due to demineralization leads caries, its inorganic portion of tooth through the termination of biological constituent unpaid to a multifactorial aetiology [12], and its results from interactions between a susceptive mass, bacteria cause caries related and cariogenic nourishments [13]. Organic acids in dental plaque promote demineralization of enamel and dentine due to anaerobic microbes metabolising food carbohydrates [14]. Dietary acids, specifically, can cause enamel abnormalities such as hypoplasia and fluorosis [15].

Medicinal plants are commonly employed in dentistry clinics. According to the World Health Organization, 65% to 80% of the population in poor nations utilizes oral hygiene products to reduce inflammation, prevent pathogen growth, and provide anti-inflammatory, antiseptic, antioxidant, and analgesic effects [16,17].

Patient visited tooth ache problem, observation of patient history, food habits, behaviors, tooth infections upper and lower region of jaws noticed.

MATERIALS AND METHODS

Epidemiology of dental infection

Patient came to Saveetha Dental College with teeth infection in upper region, noticed that the morphological viewed of the tendril observed black patches on teeth, further internal analysis focused for bacterial infection depth on the teeth.

X ray analysis of infected teeth

Dental imaging uses many picture modalities, with X-rays being the most frequent for classifying bone and hard tissues. Dental imaging is widely used to detect fractures, tooth structures, jaw alignment, cysts, and bone loss [18], IOPA radiogram - 2D images, radio uptake and radio efficiency.

Plant sources for toothaches

This review assessed 80+ articles that met the inclusion criteria out of 300+. To supplement the existing material, we manually searched the reference lists of the selected publications and discovered an additional 294+ articles. Phytochemicals are plant-based compounds with favorable impacts on human health and nutrition [19]. Medicinal plants are mostly used for their leaves, seeds, flowers, and roots. Roots are crucial for plant health as they contain more bioactive compounds than other sections. Phytochemicals used to treat toothache have various mechanisms of action, including antioxidant activity [20], action on TRP channels [21], Σ-aminobutyric acid (GABA) mechanism and anti-inflammatory mechanisms (COX and LOX pathways) [22].

RESULTS AND DISCUSSION

Teeth oral cavity in mouth part contains gums, teeth, tongue, mucous, membrane, buccal mucosa, saliva secretions, saliva secretion also responsible for caries, saliva contain lot of bacteria, due to that also one of the reasons for teeth infections, carries growth, mouth contain lower and upper parts, lower called as mandible, upper maxilla. The teeth infected person oral cavity divided in to four parts, upper right 1st quadrant, 2nd left quadrant, lower left 3rd and lower right 4th quadrant. Lower left already done root canal treatment filled with gum and upper right infected with bacteria (Fig 1).

The normal teeth contain enormal, tendrin, bulb (main structure of theeth), ground part, root part, cementum covers the root dentine surface of all teeth, infected teeth focused IOPA (intra oral peripicle radiogram), X-ray analysis focused each individual teeth structure, teeth decay (Fig. 2), remove decayed tooth sensor small film taking X-ray (Fig. 3), radiolucency shows cavy region looks dark. Teeth in radio-back shows white color, didn't do proper root canal treatment it leads secondary caries, observed that up to root, those kinds of infections noticed again can't to do root canal treatments, better and must remove that teeth then implant. Upper teeth two chances their 1st need to follow hygiene, it's not fallowed, ¼, ¼ affected, upper case class 2; paroxysms surface, infected bulb need root canal proper treatment, based on depth of infections need to fill gums, after filled it looks like normal teeth.

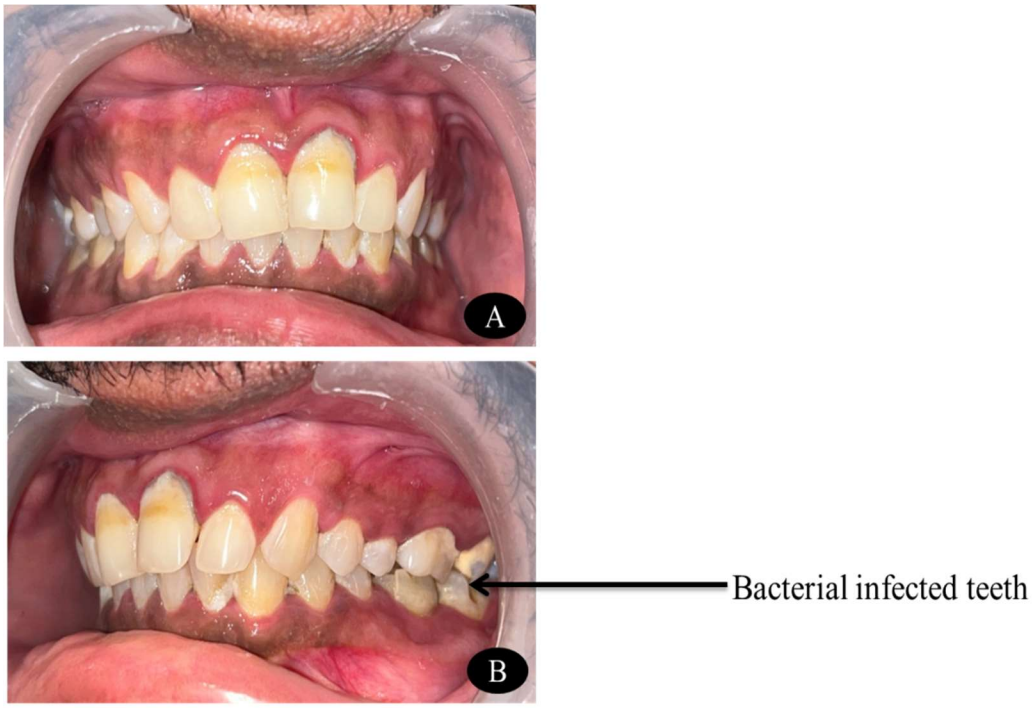

Fig. 1. Normal and infected teeth
A. Front view of a patient, B. Left side view of infected teeth

A research in India found aerobic 64 and anaerobic 87 strains among patients are 68 aged 18-58. The most common microorganisms existed 64% are *Streptococci viridans*, 43% are *Prevotella*, 26% *Peptostreptococcus*, 7% are *Porphyromonas*, and 14% are *Fusobacterium*. Anaerobic Gram -ve 40% are bacilli were the most common species, followed through aerobic gram +ve 34% are cocci, 4 strains are *Candia albicans* were found [16]. The high sensitivity in *S. viridans* exhibited to 95% are amoxicillin-clavulanate, 90% are amoxicillin, and 83% are levofloxacin. In 97% were *Prevotella* susceptible to clavulanate=amoxicillin 62% profound to erythromycin. *Porphyromonas* and *Peptostreptococcus* are particularly susceptible to 100% of amoxicillin-clavulanate and in clindamycin are 100%. The detected microbes were highly responsive to routinely administered antimicrobials, including clavulanate+amoxicillin, amoxicillin alone, clindamycin, and levofloxacin, but more resistant to erythromycin.

The non-culture approach discovered a broad population of pathogens, including species of *Treponema* and gram +ve anaerobic rods comprising *Cryptobacterium curtum, Mogibacterium timidum* and *Bulleidia extructa* [23]. Antimicrobials of macrolide were found to be fewer profound to *streptococci* of viridans group, *Prevotella* species *Streptococcus oralis*, and anaerobic *streptococci* [24].

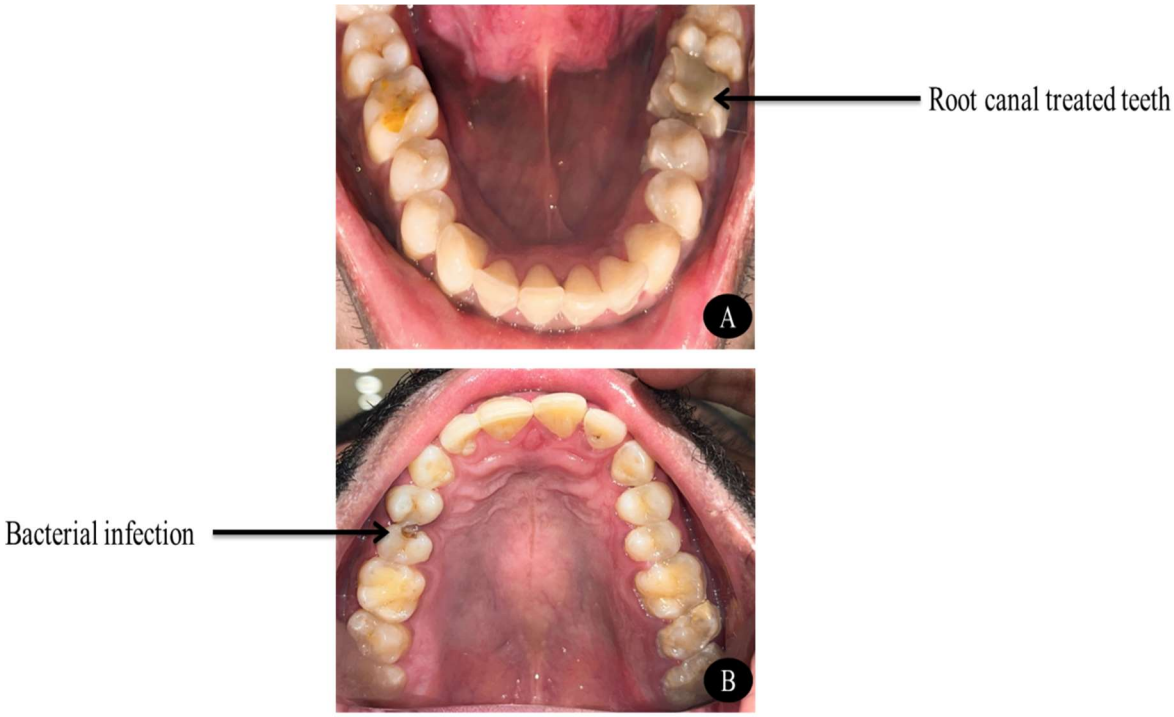

Fig. 2. Teeth arrangements, normal and infected teeth
A. Lower jaw of a patient, B. Upper jaw of bacterial infected teeth

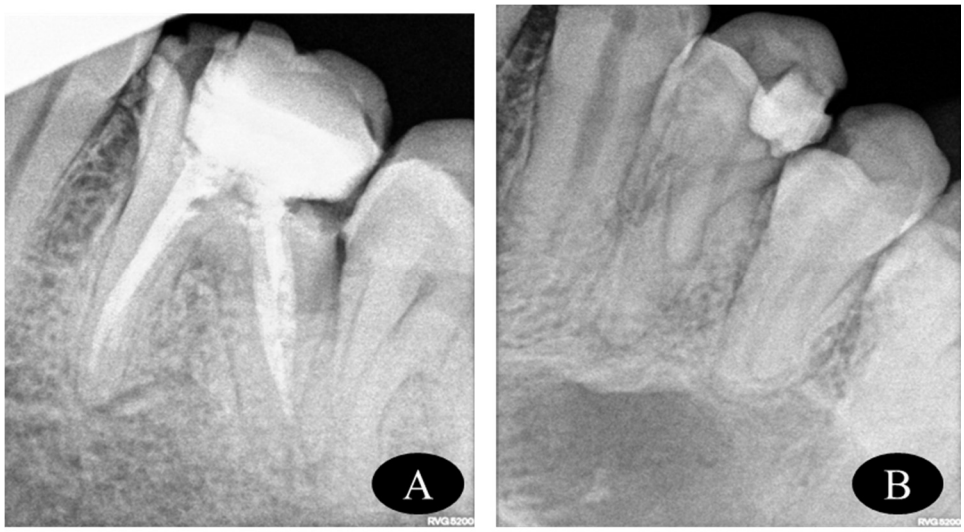

Fig. 3. Bacterial infected teeth further X-ray confirmation
A. Lower jaw of a patient, B. Upper jaw of bacterial infected teeth

In a study of 155 viridans group streptococci, the Glasgow Dental Hospital Infection Research Group and School found that *S. oralis* are 27% were impervious to penicillin, for erythromycin 51%, and in clindamycin are 6%, additionally, *S. mitis* are 11% remained penicillin unaffected, erythromycin are 40% and clindamycin are 3% [25]. Resistant against penicillin, the bacteria exhibit reduced sensitivity to other antimicrobials. Barkatullah University in India conducted research on gram + cocci (*S. oralis, S. sanguinis, S. mutans, S. sobrinus*) and bacilli (*L. rhamnosus, L. acidophilus, L. fermentum*). In this study, microorganisms showed resistance to penicillin V (48%), tetracycline (66%), amoxicillin (90%), cloxacillin (78%), and erythromycin (60%) [26], from Nepal a study found that 91% of attacking pathogens were gram +ve and 9% were gram -ve, *S. mutans* shown resistance 66.15% in penicillin, 60.76% in tetracycline and 20% in cotrimoxazole [27]. Found *S. aureus* was unaffected 91.48% penicillin, followed by 86.17% in tetracycline, and 61.70% are ampicillin. The *S. mitis* demonstrated

resistance against 78.12% intetracycline and ciprofloxacin (65.62%), tetracycline was completely ineffective against Pseudomonas spp., but 90.90% was cotrimoxazole effective [28].

A Brazilian study found that oral infections were resistant to multiple antibiotics, including amoxicillin+clavulanic acid, ampicillin, cefoxitin, amikacin, cephalothin, nalidixic acid and chloramphenicol. The revision carbapenems found (imipenem and meropenem) to be the maximum effective antibacterial drugs, with only 1.6-2.3% of infections resistant to them [29].

Ciprofloxacin and rifampin have similarly low resistance profiles, study of children 60 through vigorous contaminations in dentition major level, Clindamycin (85.9%) 8 & 16 µg/mL showed highest microbiological resistance monitored through 43.7% are amoxicillin and 12.0% are amoxicillin-clavulanic acid [30]. Polymerase chain reaction identified the most resistant microorganisms as *P. intermedia, S. oralis, S. mutans, P. gingivalis, T. denticola, S. salivarius* and *C. rectus* [31].

Disadvantageous properties of infections in oral on universal healthiness recognized for practically 3000 years, dental, chronic and oral disease particularly harmful for immune-compromised persons [32]. Studies indicate that chronic infection can lead to lifetime frightening universal illnesses and increased indisposition and death [33]. Tooth damage can negatively impact food, nutrition, and eating habits, leading to greater death rates [34]. A study of Japanese using multivariate accustomed direct relational deathtraps model found that appropriate oral precaution, such as brushing tooth, systematic consultations through surgeons of dental and denture usage, consumed an transposed relationship through impermanence amongst the mature [35].

Fig. 4. Medicinal plants for infected teeth's, prevent from microbes

Even in the USA, untreated dental disorders pose a significant public health risk, precautionary dental maintenance can enhance oral healthiness, however not all patients in the USA obtain it on a regular basis [36], in Minneapolis-St. area of Paul metropolitan of Minnesota, over 10,000 individuals need emergency dental care, costing around million of $5 each year. Patients remained preserved only for severe symptoms, without addressing the underlying pathology of the condition. According to another study [30], over 35% of population in US, 100 million people, lack dental treatment. According to one study, paediatric kids undergoing dental care in a hospital functioning chamber cost $1508 compared to $104 in non-operating rooms.

The anti-inflammatory mechanism

This is supposed to be how herbal extracts alleviate toothaches. As a result, medicinal plants, particularly curcumin-rich herbs like *C. longa*, appear to give many benefits by modulating the COX and LOX pathways [16, 21]. Curcumin is a dual inhibitor with synergistic effects and superior anti-inflammatory efficacy. *Allium cepa* (onion) includes polyphenols and flavonoids that inhibit the COX and LOX pathways, preventing the synthesis of LTs, TXB2, and PGE2 [37, 38]. Ginger chemicals, including shogaols, gingerols, gingerdiols, zingerones, and paradols, offer antioxidant, analgesic, and anti-inflammatory properties [39], *Piper sarmentosum* and ginger are used to relieve toothache (Table 1).

Medicinal plants for pharmaceutical

Traditional Chinese and Indian medicine has employed the rhizome of Zingiber officinale (ginger) to cure several diseases, including toothache [68]. Bromelain suppresses pain mediators including PGE2 and substance P and has anti-edematous properties. Baicalin controls inflammation-related genes, including COX, LOX, and inducible nitric oxide synthase. Escin reduces inflammation and edema through [40]. A study in Africa indicated that *Datura stramonium* L. leaves, roots, seeds

and stems were commonly used to relieve toothache. A. sativum was found in America, Europe, and Africa, while *Syzygium aromaticum* and *A. cepa* were found in Europe, Africa, and Asia. *Acmella oleracea, Jatropha curcas,* and *Jatropha gossypiifolia* were also discovered in America, Africa, and Asia. In contrast, certain species are found solely on one continent, such as *Thymus schimperi* Ronniger in Africa, maybe because this species is a rare plant that is highly confined and endemic to Ethiopia [41] (Fig. 2).

Table 1. List of medicinal plants used for toothache and dental uses

S. No.	List of medicinal plants	Family	Useful parts	Dental uses
1	*Barleria prionitis*	Acanthaceae	Leaves, Root	The root and leaves are chewed to treat tooth decay.
2	*Justicia diffusa*	Acanthaceae	Leaves	Boiling the leaves and using gingelly oil can alleviate toothaches.
3	*Achyranthes aspera*	Acanthaceae	Stem	The plant's stem can be used as a toothbrush, and the ash can be used as tooth powder to treat pyorrhea and toothaches.
4	*Agave americana*	Agavaceae	Entire plant	Entire plant parts used for toothache
5	*Achyranthes aspera*	Amaranthaceae	Roots	Roots can be used as a brush for pain relief and tooth cleaning.
6	*Mangifera indica*	Anacardiaceae	Young stem	Toothache can be treated using a small stem toothbrush, while gingivitis can be relieved by applying latex.
7	*Ferula asafoetida*	Apiaceae	Root	Root extract is utilized for toothaches.
8	*Cuminum cyminum*	Apiaceae	Seeds	Aphthous ulcers in the mouth are treated with seeds and a small amount of sugar.
9	*Wrightia tinctoria*	Apocynaceae	Leaf	Applying leaf paste on painful teeth might relieve pain.
10	*Saussurea costus*	Asteraceae	Tuber	Tuber infusion utilized for toothache.
11	*Achillea millefolium*	Asteraceae	Leaves	Leaves can be chewed to ease toothaches and freshen the mouth.
12	*Spilanthes acmella*	Asteraceae	Flowers	Flowers are mashed and applied to relieve toothaches.
13	*Spilanthes paniculata*	Asteraceae	Leaves and root	Chewing root and leaves and swallowing the juice can alleviate toothaches.
14	*Ehretia laevis*	Boraginaceae	Twigs	Younger twigs are used as tooth brushes.
15	*Canarium bengalense*	Burseraceae	Latex	Latex is used to treat wounds and gum infections.
16	*Tamarindus indica*	Caesalpiniaceae	Bark	Bark powdered is utilized as teeth powder.
17	*Cassia tora*	Caesalpiniaceae	Leaf	A leaf decoction was administered to children with teething.
18	*Ricinus communis*	Euphorbiacea	Cotyledons	Cotyledons are roasted in mustard oil and the smoke produced can be inhaled to treat toothaches.
19	*Acalypha indica*	Euphorbiacea	Entire plant	The herb's decoction is used to treat tooth problems.
20	*Jatropha curcas*	Euphorbiacea	Stems	Freshly stems are utilized as a toothbrush.
21	*Phyllanthus emblica*	Euphorbiacea	Fruits	Fruits are used to freshen the mouth and prevent tooth decay.

22	*Emblica officinalis*	Euphorbiacea	Twigs	Twigs are worn into the neck to treat toothaches.
23	*Phyllanthus niruri*	Euphorbiacea	Leaves	Leaves are used to treat mouth ulcers.
24	*Pongamia pinnata*	Fabaceae	Leaf twigs	Crisp leaf twigs are eaten to relieve toothaches.
25	*Abrus precatorius*	Fabaceae	Leaves	Chewing the leaves can provide relief for toothaches.

CONCLUSION

The resistance of antimicrobial is an accepted process that transpires when microorganisms progress. Need care of health is important, regularly brushing, properly, daily two times, use mouth with hot water with salt or any Doctor recommended mouth washing liquid, those kind of primary healthcare and mouth care important to avoid oral infection, teeth infection from infecting microbes. Healthy teeth are necessary for the body to function properly. In the allopathic system of medicine, treatment of oral diseases is quite expensive. The leaves and roots were the most widely used plant parts, followed by the seeds, stems and bark, we focused under SDG; number 3 good health well-being.

Declarations

Conflicts of the Interest

Authors declared that don't have conflict of interest among authors.

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REFERENCES

1. Davies, J.; Davies, D: Origins and Evolution of Antibiotic Resistance. Microbiol. Mol. Biol. Rev. 2010, 74:417-433. 10.1128/MMBR.00016-10
2. Munita, J.M.; Arias, C.A: Mechanisms of Antibiotic Resistance. Microbiol. Spectr. 2016,
3. Cook, M.A.; Wright, G.D.;: The past, present, and future of antibiotics. Science translational medicine. 2022, 14:7793. 10.1126/scitranslmed.abo7793
4. Dhingra S., Rahman N.A.A., Peile E., Microbial resistance movements: an overview of global public health threats posed by antimicrobial resistance, and how best to counter. Frontiers. 2020, 8:535668. 10.3389/fpubh.2020.535668
5. Nazir, M.A: Prevalence of periodontal disease, its association with systemic diseases and prevention. Int. J. Health Sci. 2017, 11:72-80. https://pubmed.ncbi.nlm.nih.gov/28539867/
6. Janakiram, C., Mehta, A., Venkitachalam, R. Prevalence of periodontal disease among adults in India: A systematic review and meta-analysis. J. oral bio and crani. res. 2020, 10:800-806. 10.1016/j.jobcr.2020.10.016
7. Teshome, A., Muche, A., Girma, B.,: Prevalence of dental caries and associated factors in East Africa, 2000-2020: systematic review and meta-analysis. Frontiers. 2021, 9:645091. 10.3389/fpubh.2021.645091
8. Uribe, S.E., Innes, N., Maldupa, I. The global prevalence of early childhood caries: a systematic review with meta-analysis using the WHO diagnostic criteria. Internat j paed den. 2021, 31:817-830. 10.1111/ipd.12783
9. Ray, R.R., Periodontitis: an oral disease with severe consequences. Appli Bioche and Biotech. 2023, 195:17-32. 10.1007/s12010-022-04127-9
10. Shetty H., Shukla V., Lokur A.S., Chaughule R.S., : Dental Microbial Biofilms: Control and Treatment Through Nanotechnology Approaches. Applications of Nanotechnology in Microbiology. 2024, 229-270. 10.1007/978-3-031-49933-3_9
11. Bhate M, Priyadharsini VJ, Dhiman A, Jain RK, KKN S, H NF. Assessment of Bacterial Load and White Spot Lesion Incidence in Orthodontic Subjects Using a 4-Hydroxycinnamic Acid Dentifrice: An In Vivo Assessment. World J Dent 2026; 17 (3):227-233.
12. Anil A., Ibraheem W.I., Meshni A.A., Preethanath R., Anil S. Demineralization and Remineralization Dynamics and Dental Caries. In Dental Caries-The Selection of Restoration Methods and Restorative Materials. IntechOpen. 2022. 10.5772/intechopen.105847
13. Cai, J.N., Kim, D.,: Biofilm ecology associated with dental caries: understanding of microbial interactions in oral communities leads to development of therapeutic strategies targeting cariogenic biofilms.

In. Advan in App Micro . 2023, 27:75. 10.1016/bs.aambs.2023.02.001
14. Takahashi, N., Oral microbiome metabolism: from "who are they?" to "what are they doing?" . J dental res. 2015, 94:1628-1637. 10.1177/0022034515606045
15. Wright, J.T., : Enamel phenotypes: genetic and environmental determinants . Genes. 2023, 14:545. 10.3390/genes14030545.
16. Tirupathi, S., Afnan, L. Effectiveness of Reso-Pac® in Post-Operative Intraoral Wound Healing Parameters Related to Third Molar Extraction. J. Maxillofac. Oral Surg. (2025). https://doi.org/10.1007/s12663-025-02455-x
17. Palombo EA. Traditional Medicinal Plant Extracts and Natural Products with Activity against Oral Bacteria: Potential Application in the Prevention and Treatment of Oral Diseases. Evid Based Complement Alternat Med. 2011: 680354.
18. Rahman, M.A., Hasnain, S.M.M., Paramasivam, P. Advanced materials and surface engineering strategies for mitigating fouling and corrosion in geothermal heat exchangers. Discov Mechanical Engineering 5, 85 2026 https://doi.org/10.1007/s44245-026-00264-1
19. Johnston GAR, Hanrahan JR, Chebib M,. Modulation of ionotropic GABA receptors by natural products of plant origin. Adv Pharmacol 2006; 54: 285–316.
20. Hanrahan JR, Chebib M, Johnston GAR. Interactions of flavonoids with ionotropic GABA receptors. Adv Pharmacol 2015; 72: 189–200.
21. Tasneem S, Liu B, Li B, et al. Molecular pharmacology of inflammation: Medicinal plants as anti-inflammatory agents. Pharmacol Res 2019; 139: 126–140.
22. Iseghohi SO. A Review of the Uses and Medicinal Properties of Dennettia tripetala (Pepperfruit). Med Sci Basel 2015; 3: 104–111.
23. Haque, M., Sartelli, M. and Haque, S.Z., : Dental infection and resistance—global health consequences . Dent j. 2019, 7:22. 10.3390/dj7010022.
24. Dashper, S.G., Nastri, A., Abbott, P.V., : Odontogenic bacterial infections. Contem Oral Med. 2019, 819-870. 10.1007/978-3-319-72303-7_45
25. Brooks, L., Narvekar, U., McDonald, A., : Prevalence of antibiotic resistance genes in the oral cavity and mobile genetic elements that disseminate antimicrobial resistance: A systematic review. Mole Oral Micro. 2022, 37:133-153. 10.1111/omi.12375
26. Dwivedi, D.; Kushwah, T.; Kushwah, M.; Singh, V: Antibiotic susceptibility pattern against pathogenic bacteria causing Dental Caries. South Asian J. Exp. Biol. 2011, 1:31-35. 10.38150/sajeb.1(1).p31-35.
27. Yadav, K.; Prakash, S.; Yadav, N.P.; Sah, R.S: Multi-Drug Resistance of Bacterial Isolates among Dental Caries Patients. Janaki Med. Coll. J. Med. Sci. 2015, 3:37-44. 10.3126/jmcjms.v3i1.15374
28. Shortridge, D., Kantro, V., Castanheira, M., : Meropenem-Vaborbactam Activity against US Multidrug- Resistant Enterobacterales Strains, Including Carbapenem-Resistant Isolates. Microbiology Spectrum. 2023, 11:04507-22. 10.1128/spectrum.04507-22.
29. Gaetti-Jardim, E.C.; Marqueti, A.C.; Faverani, L.P.; Júnior, G.J.E.,: Antimicrobial resistance of aerobes and facultative anaerobes isolated from the oral cavity. J. Appl. Oral Sci. 2010, 18:551-559. 10.1590/s1678-77572010000600004.
30. Loyola-Rodriguez J.P., Garcia-Cortes J.O., Martinez-Martinez R.E., et al.: Molecular identification and antibiotic resistant bacteria isolated from primary dentition infections. Aust. Dent. J. 2014, 59:497-503. 10.1111/adj.12213.
31. World Health Organization. Oral Health. The 11th IDAR World Congress on Preventive Dentistry. (2017). http://www.who.int/oral_health/events/congress-preventive-dentistry-oct2017-outcomes/en/.
32. Pflipsen, M. and Zenchenko, Y.,: Nutrition for oral health and oral manifestations of poor nutrition and unhealthy habits. Gen Dent. 2017, 65:36-43. https://pubmed.ncbi.nlm.nih.gov/29099364/
33. Hayasaka, K.; Tomata, Y.; Aida, J.;Watanabe, T.; Kakizaki, M.; Tsuji, I: Tooth loss and mortality in elderly Japanese adults: Effect of oral care. J. Am. Geriatr. Soc. 2013, 61:815-820. 10.1111/jgs.12225.
34. Peres M.A., Macpherson L.M., Weyant R.J., et al.: Oral diseases: a global public health challenge . The Lancet. 2019, 394:249-260. 10.1016/S0140-6736(19)31146-8
35. Wiersinga W.J., Rhodes A., Cheng A.C., Peacock S.J., Prescott H.C.: Pathophysiology, Transmission, Diagnosis, and Treatment of Coronavirus Disease 2019 (COVID-19). Jama. 2020, 324:782-793. 10.1001/jama.2020.12839
36. Vujicic, M., Buchmueller, T., Klein, R., : Dental care presents the highest level of financial barriers, compared to other types of health care services. Health affairs. 2016, 35:2176-2182. 10.1377/hlthaff.2016.0800
37. Marefati N, Ghorani V, Shakeri F. A review of anti-inflammatory, antioxidant, and immunomodulatory effects of Allium cepa and its main constituents. Pharm Biol 2021; 59: 287–302.
38. Wilson EA, Demmig Adams B. Antioxidant, anti-inflammatory, and antimicrobial properties of garlic and onions. Nutr Food Sci 2007; 37: 178–183.
39. Rondanelli M, Fossari F, Vecchio V. Clinical trials on pain lowering effect of ginger: A narrative review. Phytother Res 2020; 34: 2843–2856.
40. Isola G, Matarese M, Ramaglia L. Efficacy of a drug composed of herbal extracts on postoperative discomfort after surgical removal of impacted

mandibular third molar: a randomized, triple-blind, controlled clinical trial. Clin Oral Investig 2019; 23: 2443–2453.

41. Szyszkowska A, Koper J, Szczerba J. The use of medicinal plants in dental treatment. Herba Pol 2010; 56: 97–107.