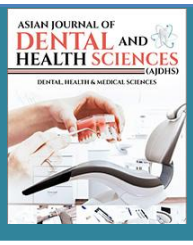

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Oral health benefits of *Moringa oleifera*

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Abstract

Allopathic medicines are used to treat or manage dental infections, inflammation, and pain. But due to the adverse effects associated with these allopathic medicines, Herbal Medicine should be considered as an alternative therapy for the management of oral health and treating dental Pain. Oral diseases persist as a significant health problem all over the world. Various microorganisms have been identified as possible pathogens responsible for oral diseases. *Moringa oleifera* has been used in traditional medicine for centuries. All parts of the Moringa tree are helpful in some way, and people depend on it for their livelihood. The leaves of the Moringa tree are an excellent source of Nutrients like Minerals, Protein and Vitamins (A and C). The Moringa tree contains approximately 46 antioxidants and is one of the cheapest sources of natural antioxidants. Antioxidants provide the free radicals the human body needs and mitigate their effects. *Moringa oleifera* contains active compounds such as flavonoids, tannins, saponins, alkaloids, phenolics, and triterpenoids, which possess antibacterial effects. *Moringa oleifera* has high mineral and protein content and has been previously investigated for its potential in the treatment of various oral soft tissue diseases. This review summaries the applications of *Moringa oleifera* in dentistry.

Keywords: *Moringa oleifera*, Anti-oxidants, Oral diseases, Oral health, dentistry

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Introduction

Global Burden of Disease (2019) show that periodontal disease ranks as the seventh most prevalent disease globally, with a prevalence of 29.3%.[1] According to the Riskesdas report (2018), the prevalence of periodontal disease in Indonesia is 74.1%. [2, 3] Dental health has been a concern for researchers to this day. Various infections that can occur in the teeth can lead to health decline. Dental infections occur due to the growth of different microbes in the oral cavity and dental area. Among these are odontogenic infections and periradicular periodontitis that happen in the root canal system, caused by anaerobic bacteria such as Porphyromonas gingivalis, Enterococcus *faecalis*, and *Candida albicans* [4, 5, 6, 7]. Natural products have been used as folk medicines for thousands of years and are promising sources for novel therapeutic agents. Due to the adverse effects associated with allopathic medication, herbal medicines are preferred as an alternative therapy for the management of oral health and dental Pain. [3, 8, 9]

Moringa oleifera is the most widely cultivated pan-tropical species of a monogeneric family, the Moringaceae, which is native to the sub-Himalayan tracts of India, Pakistan, Bangladesh and Afghanistan. *Moringa oleifera.* Moringa is known by various local names, such as benzolive, drumstick tree, kelor, marango, mlonge, mulangay, nébéday, saijhan, and sajna. [10, 11]. All parts of the moringa are beneficial, as they contain a variety of phytoconstituents with nutritional and pharmacological value. In developing tropical countries, Moringa trees have been used to combat malnutrition, especially among infants and nursing mothers [11,12,13]. Moringa leaves are an excellent source of Nutrients like Minerals, Protein and Vitamins (A and C) [14,15,16]. Moringa is one of the most potent sources of natural antioxidants, containing approximately 46 antioxidants. Moringa contains antioxidants that the human body needs to mitigate the effects of free radicals. *M. oleifera* contains many phytochemicals such as flavonoids, tannins, saponins, alkaloids, phenolics, and triterpenoids, which possess antibacterial effects. This review summaries the

applications of *Moringa* extracts in the management of oral infections, inflammatory conditions, the remineralisation of hard tissues, oral wound healing, and tissue regeneration.

Oral health benefits of Moringa oleifera

The Moringa tree is one of the most potent sources of natural antioxidants, with approximately 46 antioxidants. *M. oleifera* contains active compounds such as flavonoids, tannins, saponins, alkaloids, phenolics, and triterpenoids, which possess anti-bacterial effects. Many adverse effects are associated with allopathic medicines; hence, they can be used as a safe and cheap antimicrobial agent as an alternative therapy. The extract from leaves of *Moringa oleifera* has high mineral and protein content and its historic reputation as a traditional medicine for different diseases has been previously investigated for its potential in treating various oral soft tissue diseases [17, 18].

Moringa oleifera extract contains the highest values of calcium and phosphate that are required for the remineralization process. Therefore, *Moringa oleifera* extract is investigated by Younis et al for its ability to treat induced enamel lesions, and results suggest that the formulated varnish reinforced mineralisation of the lesions with complete reestablishment of the enamel surface in comparison to plain and fluoride varnishes. [17] in a study by Yunus et al. Scanning electron microscopy revealed that the *Moringa oleifera* Leaves extract-loaded varnish showed the most re-establishment of normal enamel architecture. Elemental analysis of the treated surfaces showed the surfaces treated by *Moringa oleifera* leaf extract-loaded varnish groups had significantly higher Ca, P, and O deposition than the fluoride varnish group. Hence, *Moringa oleifera* Leaves extract might be considered as a biomimetic material as it has the capacity to guide enamel tissue remineralization.[19]

Hanaa Elgamily et al. carried out a study to assess the antibacterial and antifungal potentials of different parts of the Moringa oleifera plant using various extraction methods, to formulate natural dental remedies from this plant. The various extracts of different parts of *Moringa oleifera* showed an antibacterial effect against *Staphylococcus aureus* and *Streptococcus mutans* growth. The novel toothpaste of ethanolic leaves extract has antimicrobial and antifungal potential effects all selected strains.[20] The results of the study by Risnayanti Anas et al. revealed an increase in calcium levels in the teeth after application of a Moringa oleifera-based paste and Casein phosphopeptide-amorphous calcium phosphate (CPP-ACP). *Moringa oleifera* based paste and CPP-APP are effective to increasing calcium levels in teeth compared to the pre-test group.[21]

Dental caries is closely related to cariogenic biofilm, an oral biofilm containing a high proportion of *Streptococcus mutans* [22]. Generally, oral biofilm is structurally and functionally organized and includes a balance of normal flora and pathogenic bacteria like *S. mutans* [23]. Su-Kyung Jwa has investigated the antimicrobial effects of the *M. oleifera* leaf extracts on *S. mutans* and the formation of cariogenic biofilm. An extract from *M. oleifera* leaves was derived using distilled water (DW) and ethyl alcohol (EtOH). *S. mutans* susceptibility assays were performed for each extract. Cariogenic biofilm was formed with or without DW and EtOH extract, and cariogenic biofilm was treated with both extracts. Both extracts showed antimicrobial activity against *S. mutans* and inhibited the formation of cariogenic biofilm. At the same concentration, the heated ethanol extract exhibited inhibitory activity better than the non-heated extracts. This study showed that the ethanol extract was more effective than the aqueous extract against *S. mutans* [24]

Table 1: Application of *Moringa oleifera* in Oral health

S.N.	Author	Objective of the study	Application	Ref
1	Rao P K, et al 2011	To assess the antibacterial activity of isolated compounds from *M. oleifera* against selected oral bacteria	All the isolated compounds from *M. oleifera* were active against Streptococcus mutans (MTCC 497), Streptococcus salivarius, Lactobacillus fermentum, Streptococcus anginosus, Streptococcus gordonii, Lactobacillus acidophilus.	25
2	Hanaa Elgamily et al 2016	To assess the antibacterial and antifungal potentials of different parts of *Moringa oleifera*	For dental remedies, experimental toothpaste exhibited higher mean inhibition than the mouthwash against *Staphylococcus aureus, Streptococcus mutans* and only the toothpaste revealed antifungal effect against *Candida albicans*	20
4	Carranza J B, 2017	To identify the secondary compounds of three varieties of *Moringa oleifera* Lam. Extracts namely; Native, Chinese, and Yard Long malunggay using phytochemical analysis	The extracts of moringa varieties contain flavonoids, alkaloids and tannins that are known to have antimicrobial and anti-inflammatory properties; thus, these have potential natural components in the manufacture of toothpastes	26
5	Su-Kyung Jwa et 2019	to investigate the antimicrobial effects of the *M. oleifera* leaf extracts	extracts showed antimicrobial activity against *S. mutans* and inhibited formation of cariogenic biofilm	24

6	Piasti Sopandani et al 2020	to assess the antibacterial effect of *M. oleifera* extract as an irrigation solution against *E. faecalis*	*M. oleifera* extract solution at concentrations of 75% and 100% is as effective as 5.25% NaOCl against *E. faecalis*	27
7	Mahassen M Farghaly et al 2020	to formulate a nontoxic mouthwash from *Moringa oleifera*	Moringa extract showing antibacterial and antiplaque effect will be used	28
8	Younis SH 2020	To assess the effect of Leaves extract of *Moringa oleifera* loaded-varnish groups IV & V on enamel	Moringa leaf extract loaded-varnish groups had significantly higher Ca, P, and O deposition than the fluoride varnish group. The extract of *Moringa oleifera* leaves might be considered as a biomimetic material that has the capacity to guide enamel tissue remineralization	19
9	Anas R et al 2021	To study the Effectiveness of paste-based *Moringa oleifera* To Increase Calcium Levels in Human Tooth	Results of this research showed that *Moringa Oleifera* paste has a higher calcium level compared to the Pre-test groups and *Moringa oleifera* paste can be effective in increasing calcium levels of human teeth	21
10	Nawal Aidaros et al 2021	To investigate and compare the effect of green tea, black tea and *Moringa oleifera* on artificially demineralized enamel and dentin	In dentin, the highest mean value was found in *Moringa oleifera*. Study concluded that *Moringa tree* enhanced the remineralization process and thus, might be considered as an effective natural remineralizing agents	29
11	Buakaew et al 2021	*Moringa oleifera* and *Azadirachta indica* were assessed for oral healthcare and gingivitis adjunctive treatment	The author states that accumulative reduction percentages of both Staphylococcus spp. and Candida spp. were found and indicated that the herbal mouthwashes reduced Gingival index and plaque index and showed potential as oral healthcare products	30

A study by Nawal Aidaros et al concluded that *Moringa oleifera* enhanced the remineralisation process of demineralised enamel and dentin, and thus, might be considered as an effective natural remineralising agent[29]. Few studies have evaluated the biological activity of *M. oleifera* in relation to oral disorders. *M. oleifera* leaves extracts in form of lozenge or mouthwash successfully reduced root canal infection, inflammation, gingivitis, and plaque [30, 31, 32]. Isothiocyanate from *M. oleifera* seeds showed inhibitory action against gene expression involved in mitophagy in the stem cell of the human periodontal ligament [33,34] A hydrophilic gel of *M. oleifera* and acemannan extract was used to coat titanium dental implants before implanting them within the tibia and femur of rabbits. These coatings produced hydrophilic implant surfaces that improved bone-to-implant contact, stimulated new bone formation, and reduced inflammation, fibrosis, and degenerative and necrotic changes within the newly formed bone [35].

In recent investigations, the antimicrobial efficacy of M. oleifera leaf extract was examined by Alharbi et al. who compared the microbial efficacy of *Moringa oleifera* leaf extract, octenidine dihydrochloride (OCT), NaOCl, and their combinations as intracanal irrigants against *Enterococcus faecalis*. Both *M. oleifera* extract and 0.1% OCT demonstrated antibacterial effects against *E. faecalis* comparable to 2.5% NaOCl and could be considered as potential root canal irrigants. Furthermore, combination groups exhibited superior anti-microbial activity compared to individual irrigants. However, further studies are required to investigate the biocompatibility and possible toxic effects of the tested irrigants.[36].

Sharma et al evaluated the efficacy of chitosan chips with *and without Moringa oleifera (MO)* in treating chronic periodontitis. Results from this study revealed that *Moringa oleifera* in chitosan chips may be an effective natural treatment for chronic periodontitis. The study shows significant improvements in clinical parameters, including plaque index, gingival index, and probing pocket depth, in the Moringa group, suggesting its potential to enhance treatment outcomes in periodontal care. Further exploration of its applications is encouraged. [37] Kumar et al. investigated the antimicrobial effects of *M. oleifera* extracts to assess the antibacterial efficacy of 5% *Moringa oleifera* mouthwash reinforced with silver nanoparticles against oral aerobic organisms. The results of the study revealed that the 5% aqueous extract of *M. oleifera* exhibited a dose-dependent antimicrobial activity against oral anaerobic microorganisms. Notably, this anti-microbial effect became more pronounced with longer exposure times of the treated samples. Furthermore, in the cytotoxicity assay, the aqueous extract exhibited superior performance at lower concentrations than the ethanol extract. The combined benefits of phytomedicine with nanomedicine can result in more effective treatment with fewer side effects. [38].

In the recent investigation, Eliwa et al. compared the remineralising potential of *Moringa Oleifera* extract, eggshell, and sodium fluoride varnish on the microhardness of artificially demineralised enamel of primary teeth using a biomimetic, minimally invasive approach, following the world paradigm shift towards natural products in paediatric dentistry. Regarding EDX analysis, there was a statistically significant difference

($p < 0.05$) between the *Moringa Oleifera* and Eggshell groups compared with the fluoride varnish, with the highest values observed in the *Moringa Oleifera* and Eggshell groups. On the other hand, there was no statistically significant difference ($p > 0.05$) between *Moringa Oleifera* and Eggshell in both measurements. *Moringa Oleifera* and Eggshell might be considered biomimetic natural materials capable of guiding enamel tissue remineralisation in early carious lesions of primary teeth. [39] Soraya et al. investigated the anti-bacterial properties of *M. oleifera* gel in inhibiting the growth of *S. mutans,* which were involved in the pathogenesis of dental caries. After 48 h, the 12.5% concentration exhibited the highest effectiveness in reducing *S. mutans* growth. Within 24 h, the 6.25% and 3.125% concentrations exhibited remarkable ability to suppress *S. mutans* growth. Notably, the 6.25% concentration exhibited superior efficacy in reducing S. mutans biofilm formation. The application of *M. oleifera* gel extract created conditions in which *S. mutans*, a commensal bacterium, struggled to form a biofilm, with inhibition levels surpassing 70%. The absence of substantial biofilm development evidenced this. It is worth mentioning that at all tested concentrations, *M. oleifera* exhibited a toxic effect on *S. mutans* cells. The ethanol extract gel of *M. oleifera* demonstrated the ability to curtail both the growth and biofilm formation of *S. mutans* on tooth surfaces while concurrently exerting toxicity on *S. mutans* cells, potentially due to the presence of anti-bacterial compounds [40]. Amalunweze et al formulated antimicrobial toothpaste (dentifrice) with M. oleifera root essential oil, which can compete with existing toothpaste. The phytochemical screening revealed a high concentration of flavonoid, a bioactive agent with antimicrobial activity in nature. The antimicrobial potential of this toothpaste was evaluated by the muller Hinton agar well diffusion method against the selected bacteria. The results of this study revealed that the Moringa root herbal toothpaste has a higher antimicrobial potential than Oral-B herbal toothpaste against tooth plaque. It might be considered a good source of active agents in the formulation of medicinal toothpaste. [41]

Standard treatment involves scaling and root planing, often combined with adjunctive antibiotics. However, inappropriate antibiotic use may lead to resistance. Therefore, natural antibacterial agents with a lower risk of resistance, such as *Moringa oleifera* leaves, are of interest [3, 42]. Results from the study by Sawant et al. showed that *Moringa oleifera* leaf extract demonstrated comparable efficacy to 1% chlorhexidine gel in reducing GI, PI, and papillary bleeding index when used as an adjunct to scaling and root planing with topical application [43]. In conclusion, *Moringa oleifera* leaves have significant potential for further development as antibacterial agents, both as herbal medicines and as raw materials for pharmaceutical products [3]. A study by Obeid et al. confirmed that *Moringa oleifera* leaves have an extraordinary effect on the remineralisation of dentin and cementum, and they have a promising ability to control dentinal hypersensitivity and form biomimetic cementum tissue. Clinical trials using *Moringa oleifera* leaves to control hypersensitivity sensation under deep restorative preparations and with root exposure will be of great dental value. [44].

Conclusion

Standard treatment involves scaling and root planing, often combined with adjunctive antibiotics. However, inappropriate antibiotic use may lead to resistance. Therefore, natural antibacterial agents with a lower risk of resistance, such as *Moringa oleifera* leaves, are of interest. *M. oleifera* contains active compounds such as flavonoids, tannins, saponins, alkaloids, phenolics, and triterpenoids which possess antibacterial effects; hence, it can be used as safe and cheap plant antimicrobial agent. *Moringa oleifera* leaf extracts appear to be potent anti-microbial, anti-inflammatory, anti-cancer agents against oral ailments, also having activity in enamel re-mineralisation and preservation of root extraction sockets. As traditional medicine, it has potential in treating different oral soft tissue diseases. Further research on *Moringa oleifera* is needed to exploit the pharmacological uses for the management and prevention of oral disease.

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