Role of a Miracle Tree (*Moringa oleifera*) in Healthcare

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ABSTRACT

BACKGROUND

Moringa oleifera Lam is a plant found in Himalayan foothills. A large corpus of literature exists about moringa and its medicinal values. Various medicinal and health properties of moringa make it a part of various phytomedicinal preparation. It is used as a part of routine diet and has anti-fibrotic, anti-inflammatory, antimicrobial, antioxidant, anti-hyperglycaemic and anti-tumour properties. It is also used in production of seed oil, fodder and medicine. It is highly useful as a nutritional supplement, in the management of various diseases and in the management of public health problems. *Moringa oleifera* Lam is an important part of South Indian diet. Its antibacterial properties were found to be effective against *E. coli*, *Salmonella typhi and Shigella dysenteriae*. Hence, it may be used as a low-cost material for water purifications in poor communities. This plant has significance in dental health due to its antimicrobial effect on bacteria present in dental plaque like *Staphylococcus aureus* and *Streptococcus mutans*. There has been limited research on efficacy and safety of various *Moringa oleifera* (MO) extracts and parts in oral healthcare. MO has found its applications in various aspects of public health. As a plant with high nutritional value and relatively low cost, it has been endorsed as a plant with immense potential as for use as nutrient supplement in the parts of the world with widespread malnutrition and nutritional deficiencies. Further research needs to be conducted in the field of pharmacological management and prevention of oral disease.

KEY WORDS

Antimicrobial, Dental Diseases, *Moringa oleifera*, *Streptococcus mutans*.

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BACKGROUND

Moringa oleifera lam. is a medium size tree of family moringaceae distributed in tropical and sub-tropical regions of India (especially in the Himalayan foothills).[1,2,3] It is distributed worldwide and often cultivated for its nutritional value and medicinal properties. Even though the tree best grows in a temperature range of 25 - 35 C, it can survive even high temperatures found in tropical countries.[4] Owing to its nutritional value, various parts of moringa, especially, seeds, flowers and pods are widely used as a part of routine diet.[5]

Additionally, moringa is also used in production of seed oil, fodder and medicine.[6] Its nutritional properties have been well recognised. Studies have found it to be a good source of various minerals such as potassium, calcium, iron etc.[7,8,9] Moringa has also been found to be a good source of essential amino acids and various antioxidants.[10] This makes it an important nutrient source, especially in areas of the world where malnutrition is common.

A large corpus of literature exists about moringa and its medicinal values. Various medicinal and health properties of moringa also make it a part of various phytomedicinal preparation.[11,12] In addition to its nutritive value, it is also used as an anti-fibrotic, anti-inflammatory, antimicrobial, anti-oxidant, anti-hyperglycaemic and anti-tumour properties.[13] Parts of the plant such as leaves, seed, stem, roots and flowers are used to prepare various medicinal and food products.[14,15] Preparations of methanolic and aqueous extracts of different parts of the plant have been tested previously. These preparations are often used as herbal medicines for control and treatment of diseases and health-related conditions.[16]

Use of moringa in India is even more relevant as it is often cultivated and widely used as an ingredient of food and food products. Although it is widely consumed by people of the complete subcontinent, but it is especially considered as an important part of South Indian diet.

In spite of its various uses as a medicinal plant, use of moringa in dentistry is limited. Even though it has been used in a few toothpaste and mouth rinse preparations, research is still missing on implications of this plant and its extracts on dental and oral health. The purpose of the present research is exploring the use of *Moringa oleifera* Lam. and its extracts in pharmacological prevention, control and treatment of oral and dental diseases.

MORINGA AS A MEDICINAL PLANT

MO has been popular and extensively used as a medicinal plant since a long time. Due to its widespread medicinal use, it has often been called as 'miracle tree'.[6,17] Different parts of MO are rich in different components which make them useful pharmacological agents. The Moringa seeds contain cytokines. Various cytokines have been extracted from MO seeds through aqueous extracts.[18] Its bark is known to contain moringine and moringinine alkaloids.[19] Apart from these alkaloids, various other chemicals are also extracted from the seeds of moringa which have medicinal properties. MO flowers contain nine amino acids along with sugars and alkaloids.[20] Similarly, leaves of MO also contain chemicals with medicinal potential. Roots of MO have been used as rubefacient, carminative, anti-inflammatory and laxative.[21] It has also been used in treatment of pains such as rheumatism and articular pains.[22] Its stem has been used in ocular afflictions as well as splenomegaly treatment of ulcers.[23] Leaves of MO have been used as home remedy for sores and headaches. Additionally, they have also been used in treatment of sore throat, piles and ear infections. moringa gum has been used for oral health and dental caries. With a wide variety of uses in health, MO is a plant with high potential for extraction of herbal medicines.[24]

Moringa in the Treatment of Cancer

Moringa oleifera Lam preparations have been used in multiple ways during treatment of cancers. Anticancer effect of moringa has been attributed to inhibition of cancer cell growth and proliferation due to three bioactive components - 4-(α-L-rhamnosyloxy) benzyl isothiocyanate, β-sitosterol-3-O-β-D-glucopyranoside, and nizimicin.[25] Glucosinolates in moringa extracts have been found to be effective in induction of apoptosis of cancer cells.[26] In some cases, these extracts have also acted to induce *P53* tumour suppressor gene during cancer therapy. Anticancer properties have been observed in leaf and bark extracts of moringa, while the seed extract has not been proven to have an anti-proliferative effect on cancer cells.[27,28]

Therapeutic activities of *Moringa oleifera* have also been studied in cancer cachexia. MO leaf diet has shown improvement in ATPase activity in experimental animals, thereby, implying help in muscular degeneration during cancer cachexia.[29] additionally, effect of MO has also been found as having antioxidant properties, thereby reducing oxidative stress during cancer cachexia. However, these properties have been proven in experimental animals, and human studies need to be undertaken before definitive evidence on efficacy is obtained for use of MO in cancer cachexia.

Studies have been conducted to demonstrate in vitro effects of MO extracts on various cancer cell lines. More importantly, affects have been studied in oesophageal cancer, hepatocellular carcinoma and colorectal cancer. Owing to effect of MO extracts on different cancer lines, it is important that effect of these extracts should also be studied on oral cancer cell lines.

Antimicrobial Aspects of Moringa

Antimicrobial activity of MO may be contributed to the essential oil fraction of the distillate from the plant sources.[30] Antibacterial and antifungal activity has been demonstrated from MO extracts. Antibacterial effect has been mainly demonstrated against *E. coli, S. aureus, K. pneumoniae, B. subtilis and P. aeruginosa*. Broad spectrum activity of MO leaf extracts has been demonstrated against food-borne microorganisms. This activity mainly comes from MO leaf and seed extract. Ethanolic extracts of MO leaves have been found to be effective against *E. coli*, *Enterobacter aerogenes, Pseudomonas aeruginosa, and Staph. aureus. Salmonella typhimurium and E. coli* have been found to be affected by the seed chlorophyll extracts of MO. Isothiocyanates from MO are also effective against *Helicobacter pylori*, a microorganism that is often found in geographical regions of world where there is a lack of medical facilities and widespread poverty. The other

similar microorganism against which MO extracts are effective is Vibrio cholera. Antimicrobial activity of MO extends to certain fungal species also.[31]

An important aspect of antimicrobial activity of MO is its anti-biofilm activity.[32] This activity has been studied in vitro as well as in increasing shelf life of certain food products. Antioxidant activity of MO owing to the presence of flavonoids, keratinoid, ascorbic acid and phenolic compounds is useful in prevention of biofilm on food products.[33,34]

However, there has been no study on dental plaque biofilm and effects of MO extracts on its prevention and breakdown. Antimicrobial aspects of MO have been studied on oral hygiene and as a part of dentifrices, however, detailed studies and mechanism of action of MO on plaque formation has not been studied and may prove to be important part of future research.

MORINGA IN PUBLIC HEALTH

MO has found its applications in various aspects of public health. As a plant with high nutritional value and relatively low cost, it has been endorsed as a plant with immense potential as for use as nutrient supplement in the parts of the world with widespread malnutrition and nutritional deficiencies. In line with the nutrient properties, MO has been used as a food supplement, especially for treatment of malnutrition in children. Proteins make up about a quarter of its dry weight and mostly contain proteins. MO contains 19 amino acids that make it a good source of proteins. Further, animal studies have shown that moringa has significant hepato-protective activity as well as nephro-protective activity in animals on drugs like Gentamycin, acetaminophen, and rifampicin.[35]

MO seed powder and extract has been found useful in water purification. According to a study conducted in Ethiopia, seed powder as well as acetone extract have proven to be useful for reduction in water borne disease. It has been effective in reducing coliform count as well as improving pH of water. It was also effective in reducing turbidity of water. Its antibacterial properties were found to be effective against *E. coli, Salmonella typhi and Shigella dysenteriae*. Hence, it may be used as a low-cost material for water purifications in poor communities.[36]

IMPLICATIONS OF MORINGA IN DENTAL HEALTHCARE

Studies on use of MO in oral care have been few and non-extensive. These studies broadly imply on antimicrobial properties of MO. These may further be applied towards reduction of cariogenic bacteria in oral environment. *Staphylococcus aureus* and *Streptococcus mutans* are the two bacteria where MO has been found to be effective. These two bacteria form important components of the plaque layer.[37,38] Table 1 shows studies proving antimicrobial effect of MO in dental health.

MO is one of the herbs used by people of Dakshin Kannada for the maintenance of their oral hygiene.[39] MO is also known to remineralise enamel and dentin in patients having erosive and wasting diseases of teeth.[40] Therefore, MO's effectiveness as antimicrobial agent for preventing oral disease is well validated.[40,41,42,43] Similar to MO, honey and *Quercus infectoria* also have antimicrobial effect on *Streptococcus mutans*.[44,45] So, medicinal plants are potential of antimicrobial compounds.

However, the research on use of MO in dental hygiene and dental care is limited, so future research needs to be conducted in this field.

Sl. No.	Authors	Year	Type of Study	Study Objective	Dental Health Implications
1	Jose M, Bhagya B, Shantaram M.[41]	2011	Descriptive study	To document the ethno-medicinal practices followed for oral health and diseases by people of Dakshina Kannada (DK) district,	32 identified species belonging to 29 genera and 20 families, were commonly used by the people of Dakshin Kannada region to maintain oral health and hygiene and as remedy for dental diseases. MO was one among them.
2	S Khalaf E A, Nagib A M, Amin L E M, Ibrahim F M M[42]	2016	Intervention study	To determine the effect of renal insufficiency on patients' teeth (enamel and dentin) and study biological effects of topical application of moringa extract versus fluoride on extracted teeth.	Increase in calcium and phosphorus levels was statistically significant with moringa as same as CPP-ACPF groups. *Moringa oleifera* has a protective effect on enamel and dentin remineralisation that is similar to CPP-ACPF paste in preventing erosion of enamel and dentin by localising Ca and P at the tooth surface.
3	Rao P K, Rao D B, kiran C, Nadh M R, Madhavi Y, Rao T R.[43]	2011	Intervention study	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*.
4	Alsaraf KM, Abd S T, Husain S N[44]	2016	Intervention study	To assess the antibacterial and antifungal activities of aqueous extracts of plant *Moringa oleifera* in comparison to chlorohexidine gluconate and de-ionized water.	The water extract of *Moringa oleifera* showed better antibacterial effect than chlorhexidine on the tested organisms: Staphylococcus aureus and streptococcus spp. Maximum zone of inhibition was seen against *S. aureus*
5	Rostiny, Djulaeha E, Hendrijantini N, Pudijanto A[45]	2016	Intervention study	To evaluate the effect of combined *Moringa oleifera* leaf extract and demineralised freeze-dried bovine bone xenograft (DFDBBX) towards the formation of osteoblasts and osteoclasts in the tooth extraction sockets of *Cavia cobaya*	Combination of *Moringa oleifera* leaf extract and DFDBBX at 2 % concentration can increase the number of osteoblasts and decrease osteoclasts in the healing of tooth extraction sockets of *Cavia cobaya*
6	Elgamily H, Moussa A, Elboraey A, El Sayed A, Al Moghazi, Abdalla A[39]	2016	Intervention study	To assess the antibacterial and antifungal potentials of different parts of *Moringa oleifera* plant using different extraction methods	Ethanol extracts as well as leaf extracts demonstrated the highest significant mean inhibition zone values ($P \leq 0.05$) against *Staphylococcus aureus and Streptococcus mutans* growth
7	Carranza J B, Molina P G L, Ortanez J J, Taclan L B, Mergal V C, Yllano O[40]	2017	Intervention study	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

Table 1. Dental Health Implications of Moringa oleifera

CONCLUSIONS

Moringa oleifera Lam is a widely grown plant with multiple uses in healthcare. Its pharmacological benefits are well documented and applied. It is highly useful as a nutritional supplement, in the management of various diseases and management of public health problems. However, its use in prevention and management of dental disease is limited. There has been limited research on efficacy and safety of various MO extracts and parts in oral healthcare. Future research in this field may hold promising results in pharmacological management and prevention of oral disease.

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