

Systematic Review of *Moringa oleifera*'s Potential as Antibacterial and Anti-Inflammatory in the Oral Cavity

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Abstract: *Introduction: Moringa plant is a plant that is spread throughout the region in Indonesia and has many benefits. Moringa oleifera L. plant is also known as the “miracle of tree” because almost all parts of the plant, from the leaves, bark, seeds, fruit of moringa to the roots are used by humans, especially as traditional medicine. Moringa has been proven effective as antibacterial and anti-inflammatory, for example in toothpaste, mouthwash, and root canal irrigation from chitosan. So this systematic review reviews some of the literature on the potential of moringa plants as antibacterial and anti-inflammatory in the oral cavity. Methods: In this systematic review, article searches were conducted on Google Search and Pubmed. Studies published from 2011 to 2020. 104 articles were rated, including 104 articles from electronic databases, 0 from manual search. 96 records were screened, 63 records were excluded, 33 full-text articles were assessed for eligibility and 17 full-text articles were included. Result: There are 8 articles about antibacterial of Moringa oleifera and 10 articles about anti-inflammatory of Moringa oleifera. Conclusion: Based on 18 articles show that chitosan is very potential as a herbal plant that can be antibacterial and anti-inflammatory in the oral cavity.*

Keywords: *Moringa oleifera, Antibacterial, Anti-inflammatory, Oral cavity*

1. INTRODUCTION

Moringa (*Moringa oleifera*) is a native Indonesian plant that can be used as medicine. Moringa plants can grow well in different environments with temperatures of 250 - 350 C. Moringa plants have a height of 7-11 meters and thrive from lowlands to an altitude of 700 meters above sea level. Moringa can grow in tropical and subtropical areas on all types of soil and is resistant to dry seasons with drought tolerance of up to 6 months. Moringa is known to contain more than 90 types of nutrients in the form of essential vitamins, minerals, amino acids, anti-aging, antibacterial, and anti-inflammatory.^{1,2,3}

Moringa is known in several countries as horse radish, drumstick, benzoline (UK), mlonge (Tanzania), marango (Nicaragua), moonga (India), mulangay (Philippines), nebeday (Senegal), and sajna (Bangladesh). In addition, the moringa plant also has several well-known nicknames including the miracle tree, tree for live, and amazing tree. The nickname arises because the parts of the Moringa plant, starting from the leaves, fruit, seeds, flowers, bark to the roots, have tremendous benefits for humans, especially for health.^{4,5,6}

The leaves are usually used for food, traditional medicine, and traditional ritual ingredients. One of the uses of leaves for the treatment of jaundice. It is noted that Moringa leaves contain

more vitamin A than carrots, more calcium from milk, more iron from spinach, more vitamin C from oranges and more potassium from bananas. Utilization of roots to treat goiter, cholesterol, cough, fever, gout, diabetes and thrush. Moringa stems are used for animal feed, medicine for stomach aches, coughs and fever. Moringa fruit is usually used as a vegetable. The seeds are used to treat stomach aches.^{7,8,9}

According to the World Health Organization, medicinal plants will be the best source for obtaining various drugs for diseases. Therefore, these plants must be investigated for their properties, safety and efficacy. Based on the research, it was found that the alcohol extract from the Moringa plant was reported to have analgesic activity and the water extract of the moringa plant root also showed an anti-fertility profile. This herb is also reported to have a wide variety of pharmacological effects which include anti-tumor, antipyretic, antispasmodic, diuretic, antiulcer, hypotensive, hypolipidemic, hepatoprotective, antifungal and antibacterial activity. The many pharmacological effects possessed by the Moringa plant make this plant an herbal plant that is used to treat various diseases including treatment of the oral cavity or dentistry.^{1,10, 11,12}

The use of Moringa plants in the field of dentistry is also widely found and researched for its development. Moringa plant can be used as an ingredient in toothpaste, mouthwash, root canal irrigation, wound healing after tooth extraction, medicine for gingivitis, canker sores, and can be used to prevent dental caries with its antibacterial properties. The information previously mentioned is an interesting reason to know the potential of the Moringa plant so that it can develop other uses. Therefore, this systematic study aims to examine more deeply the potential of moringa plant as antibacterial and anti-inflammatory in the oral cavity.^{1,5,6,13}

2. METHODS

Search Strategy

A search was performed on Google Search and Pubmed. Studies published from 2011 to 2020. Pubmed keywords and terms used for the search included various combinations of the following “*Kelor*,” “*antibacteri*”, antiinflamasi, dan rongga mulut or each of the searches, abstracts and titles were screened and the text full versions of articles that met criteria were downloaded.

The flowchart in Figure 1 identifies the excluded and included articles at each stage. 104 were assessed, including 104 articles from the databases electronic, 0 from the manual search. 96 records screened, 63 records excluded, 33 full-text articles assessed for eligibility and 18 full text articles included.

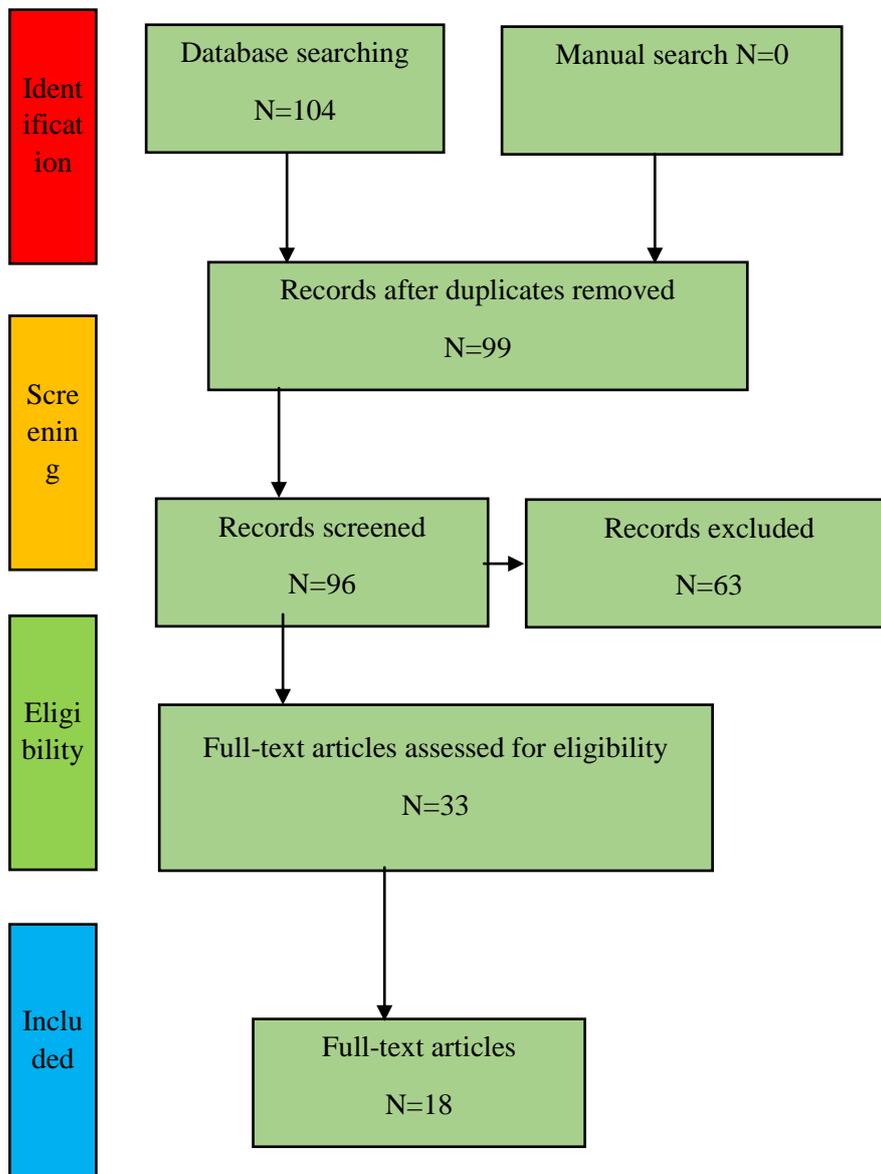


Figure 1. A flow chart describing the search methodology and numbers of articles included and excluded at each stage

3. RESULTS

In this systematic review there was a choice of studies: the inclusion criteria for this review were: 1) Articles 2011-2020 years, 2) English and Indonesian, 3) Type of publication and all study designs considered, 4) published and unpublished data is being sought. The exclusion criteria were studies that did not discuss the effect of moringa plants on the oral cavity.

Table 1. Article on Moringa Plants as Antibacterial

No.	Author	Year	Title	Conclusion
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1	Erma Yunita, Dheanissa Galuh Permatasari, Deni Lestari ¹⁴	2020	Antibacterial Activity Of Moringa Leaves Extract Against Pseudomonas Aeruginosa	Moringa leaf ethanol extract has antibacterial activity against <i>P. aeruginosa</i> bacteria at a concentration of $\geq 4\%$. The ability of the antibacterial activity of Moringa leaf extract is due to the presence of flavonoid compounds, alkaloids, saponins, tannins and terpenoids.
2	Nurul Cholifah, Ahmad Rihday, Pasjan Satrimafitrah, Ruslan, Hardi Ys ¹⁰	2020	Antibacterial Activity of Methanol Extracts from The Stem Bark of Moringa oleifera Lam. Against Staphylococcus aureus and Escherichia coli	Methanol extract of Moringa stem bark was able to suppress the growth of <i>S. aureus</i> and <i>E. coli</i> bacteria. Testing of the methanol extract of Moringa stem bark at a concentration of 4% against <i>S. aureus</i> and <i>E. coli</i> bacteria resulted in an inhibition zone > 17 mm or classified as antibacterial with strong activity. The methanol extract of moringa bark has the potential to be used as a new antibacterial agent.
3	Monalisa Mohanty, Samita Mohanty, Sanat Kumar Bhuyan, Ruchi Bhuyan ¹⁵	2020	Phytoperspective of Moringa oleifera for oral health care: An innovative ethnomedicinal approach	<i>Moringa plants have antibacterial properties on the leaves and seeds. Moringa acts as an antibacterial agent in oral bacteria, namely Porphyromonas gingivalis, Prevotella intermedia Staphylococcus aureus, and Streptococcus mutans.</i>
4	Su-Kyung Jwa ¹⁶	2019	Efficacy of Moringa oleifera Leaf Extracts against Cariogenic Biofilm	Moringa leaf extract has antimicrobial activity against cariogenic bacteria and biofilms. EtOH (ethyl alcohol) moringa extract may be more effective against caries-related bacteria and biofilms compared to DW (aquades) extract. These results indicate that <i>M. oleifera</i> leaves are potential candidates for preventing dental caries.
5	Luc'ia Are'valo-	2018	Antibacterial and	Moringa plants and Azadirachta

	H' rjar, Miguel A' ngel Aguilar-Luis , Stefany Caballero-Garci'a, Ne'stor Gonza'les-Soto, and Juana Del Valle-Mendoza ¹⁷		Cytotoxic Effects of Moringa oleifera (Moringa) and Azadirachta indica (Neem) Methanolic Extracts against Strains of Enterococcus faecalis	indica showed antibacterial effects against E. faecalis without toxicity at low concentrations. Hence, they can be considered as alternative antimicrobial agents for use in the field of root canal therapy in the field of odontology. More research is needed regarding the cytotoxicity of their respective active components as well as the adverse reactions.
6	Hanaa Elgamily, Amani Moussa, Asmaa Elboraey, Hoda EL-Sayed, Marwa Al Moghazy, Aboelfetoh Abdalla ¹⁷	2016	Microbiological Assessment of Moringa Oleifera Extracts and Its Incorporation in Novel Dental Remedies against Some Oral Pathogens	Moringa plant extracts can be used to formulate new dental products to control oral pathogens due to their antimicrobial potential. However, further research is needed to clarify the optimal concentration, cell toxicity and physical stability prior to its clinical application.
7	Ajayi A.O dan Fadeyi T.E ¹⁸	2015	Antimicrobial Activities and Phytochemical Analysis of Moringa oleifera Leaves on Staphylococcus aureus and Streptococcus species	Moringa plant has antiviral, antibacterial, antifungal, anthelmintic, antimolluscal and anti-inflammatory properties. Discovery and the availability of moringa for clinical use increases its economic sustainability in developing countries. This research helps validate the nutritional and medicinal value of the moringa plant in Southwestern Nigeria. and Africa as a whole, which is now widely adopted as a herbal preparation and tea complement in various parts of the world. The medicinal properties and active components of moringa also make it valuable for various therapeutic purposes.
8	Ji-Sun Kim, DongHoon Shin ¹⁹	2011	In vitro antibacterial activity of Moringa oleifera against dental plaque bacteria	The methanol extract of Moringa has shown various inhibition zones in all tested pathogens due to the isolation of biologically active

				<p>biomolecules. In this study, five compounds MO-1, MO-2, MO-3, MO-4 and MO-5 were isolated. Where MO2 and MO3 showed a broad spectrum of antibacterial activity against all tested bacteria as evidenced by the presence of an inhibition zone at a concentration of 5 µg / ml. These compounds were identified MO-2 as Niazinin-A, MO-3 as β-Stigmasterol, MO-4 as Quercetin-3-O-β-D-Glucopyranoside and MO-5 as Kaempferol-3-O-β-D-Glucopyranoside. The remaining MO-1 compound as β-sitosterol was found to be inactive in this study.</p>
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Table 2. Articles on Moringa Plants as Anti-Inflammatory

No.	Author	Year	Title	Conclusion
1	Arni Irawaty Djais, Sri Oktawati, Hasanuddin Thahir, Muchammad Hatta, Bayu Indra Sukmana, Nurdiana Dewi, Huldani, Yayah Inayah, Widodo, Irene Edith Riewpassa, Harun Achmad, Dewiayu Dewang ²⁰	2020	Effect of the Combination of Demineralization Freeze Dried Dentin Matrix (DFDDM) and Moringa Oleifera Lam on Nuclear Factor Kapa B as a Marker of Bone	Moringa plant has therapeutic properties because of its distinctive properties. Potential anti-inflammatory activity of NFκB activation. Moringa plant can exert anti-inflammatory effect on the hind leg edema of male albino rats induced by carrageenan, and its seed extract has been reported to reduce the weight of the distal intestine which is a marker of inflammation.
2	Delisma Simorangkir, Jenti Hutagalung, Palas Tarigan ²¹	2020	Inflammatory Activity Test of Moringa Leaf Ethanol Extract (Moringa Oleifera L.) Against Male White Rats (Wistar Line)	The ethanol extract of Moringa oleifera L. leaves has an anti-inflammatory effect on male white rats. Moringa leaf ethanol extract 200 mg / kgBW had the best anti-inflammatory effect compared to

				ethanol extract 100, 150 mg / kgBW, but was still below NaDiclofenac.
3	Mahdiyeh Sahrakary, Vida Nazemian, Maryam Aghaloo, Akhtar Akbari, Mahdi Shadnoush, Behzad Nasserri, Jalal Zaringhalam ²²	2017	Treatment by Moringa oleifera extract can reduce gingival inflammatory cytokines in the rat periodontal model	It was found that before and after treatment with moringa plant extracts reduced inflammatory cytokines in the gingival tissue and reduced inflammatory symptoms in a mouse periodontal model.
4	Amit Mittal, Monica Sharma, Abhinav David, Pinki Vishwakarma, Manish Saini, Mani Goel, K. K. Saxena ²³	2017	An experimental study to evaluate the anti-inflammatory effect of moringa oleifera leaves in animal models	In this study it can be concluded that the water extract of Moringa leaves (200 mg / kg) has shown anti-inflammatory activity in all inflammatory models. The data obtained from this study have shown that the aqueous extract of Moringa leaves can help in preventing inflammatory conditions and hopefully serve as a good biological resource to produce available herbal formulations that may be equally potent and cost-effective than conventional synthetic drugs has been there.
5	Sunita Verma ²⁴	2016	Medicinal plants with anti-inflammatory activity	The water and ethanol extracts of moringa plants, especially the stem bark, showed% inhibition after 5 hours, a maximum of 27.27 and 30.30% significant reduction of P <0.01 and P <0.05 in edema volume at a dose of 300 mg / kg body weight, which were comparable to the standard drug Diclofenac sodium. Standard medication showed 44.44% (25 mg / kg) body weight inhibition and a significant value of P <0.01. The percentage of foot edema was found to be better with alcohol

				extract than with water extract with moringa plant.
6	Il Lae Jung , Ju Hye Lee And Se Chan Kang ²⁵	2015	A potential oral anticancer drug candidate, Moringa oleifera leaf extract, induces the apoptosis of human hepatocellular carcinoma cells	Moringa plants (leaves, stems and roots) have been shown to produce a variety of biological activities, including anti-atherosclerotic, immune-enhancing, anti-cardiovascular disease, antiviral, antioxidant, antimicrobial, anti-inflammatory and tumor-suppressing effects. The significant inhibition of tumors produced by oral administration of moringa may be due to the high bioavailability of the extract.
7	Rini Sulistyawati, Pramita Yulli Pratiwi ²⁶	2015	Analgesic and Antiinflammatory Activity Of Ethanol Extract Of Kelor Leaves (Moringa Oleifera L.) Through Expression Of Cyclooxygenase Enzyme	The anti-inflammatory power at a dose of 140 mg / kgBW was $24.30 \pm 2.960\%$ and decreased COX-2 expression by $46.37 \pm 6.434\%$.
8	Julia P. Coppina , Yanping Xua , Hong Chena , Min-Hsiung Panb , Chi-Tang Hoc , Rodolfo Juliania , James E. Simona , Qingli Wu ²⁷	2013	Determination of flavonoids by LC/MS and anti-inflammatory activity in Moringa oleifera	Of the three samples of moringa that were screened for anti-inflammatory activity, two PKM varieties (1 and 2) showed activity whereas local moringa (sample Z-11) was found to be inactive. This was unexpected given that the genetics and chemistry of plants even within the same species can vary widely. Therefore, it is important to carefully choose the variety or source of moringa to achieve maximum flavonoid accumulation and anti-inflammatory activity. Given that several plant products exist on the commercial market as sources of the same flavonoids, the high concentrations found in these

				species will be attractive as new sources of these bioactive natural products.
9	Larissa Cardoso Corrêa Araújo, Jaciana Santos Aguiar, Thiago Henrique Napoleão, Fernanda Virgínia Barreto Mota, André Luiz Souza Barros, Maiara Celine Moura, Marília Cavalcanti Coriolano, Luana Cassandra Breitenbach Barroso Coelho, Teresinha Gonçalves Silva, Patrícia Maria Guedes Paiva ²⁸	2013	Evaluation of Cytotoxic and Anti- Inflammatory Activities of Extracts and Lectins from Moringa oleifera Seeds	Dilute seed extract and cMoL have the potential to be cytotoxic against peripheral blood mononuclear cells, whereas dilute seed extract and WSMoL are not cytotoxic against these cells. None of the moringa plant preparations tested improved erythrocyte haemolysis, and the aqueous seed extract did not cause systemic toxicity in mice. The seed extract and lectins exhibited in vitro anti-inflammatory activity on LPS-stimulated macrophages by regulating cytokine and NO production. The anti-inflammatory properties of the aqueous seed extract were confirmed using an in vivo acute inflammation model; we observed decreased leukocyte migration, myeloperoxidase activity and TNF- α and IL-1 β levels.
10	Gurvinder Pal Singh, Rakesh Garg, Sudeep bharwaj, Sandeep Kumar Sharma ²⁹	2012	Moringa plant anti- inflammatory test	Moringa plant extract has a good action against inflammation as the results of the test results of the use of moringa extract in herbal formulations are useful as anti-inflammatory and can be useful in primary health care.

4. DISCUSSION

Moringa oleifera, including herbal plants that grow in Indonesia, is a natural resource that is often used for health. Herbal plants are used to treat disease and improve body health. Moringa oleifera herbal plant extracts which contain various phytochemicals such as alkaloids, flavonoids, steroids, glycosides and others can be used as antimicrobial, anti-inflammatory, antioxidant, anticancer, antidiabetic and other benefits.³⁰⁻³³

Moringa oleifera is a plant that can be consumed as a vegetable and drink. A wide variety of nutritional and medicinal potential have been attributed to its roots, bark, leaves, flowers,

fruits, and seeds.²⁴ *Moringa oleifera* has been used for the treatment and management of different diseases in traditional medicine for its antihypertensive, antioxidant, antimicrobial, antibacterial, antispasmodic, antifungal, anti-inflammatory, anti-TB, analgesic, antidiabetic, diuretic, lowers cholesterol, and hepatoprotective properties. Moreover, it can exhibit hypolipidemic, antiatherosclerotic, and immune-boosting effects.^{34,35}

For this reason, the moringa plant is trusted in the community and research is rampant regarding its usefulness in the human oral cavity. *Moringa oleifera* with its active ingredients can be used as an antibacterial agent in the oral cavity. For example, inhibiting the activity of bacteria that cause dental caries, dental plaque, gum disease, and others, or in other words, this *Moringa* plant functions as an antimicrobial. Not only that, *Moringa oleifera* also has potential as an anti-inflammatory in the human oral cavity. This is because the active substances in the moringa plant can reduce the inflammatory response in the oral cavity. So, the systematic aim of this review is to discuss more deeply the potential of the *Moringa* plant as an antibacterial and anti-inflammatory in the oral cavity.^{35,36,37}

Moringaoleifera Plants as Antibacterial in the Oral Cavity

The use of medicinal plants as natural ingredients to cure infection is increasingly being chosen by the public because of their relatively small side effects as well as in the human oral cavity. Plants that can be used as medicine and are widely cultivated in Indonesia are the *Moringa oleifera* Lam plant. *Moringa* leaves contain various beneficial chemicals. The results of previous studies stated that *Moringa* leaf extract has an inhibitory power against *Staphylococcus aureus* and *Escheria coli* bacteria that are resistant to antibiotics.³⁸⁻⁴⁰

Testing for the antibacterial activity of the moringa stem bark methanol extract (against *S. aureus* and *E. coli* bacteria using the well diffusion method. Positive results are indicated by the formation of a clear zone around the plant, after incubation for 24 hours at 37°C. The results of testing the activity of the moringa stem bark methanol extract with concentrations of 1%, 2%, 3% and 4% against the *S.aureus* and *E. coli* test bacteria showed that the extract had antibacterial activity by forming a clear zone. The inhibition zone resulted from testing the moringa stem bark extract expanded with increasing concentration.^{10,41,42}

Pseudomonas aeruginosa is a bacteria that can cause burns, ear infections and wounds after surgery. *P. aeruginosa* bacteria is an opportunistic pathogenic bacteria that can cause an invasive condition in patients with critical illness or patients with very low levels of immunity. Generally, these bacteria are often found as a cause of nosocomial infections in hospitals. The *P. aeruginosa* bacteria tested were categorized as resistant to the antibiotics amoxicillin, erythromycin, and chloramphenicol, but they still had criteria that were sensitive to the antibiotic ciprofloxacin.^{14,46-48}

Based on previous research, it was found that the ability of the antibacterial activity of *Moringa* leaf extract against *P. aeruginosa* bacteria was due to the chemical content in the *Moringa* leaf extract. Flavonoids and tannins are known to inhibit the growth of Gram positive and Gram negative bacteria. *Moringa* leaves extracted using ethanol solvent can attract most of the active compounds in the moringa leaves, so that the extract can inhibit

bacteria that are experiencing growth. This can occur because of the secondary metabolites in Moringa leaves such as flavonoids, alkaloids and other phenolic compounds.^{14,10, 49}

The methanol extract of Moringa has shown various inhibition zones in all tested pathogens due to the isolation of biologically active biomolecules, in this study the isolation of five Moringa oleifera compounds symbolized by MO-1, MO-2, MO-3, MO-4 and MO-5. Where MO2 and MO3 showed a broad spectrum of antibacterial activity against all tested bacteria as evidenced by the presence of an inhibition zone at a concentration of 5 µg / ml. These compounds were identified MO-2 as Niazinin-A, MO-3 as β-Stigmasterol, MO-4 as Quercetin-3-O-β-D-Glucopyranoside and MO-5 as Kaempferol-3-O-β-D-Glucopyranoside. The remaining MO-1 compound as β-sitosterol was found to be inactive in the study.^{19,38,41}

The antibacterial properties found in this Moringa plant make this plant widely used and utilized in dentistry. Moringa plants from leaves, fruit, seeds, flowers, bark to roots have tremendous benefits for humans. The use of moringa plants in dentistry acts as an antibacterial agent in oral bacteria, namely Porphyromonas gingivalis, Prevotella intermedia, Staphylococcus aureus, and Streptococcus mutans. Therefore, moringa plant extracts can be used for the treatment of the oral cavity associated with the role of these pathogenic bacteria, such as gingivitis, periodontitis, mouth sores, caries, and root canal treatment.^{15,33}

The use of Moringa plants in the prevention of dental caries is an interesting topic to discuss. The biofilm in the oral cavity is structurally and functionally regulated by a balance of bacteria. However, when the proportion of *S. mutans* increases due to environmental changes, the oral biofilm becomes a cariogenic biofilm. Cariogenic biofilms are more resistant to antibiotic agents because of the abundance of glucans that act as a physical barrier. Also, the exopolymer matrix, which includes glucans, has a strong negative charge and inhibits the diffusion of the positive charged antibiotic agent in the biofilm. So it takes a fairly good antibacterial activity for this. Based on the research, it was found that Moringa leaf extract has antimicrobial activity against cariogenic bacteria and biofilms. EtOH (ethyl alcohol) moringa extract may be more effective against caries-related bacteria and biofilms compared to DW (aquades) extract. These results indicate that the leaves of the Moringa plant are potential candidates for preventing dental caries.^{16,17}

Root canal treatment requires ingredients with antibacterial properties for successful treatment results. The use of herbal plants is often an alternative choice. The combination of Moringa plants with *Azadirachta indica* plants showed an antibacterial effect against *E. faecalis* without toxicity at low concentrations. The results showed that the bactericidal concentrations for *A. indica* and moringa were 25 µg / ml and 75 µg / ml, respectively. Then the cytotoxicity of the methanol extract of *A. indica* and moringa plants inhibited 50% of cellular viability at a concentration of 70 µg / ml.^{17,26}

The antimicrobial properties of the moringa plant can be used to formulate new dental products to control oral pathogens. Dental products such as toothpaste with the use of moringa plant extracts act as anti-caries and maintain gum health. Not only that, products

such as mouthwash are also effective in lowering muut cavity bacteria. Gel for the treatment of oral thrush is also a new product in dentistry that is being developed. Likewise in the endodontic world, Moringa plants are used as an alternative ingredient in root canal treatment.^{17,28,35}

The discovery and availability of moringa for clinical use in dentistry, enhancing its economic sustainability in developing countries. Much research has helped validate the nutritional and medicinal value of the moringa plant in Southwest Nigeria and Africa as a whole, which is now widely adopted as an herbal preparation and tea complement in various parts of the world. The medicinal properties and active components of moringa also make it valuable for various therapeutic purposes including in the treatment of diseases or infections of the oral cavity due to the antibacterial properties possessed by the moringa plant.^{1-3,18}

Moringaoleifera plants as anti-inflammatory in the oral cavity

Health is one of the important factors that play a role in human life. This causes humans to focus on the health of their bodies, the health of their oral cavity is often neglected. Oral health is also an important factor that plays a role in determining the quality of life of people. It is not uncommon for the human oral cavity to experience swelling which causes pain, chewing disorders, and can affect the quality of life. So, we need a drug that can reduce or overcome these problems.^{50,51}

One alternative that is widely used in the medical world besides the use of pharmaceutical drugs is the use of drugs from herbal plants. Moringa plant is a medicinal plant that has properties to reduce or even treat swelling that occurs, including in the human oral cavity. Moringa plant has therapeutic properties because of its distinctive properties. Potential anti-inflammatory activity of NFκB activation. Moringa plant can exert anti-inflammatory effect on the hind leg edema of male albino rats induced by carrageenan, and its seed extract has been reported to reduce the weight of the distal intestine which is a marker of inflammation. This is the reason why moringa can be used as an anti-inflammatory in the oral cavity.^{21,33}

Inflammation is a normal protective response mechanism against tissue injury caused by physical trauma, hazardous chemicals or microbiological agents. The main signs and symptoms of inflammation are redness, pain, swelling, and heat. Similar research on moringa and anti-inflammatory plants, namely the ethanol extract of Moringa oleifera L. leaves has anti-inflammatory effects on male white rats. The results of this study indicate that the ethanol extract of 200 mg / kgBW Moringa leaves has the best anti-inflammatory effect compared to the ethanol extract of 100, 150 mg / kgBW, but it is still below NaDiclofenac. Based on the phytochemical screening that has been carried out, the results show that the Moringa leaf extract positively contains flavonoid compounds. This compound plays a role in providing benefits and biological effects.^{21,22,43}

The anti-inflammatory effect is thought to be due to the activity of secondary metabolites contained in the ethanol extract of Moringa leaves, namely flavonoids. Flavonoids inhibit arachidonic acid and lysosomal enzyme secretion from the endothelial thereby inhibiting the proliferation and accreditation of the inflammatory process. The inhibition of the release of

arachidonic acid from inflammatory cells will cause the lack of arachidonic substrate for the cyclooxygenase and lipooxygenase pathways. Lysosomes contain proteases and other enzymes. Lysosome protease is a chemical mediator of inflammation which has direct enzymatic activity so that inhibition of this enzyme can reduce inflammation. Another study related to similar results found that aqueous extract of Moringa leaves (200 mg / kg) had shown anti-inflammatory activity in all inflammatory models. The data obtained from this study have shown that the aqueous extract of Moringa leaves can help in preventing inflammatory conditions and hopefully serve as a good biological resource to produce available herbal formulations that may be equally potent and cost-effective than conventional synthetic drugs has existed.^{33-37, 53}

In another study regarding moringa plant as an anti-inflammatory in the oral cavity it was found that before treatment and after treatment with moringa plant extracts reduced inflammatory cytokines in the gingival tissue and reduced inflammatory symptoms in the periodontal model of mice. This is what makes moringa plant extracts an active ingredient in the treatment of gingivitis and periodontitis in humans by reducing inflammatory cytokines and reducing inflammatory symptoms that appear clinically. The water and ethanol extracts of moringa plants, especially the stem bark, showed% inhibition after 5 hours, a maximum of 27.27 and 30.30%, a significant reduction of $P < 0.01$ and $P < 0.05$ in edema volume at a dose of 300 mg / kg body weight, which is comparable to the standard drug, namely Diclofenac sodium. Standard drug showed 44.44% (25 mg / kg) body weight inhibition and a significant value of $P < 0.01$. The percentage of leg edema was found to be better with alcohol extract than with water extract with Moringa plant.^{16,33}

Moringa plants (leaves, stems and roots) have been shown to produce a variety of biological activities, including anti-atherosclerotic, immune-enhancing, anti-cardiovascular disease, antiviral, antioxidant, antimicrobial, anti-inflammatory and tumor-suppressing effects. The significant inhibition of tumors produced by oral administration of the moringa plant may be due to the high bioavailability of the extract. As for the cytotoxic test and anti-inflammatory activity of moringa plants, it was found that dilute seed extract and cMoL had the potential to be cytotoxic against peripheral blood mononuclear cells, while the dilute seed extract and WSMoL were not cytotoxic against these cells. None of the moringa plant preparations tested improved erythrocyte haemolysis, and the aqueous seed extract did not cause systemic toxicity in mice. The seed extract and lectins exhibited in vitro anti-inflammatory activity on LPS-stimulated macrophages by regulating cytokine and NO production. The anti-inflammatory properties of the aqueous seed extract were confirmed using an in vivo acute inflammation model; we observed decreased leukocyte migration, myeloperoxidase activity and levels of TNF- α and IL-1 β .^{28,29,52,53}

Of the three samples of moringa plants that were screened in this study for anti-inflammatory activity, two PKM varieties (1 and 2) showed activity while local moringa (sample Z-11) was found to be inactive. This was unexpected given that the genetics and chemistry of plants even within the same species can vary widely. Therefore, it is important to carefully choose the variety or source of moringa to achieve maximum flavonoid accumulation and anti-

inflammatory activity. Given that several plant products exist on the commercial market as sources of the same flavonoids, the high concentrations found in these species will be attractive as new sources of these bioactive natural products. Moringa plant itself has anti-inflammatory power at a dose of 140 mg / kgBW of $24.30 \pm 2.960\%$ and reduces COX-2 expression $46.37 \pm 6.434\%$ so it plays a very important role in the anti-inflammatory that occurs. So it can be concluded that the moringa plant extract has a good action against inflammation as the test results of the use of moringa extract in herbal formulations are useful as anti-inflammatory and can be useful in primary health care including anti-inflammatory in the oral cavity.^{26,27,54,55}

5. CONCLUSION

The current literature shows that moringa has great potential as a natural antibacterial and anti-inflammatory agent in the oral cavity. Moringa plant can be formulated as a mouthwash, toothpaste, chewable lozenges or even other products that can inhibit bacteria in the oral cavity, so this systematic review can be used as a reference in the development of moringa plants in the future, especially dentistry.

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